OCCASIONAL PAPER NO. 202

RECORDS OF THE
ZOOLOGICAL SURVEY OF INDIA

Ecology and biogeography of Odonata with special reference to Indian Fauna

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RECORDS OF THE ZOOLOGICAL SURVEY OF INDIA OCCASIONAL PAPER

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INTRODUCTION

Dragonflies are good friends of man. According to Fraser (1933), "Life in the tropics would soon become unbearable were it not for the beneficient work of vast numbers of dragonflies acting as scavengers of the atomosphere"

These insects are inhabiting the world for nearly 220 milllion years along with cockroaches and mayflies. The oldest dragonfly is called Protodonata. The Protodonata has been discovered from the Carboniferous rock along with ancestors of modern cockroaches and mayflies. The rock which bears clue to the origin of insects has not yet been discovered hence the ancestor of Protodonata can not be defined. It is interesting to note that dragonflies closely related to modern Odonates, have appeared in the Mesozoic era.

The ecology of Odonata is based on the selection of the habitat. This is mainly done by their eyes, movable head and flight power. They have got the highest development of the compound eyes (Huxley, 1953). Eyes occupy almost the whole of the head and the number of facets vary from 10,000 to 28,000 in adults. Corbet (1962) : from Ando (1957) has cited the variation in ommatidial numbers from 7 (common) to 270 in each compound eye of second instar larvae of 23 genera under three suborders. The head is movable and is set on the prothorax or the neck. The head can be twisted sideways 180^0, backward 70^0, forward and downward 40^0. The thorax is divisible into prothorax or the neck bearing one pair of legs and a synthorax (fused meso-and metathorax) bearing two pairs of legs two pairs of wings. The synthorax is very oblique, the anterior part has become the dorsum, carrying wings on the back and legs are thrusted forward beneath the head. Three pairs of legs form a sort of basket to catch the prey. The widths of hindwings, especially in Anisoptera, help them to capture preys while on wings and elude the predator. These insects can fly backward, move vertically upward, like a helicopter or stop in turn in the midst of the rapid progression, as if they have been rammed into. This could be made possible due to adjustment of the centre of gravity between the bases of the wings and leaves a sharp contrast with all other living insects (Mitra,1999). These features have selection value and have helped Odonata to proliferate into nearly 7,OOO species in the world.

SHORT HISTORY OF ODONATA

The Protodonata, *Meganeura monyi* Brongniart has been recorded from the top of the Carboniferous series in the coal measures at Commentry, near St.Etienne in France. Meganeurids have also been collected from the Permian, the last phase of the Palaeozoic era. In the Lower Permian we get Protozygoptera and in the Upper Permian we get true

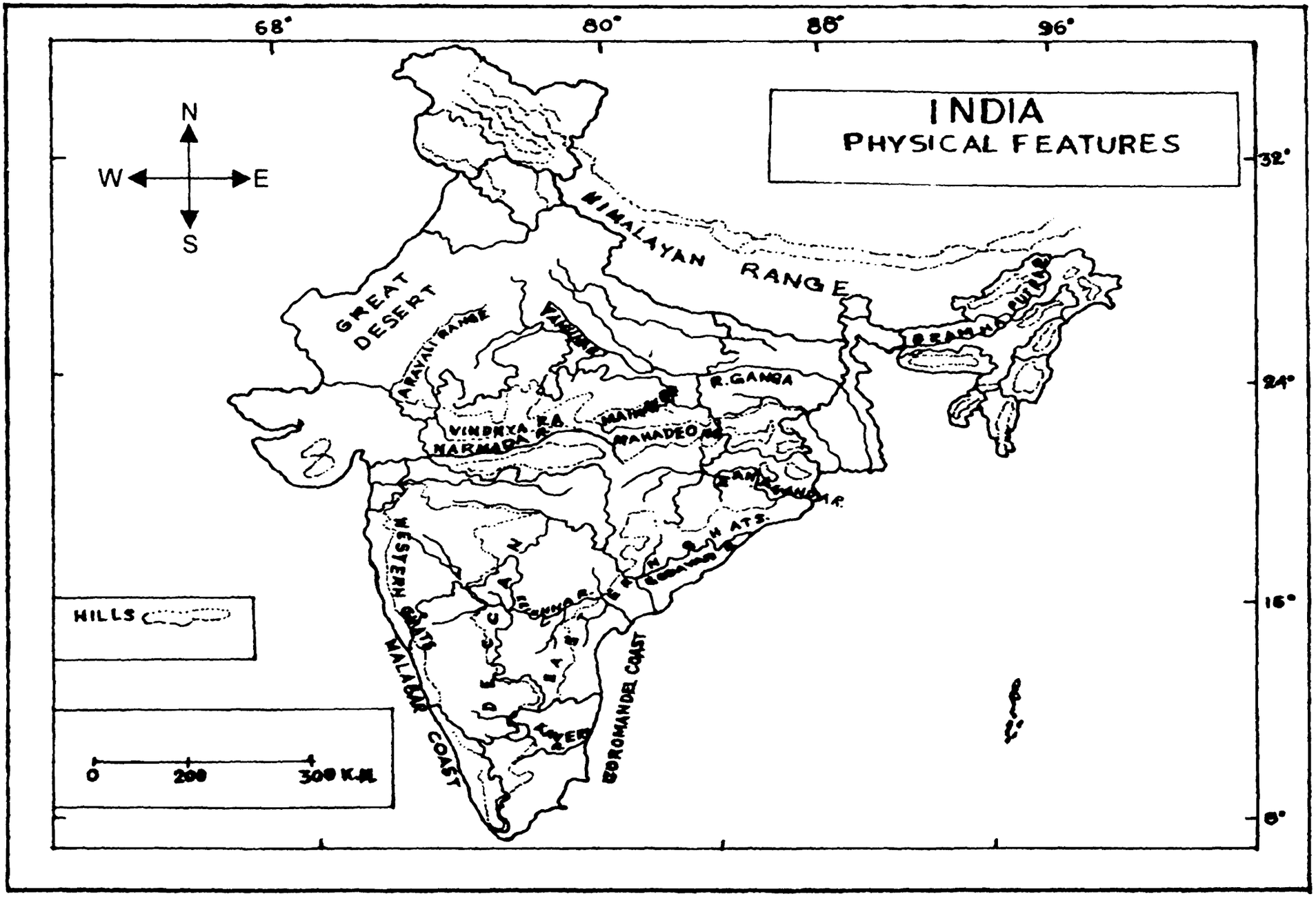

Fig. 1. Physiography of India : Showing major features of physical ecosystems.

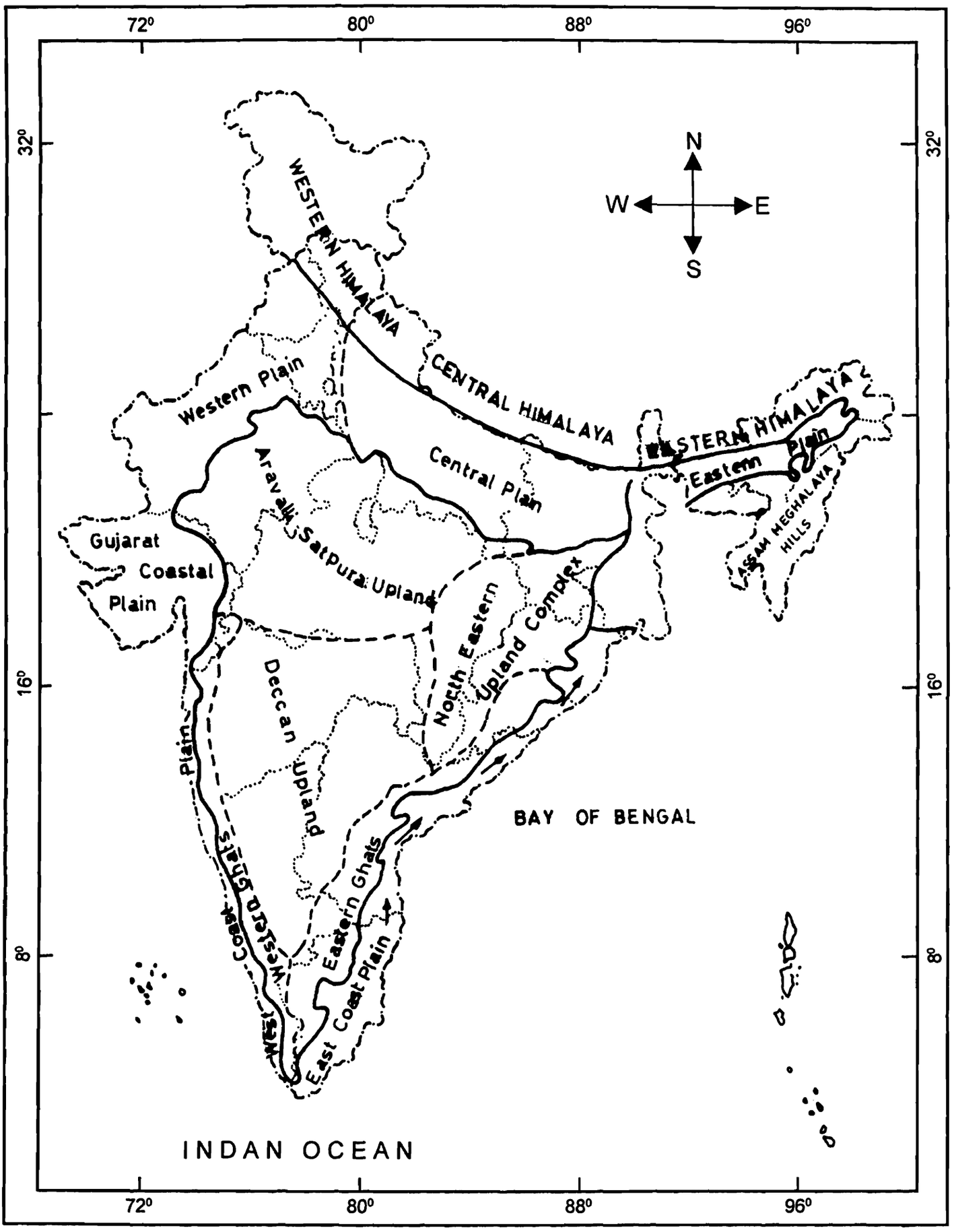

Fig. 2. States of India : Parts of physiographic divisions.

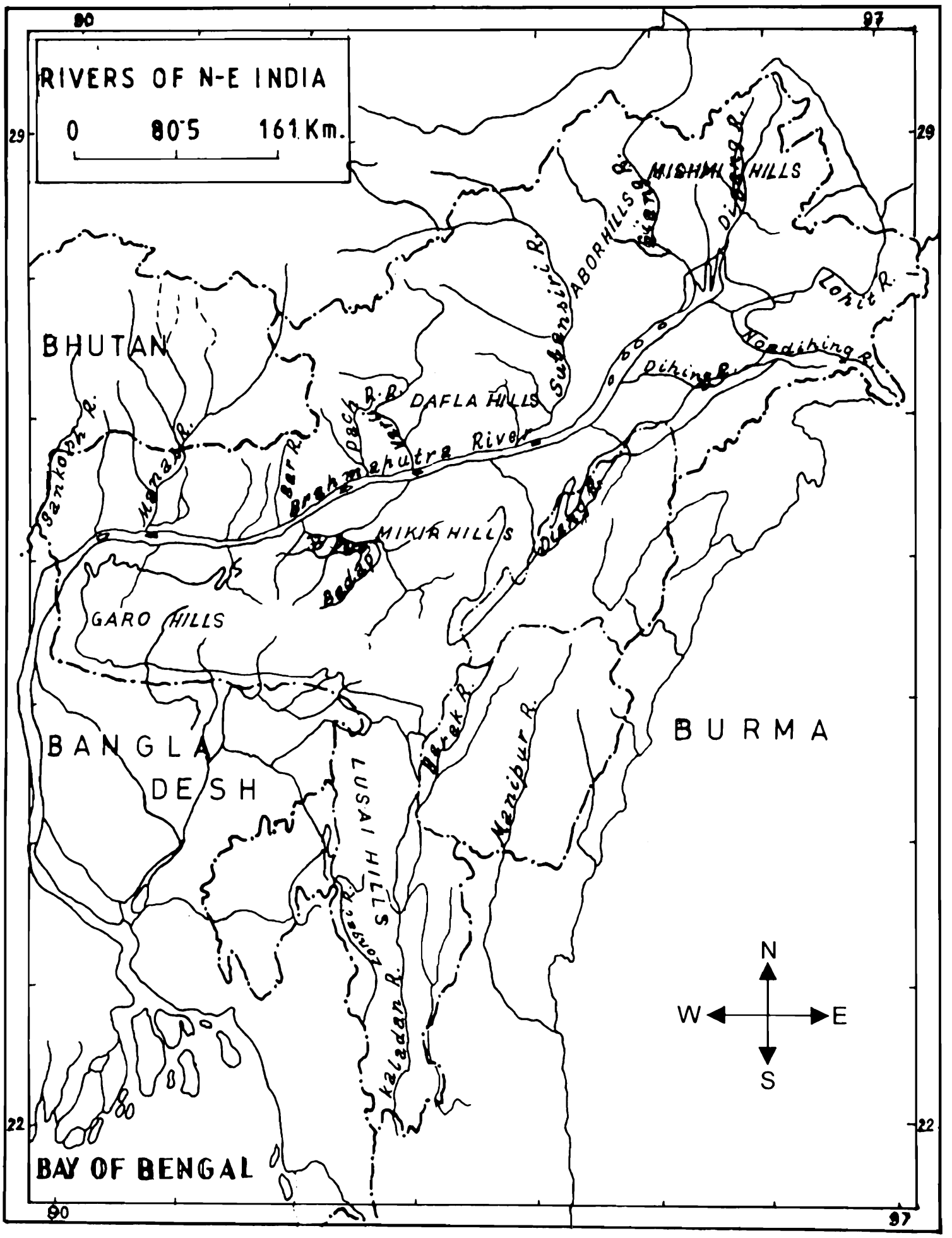

Fig. 3. Rivers in North-east India.

Zygoptera. In the Mesozoic we come across the Anisozygoptera. Solenhofen beds of Jurassic give us representatives of recent families of Zygoptera for the first time and close relatives of certain present day Gomphids, Cordulegasterids and Petalurids. In Oligocene first corduliid, ***Stenogomphus*** has been seen. In lower Miocene Coenagrionids, Aeshnids and Libellulids have been recorded. The first larva (probably of an Agrionid) has been collected from the Jurassic beds of Siberia.

ADAPTATIONS IN DIFFERENT PHASES OF LIFE

I. Probable ecology of fossil Odonata

The wing expanse (27 inches) of meganeurids raises questions about their food habits. Modern dragonflies consume quite a large number of insects. Corbet (1960) has reported that Aeshnids consume species of *Sympetrum.* Bhargava and Prasad(1974) have recorded the preying of *Orthetrum sabina* upon *Palpopleura sexmacullata,* Mitra (1990, 1994) has presented a list of insect-foods of dragonflies.Hence it is conjectured that meganeurids might have been dependent on ancestors of ephemeropterans (Corbet,1960). With the increase of population and diversity in Odonata, populations and diversity of food have also increased. For instance present day foods of Odonata which include Diptera, Hymenoptera, Lepidoptera etc. have evolved in Mesozoic. The birds have also evolved in Jurassic. Therefore, it is conjectured that present day Odonate food habit did not develop before Jurassic. The predator-birds have also not appeared before Mesozoic. On the other hand fishes and amphibians have evolved before the appearance of Protodonata. It is, therefore, considered that fishes and amphibians might have played important roles in controlling the populations of dragonflies in the earlier stages. They might have consumed the larvae of meganeurids.

II. Conspectus of ecology of modern Odonata

(a). ***Adults :*** Adults are terrestrial (aerial) and lay eggs in water. It is not clear in which geological epoch, adults started laying eggs in water. Adults fly near water bodies with bushes on the fringes, so that both adult and just emerged imago get food and place for rest. They feed on adult insects, sometimes intraspecies fight for food occurs (Mitra, 1994). There are territorial fights; which sometimes depend on size of insects (Mitra, 1994). Intercontinental and local migrants are visible. Corbet (1962) has opined that to understand the behaviour of adult Odonata several factors have to be taken into account - the important ones being age, sex, situation, time of the day and the local weather. Mitra (1994, 1999) has cited the behaviour of adult Odonata in wild conditions in different ecosystems in India. Corbet (*op. cit*) has divided the adult life into three parts : prereproductive or maturation period, reproductive and postreproductive period.

Pre-reproductive period : In this part the just emerged imago waits for sometime on a stick or in a bush. After drying up of the wings and the body, the imago leaves its resting site and performs all activities of a matured individual except the breeding activities.

After maturation the imago tries to find out the suitable breeding ground. The range of period necessary for maturation of zygopterans extends from 2 days to 30 days (Corbet,1962; Johannson, 1978; Lutz,1968). In case of anisopterans the period varies from 6 to 45 days (Pajunen,1962; Schmidt 1964). The maturation period in case of males is usually shorter than females. For example, males of *Plathemis lydia* take 8-14 days whereas females take 13-24 days. According to Corbet (1962) the males of *Anax imperator* need 7-12 days and females take 13-16 days. Corbet (1980) has reported that in a few species the maturation period serves as the aestivating stage and lasts for 8-9 months. Sometimes it varies according to latitudies. In *Lestes sponsa* the maturation period extends to about 20 days at all places lying between 40^0 N to 58^0 N. This period lengthens progressively south of 40^0 N. to about 100 days near the southern limit, i.e. 34^0 N. of the occurrence of the species (Uéda,1976). The importance of longitude and altitude in the life history of different species of Odonata needs to be studied thoroughly. In India it has been observed that *Orthetrum sabina sabina* breeds in plains during the cool season. i.e. November to January (sometimes in other seasons also (Prasad, Pers Comm.) but in Dehra Dun (Western Himalaya) the species breeds throughout the year (Mitra1994). During the maturation phase the body colour changes. In many cases the colour of immature males become identical to adult females. The difference in colour and other features sometimes causes confusion in identification. Fraser (1933, 1934 & 1936) has described immatures of several species.

Reproductive period : In this phase the imagos show breeding activities. Corbet (1962) believes that the reproductive activities of adults help to determine the flying seasons. Corbet (1980) has observed in case of the breeding season is discrete the duration of the reproductive period depends upon the emergence curve and on adult longevity.

In the permanent habitats of humid tropics the flying season is continuous. In other cases of tropics the flying season depends upon the seasonal rain; and outsides the tropical belt the flying season is not continuous. Species of these regions are grouped according to their flying period. Trottier (1971) has reported that in those species which usually maintain the resident population in the tropics as well as in temperate latitudes, the flying season becomes shorter at higher latitudes. In India *Orthetrum sabina sabina* breeds during the cool season (November to January) in the plains (sometimes in other seasons also (Prasad, Pers Comm.)); but in Tamil Nadu, the state which receives double monsoon and in Dehra Dun the species breeds throughout the year (Anil Kumar, 1990; Kumar, 1979). In this case the altitude, higher latitude and the effect of the monsoon play the role.

On reaching the breeding ground the potential breeders do not usually leave the place. The roosting sites of these adults range from less than one metre to more than 200 metres from the mating sites (Hasan 1976; Parr & Parr, 1974; and Ueda, 1976). This has also been observed in Calcutta and on the bank of the river Sankosh in Goal Para of western Assam.

Reproductive behaviour : Males usually arrive at the breeding site earlier than females both in season and day hour. Males of some species display courtship behaviour. Males

establish territories; they drive out all males of all species having identicial body size (Mitra,1994).

Dimension of territories depend directly on male populations (Corbet 1980, Mathavan 1975, Mitra, 1994); area of the breeding sites and some intrinsic factors (Mitra 1987,1990 & 1994). The territory is defended both in vertical and horizontal directions ((Mitra *op.cit*). Territoriality has also been observed in *Pseudagrion decorum* in central India by Srivastava *et. al* (1994).

The male captures the female with anal appendages and sometimes the pair remain in tandem before copulation. In *Orthetrum sabina,* Mitra (1994) reported that if the copulatory wheel becomes week the pair forms a new wheel and males wait when there is derth of receptive female. Kumar and Prasad (1977) reported the breeding of *Neurobasis chinensis* in Dehra Dun, Uttaranchal, time taken by the pair in the whole process. Corbet (1962) classified undisturbed copulation, on the basis of duration --- (a) short (3 to 17.5 sec.), (b) medium (1.5 to 5 minutes), and long (5 to 340 minutes).

Usually copulation takes place near water bodies but not always. Mitra (1999) has reported that a pair of *Diplacodes trivialis* copulated on grass field and after copulation is over neither of the pair took care of the other and the female carried the fertilized egg to lay eggs in suitable water. Sometimes pool breeding species copulate on trees (Mitra 1994). Interspecies tandem flights have also been recorded (Bick & Bick 1981; Mitra & Lahiri 1972). Apparently these observations contradicts Gause's principle, but microecological studies may reveal the truth.

Distinctive characters which probably help as a tool in visual recognition or sex, are pale coloured areas on terminal segments of abdomen particularly of certain forest dwelling species (Fraser, 1933); and the opalescent patches on the hindwings of *Tholymis tillarga* (Fraser, 1936). According to Buchholtz (1951) in european species of *Calopteryx*, the male recognizes the female by four criteria- the size of female's body, size, colour and transparency of her wings. In *Ischnura elegans* the distal pale spot on the abdomen of the female plays the key role in attracting the male to grasp her (Corbet, 1962).

After copulation the female lays eggs at suitable breeding site which is suitable to the larvae as well as adult structure and ecological preferences (Pinhey, 1978). It also depends on the microgeographic distribution of adults and microhabitats of larvae. A newly formed dam, for example, is occupied first by species with wide microgeographic distribution and by those characteristic features of later stages of ecological succession (Corbet, 1980). Sometimes man made habitats are also utilised. Kumar (1973) and Mitra (1997, 1998, 1999) have recorded larvae of *Brachythemis contaminata, Crocothemis servilia servilia, Bradinopyga geminata* in Dehra Dun and Calcutta from cemented tanks. Gambles (1986) has reported the occurrence of larvae of *Bradinopyga straachani* and *Pantala flavescens* in small rain water puddles in West Africa. Suri Babu *et. al.* (1996) have recorded existence

of variation in respect of oviposition site, period, as well as number broods per year in Anisoptera.

Eggs may be laid exophytically or endophytically; it may be in tandem with male or not; the male may or may not guard the ovipositing female (Mitra, 1987, 1988). Tyagi and Miller (1991) have reported that male *Ictinogomphus rapax* guards the ovipositing female. Among zygoptera in *Ischnura* and some other genera the females lay eggs without the assistance of the male (Bick, 1972; Parr, 1973; Rowe, 1978).

How dragonflies find out water : Mitra (1999) has reported that in the suburban of Calcutta *Pantala flavescens* occasionally shows ovipositing behaviour on the shining surface of the automobiles. Similar observations has also been made by Nevile (1960) of the same species in Ghana. Wildermuth (1997) has reported that adults recognize water by the polarized light reflected at its surface. In experimental condition it has been observed that all species (Coenagrionids, Corduliids and Libellulids) have reacted intensely on dark brown perspex whereas they have avoided the aluminium foils, white, yellow and blue plastics instead of high polarisation degree at different wave lengths. Wildermuth (*op. cit*) has also informed that generally the positive reactions of adults are evoled by highly polarized light with horizontal e-vector and low degree of reflection. Finally he (Wildermuth) has contended that the POL-System operates at a long wavc range (ca 630 nm) and that the polarised light is detected by a two channel analyzer system of more or less orthogonally arranged microvilli of the ommatidia in the ventral eye,capable of distinguishing the polarized light by water surfaces from the unpolarized light.

Post reproductive phase : A dragonfly in this phase of life can be identiffied by observing the dullness of body colour, the wings often become covered with thin film, and the gonads regress. They usually do not show breeding activities.

Longevity : Borror (1934), Corbet (1962, 1980), Gambles (1960), Kormondy (1959), Moore (1951), Parr & Parr (1972) have discussed about the longevity of dragonflies. It is believed that among the populations of the same species the average longevity varies a very little (Mitra, 1999). Excluding the maturation period, the average longevity as is known so far for Zygoptera one to two weeks, which may be 5 to 8 weeks 2 to 3 weeks and 3 to 6 weeks in case of Anisoptera (Corbet 1980). If the maturation period is added for species which neither hibernate nor aestivate after emergence, the longevity in case of Zygoptera ranges from 7 to 9 weeks and in case of Anisoptera is 8 to 9 weeks (Corbet *op.cit*).

Death : Death of imagoes may be caused by automobiles, accidents, starvations, predators, and some other reasons that have been cited by Corbet (1962, 1980), Kennedy (1950), Kiauta (1965, 1971), Kumar & prasad (1977), Mitra (1974, 1977, 1990, 1992, 1994, 1999), and Ram & Prasad (1978). Mitra (1977 & 1994) has also cited cases of natural deaths (deaths without external injury), among the predators Domestic Cat, birds (***Passer domesticus***, ,*Acridotheres tristis, Corvus splendens*), lizards (*Hemidactylus brookii, Calotes versicolour*),

spiders (*Crossopriza lyoni, Plexippus paykuli*) have been recorded from eastern India. Mitra (1977, 1994) has also cited several examples of death due to unknown cause. In addition to the above rain also acts as killer. Since due to rain odonates body becomes soaked and make them immobile due to which body becomes cold. It has been recorded that migratory species, *Pantala flavescens* can remain in starvation more than 48 hours, while *Brachythemis contaminata* cannot remain 12 hours in starvation.

Behaviour during the rain : Dragonflies usually go under shelter to avoid the rain. Lahiri (1975) has cited how a *Bayadera* specimen took shelter under a wire during the rain. Mitra (1999) has cited how a pair of *Neurothemies tullia tullia* adjusted their bodies during the rain.

Behaviour during the solar eclipse : Mitra (1996) reported that dragonflies stopped activities when the aerial temperature reached 23^0 C. They resumed their activities when the temperature gradually raised. Although light was sufficient. Birds were pecking of their foods, parrots were returning to roost. Kiauta and Kiauta (1999) have analysed the behaviour and contended that intensity of light was the responsible for the inactivity. This might be possible in the western Europe where dragonflies are adapted to cold; but in case of tropical country like Calcutta,animals are adapted to higher temperature. Hence reduction of aerial temperature might have played the key role more than light in the activities of dragonflies during the solar eclipse in Calcutta.

Thermo-regulation : Regulation of body temperature is very important biological means for survival. Corbet (1980) opined that ability of dragonflies to maintain a relatively constant body temperature is related to their body size as well as their behaviour. Corbet, (*op. cit.*) believed the perchers regulate their body temperatures primarily by making postural adjustments which involve both body and wings changing the exposure of body parts to the sun. Means of thermo-regulation include rest in shaded as well as the sunny places as per seasons and flapping of wings (Corbet 1962, Mitra 1990, 1992, 1994 & 1999). Basking in the sun in a snow cladded area in the Western Himalaya and during the cool season (min. temp. 12^0 -16^0C) in the plains also help in thermo- regulation. The author noticed in January, 1999, when the minimum temperature of the air was 16^0C a male example of *Crocothemis servilia* was basking in the sun in the early morning before undertaking the daily routine activities. When the aerial temperature reached 22^0C, the specimen flew away. In the plains (including Rajasthan) the activities of Odonates in 24-cycle vary with the variation of diurnal temperature. In April-May, 1990,the author noticed in Azamgarh, eastern Uttar Pradesh, *Ceriagrion coromandelianum* used to remain in the bushes from midmorning (10 A.M) to late afternoon when the ambient termperature ranged from 35 ^{0}C to 36 ^{0}C. Similar observations could also be made in cases of *Pantala flavescens*, *Tholymis tillarga* in Calcutta.

Roosting behaviour : Roosting is a biological phenomenon for rest. Diurnal animals roost in the night and nocturnals in the day. Some hibernate or aestivate in the roosting

sites. Roosting is very important in relation to the breeding site of dragonflies. The breeding site must be near a place which contains sufficient bush for roosting of adults and place for rest of the just emerged imago (Mitra 1990). The place for roosting in the afternoon or evening may be less than 1m to 200m or so from the breeding area (Corbet 1980). Fraser (1944) described aggregations of roosting *Bradinopyga geminata* in India. Mitra (1999) reported similar incidence in Jodhpur (Rajasthan) during March-April, 1980. And in case of *Brachythemis contaminata* on the walls of an well in Calcutta. Mitra (1994) has also recorded aggregations of *Aciagrion pallidum* and *Ceriagrion olivaceum* on tall grasses facing the sun on the bank of the river Sankosh in Jamduar forest(Assam-Bhutan border) in the Goalpara district of Assam during December 1973. Miller (1989) has opined "..... that communal roosting in *Potamarcha congener* serves to reduce nocturanal predators, and this enhances survival in a long-lived species which may remain in reproductive diapause throughout a long dry season" But Odonates are sun loving insects. Their predators are also sun lovers. Nocturnal predators of dragonflies are not very well known. Hence it is presumed that in the past some other factors might have played some role for this type of behaviour. The evolutionary priority of cause and effect cannot therefore be determined (Mitra 1999).

There is no evidence of homing in dragonflies. But Gamble's (1971) observations on the associations of *Lestes virgatus* returning to the same spot in consecutive nights is interesting.

Communal roosting in *Bradinopyga geminata, Potamarcha congener, Lestes virgatus, Ceriagrion olivaceum, Aciagrion pallidum* may throw some light on the formation of social/ communal aggregations in insects.

Flight and its significance : Flight and migration help in dispersal and geographical distribution. Corbet (1999) discussed spatial displacement by flight. Different species of odonates fly at different heights but none regularly fly above 4 m. According to Corbet (1981) flight is probably determinad by the distribution of food species. Mitra (1994) however, has opined that other factors in the past might have determined the height of the flight of dragonflies to which the food species of dragonflies have bccome adapted. The evolutionary priority of cause and effect, cannot therefore be determineed (sensu Cloudsley -Thompson, 1960, 1980) Continuous hovering of *Crocothemis servilia servilia* and *Pantala flavescens* over open fields during the midday in summer, in Calcutta, may be explained as a means of thermo-regulation; since no difference of temperature between the earth surface and at the level of flight has been noted. Flapping of wings, in this case, helps odonates to maintain the required body temperature. Kumar & Prasad (1981), Mitra (1994), Srivastava and Suri Babu (1997) have cited flight seasons of different species in Western Himalaya, Eastern India & Central India.

Migration : Fraser (1933) listed *Pseudagrion decorum, Pseudagrion microcephalum, Aciagrion occidentale, Onychargia atrocyana, Pantala flavescens, Hemianax ephippiger* as migratory Odonata in India. Among these *Hemianax ephippiger* and *Pantala flavescens* are

practically globe-trotters. Mitra (1974a,1999) has reported migratory flights of *Pantala flavescens* in Calcutta as well as in Sikkim (eastern Himalaya).

In Nearctic region *Anax junius* and *Pantala flavescens* occur from the tropics to North Canada (Corbet, 1980).

Matured individuals are carried to North by winds in early spring (Butler et. al, 1975). In this way they cross the bioclimatic zone, where larvae can survive in the winter (Trottier, 1966,1967). The larvae of such spring immigrants usually emerge in late and probably fly southwards as immatures roost en route (Corbet, 1980). This actully helps in the geographical distribution of insects.

Food and feeding behaviour : A good number of literature is available on food and feeding activities of Odonata. In general dragonflies feed on smaller insects including smaller dragonfly species. For example, Bhargava and Prasad (1974) have reported capture of *Palpoplaura sexmaculata* by *Orthetrum glaucum.* Prasad & Biswas (1981) have noted *Acisoma panorpoides* as prey of *Orthetrum sabina sabina,* Mitra (1990, 1994) has reported that *Agriocnemis pygmaea, Ceriagrion coromandelianum, Ischnura senegalensis* etc. are foods of different species of Odonata. In the list of odonate foods also come aphids, butterflies, moths, mosquitoes, flies, termites, ants, beetles etc.

Reaction toward shrinkage of habitats : Urbanisation has shrunk habitats of Odonates. Hence several species viz *Pseudagrion microcephalum, Ceriagrion coromandelianum Ceriagrion olivaceum, Ceriagrion cerinorubellum, Agriocnemis pygmaea, Onychargia atroayana, Neurothemis tullia tullia, Trithemis pallidinervis* have been collected from house in day time. *Gynacantha bayadera, Gynacantha dravida, Gynacantha rammohani, Hemianax ephippiger Orthetrum sabina, Brachythemis contaminata, Crocothemis servilia* and *Tholymis tillarga* have been captured from house in the night; while *Zyxomma petiolatum* has been collected from house both in day and night. Moreover, several species namely *Ictinogomphus rapax, Brachythemis contaminata Diplacodes trivialis, Pantala flavescens* and *Trithemis aurora* in India; and *Brachythemis leucosticta* in Africa follow mobile objects including man and animals. Corbet & Miller (1991) have reported that they have been successful in inducing the behaviour experimentally to a part of the existing population of *Brachythemis contaminata,* and they failed totally in case of *Diplacodes trivialis.* According to them (Corbet & Miller *op. cit.*) this is a predatory behaviour. If this is true then the part of the existing population of *Brachythemis contaminata* which responded to their experiment were hungry and those who did not respond they were not hungry. Probably that was the case in case of *Diplacodes trivialis.* But Mitra (1994) has conjectured that such behaviour is due to presence of unknown object at the habitat. Accidental deaths due to Automobiles have been one of the causes of death.

Larvae

(a) *Habitat preferences :* Larvae of Odonata develop in water. It is not clear in which epoch of earth's history dragonfly larvae started development in aquatic medium. Larvae

of protodonata are not available. Hence Tillyard has conjectured that larvae of Protodonata, probably used to develop in semiterrestrial amphibious swamp like condition. In support of this hypothesis studies on the life history of *Uropetala carovei* (White), a member of the primitive family Petaluridae of New Zealand reveal many facts. Corbet (1960) has reported Wolfe's study in following ways "Wolfe (1953) ... found that the larvae inhabit flooded burrows and clamber about amongst damp grass and moss, feeding on spiders, beetles and other terrestrial animals." According to Corbet (1980) there are certain Zygoptera which develop in small quantity of water that accumulates in the leaf base and the larvae of Megapodagrionidae, *Podopteryx selysi* (Foerster) develop in water contained in tree holes.

Accocding to Fischer (1964), Taketo (1971), and Willy & Eller (1972), larvae of certain species can survive for months even being out of water. After the review of several facts on the life history of different odonates, Corbet (1962) believes that the caudal lamellae act as a supplementary device which help in the survival of the larvae at critically low oxygen tension.

It is among larvae that we come across great diversity of forms and habits. It is, therefore, justifiable to think that the distribution of Odonata is practically dependent on larval adaptations to certain physical and vegetational conditions of the water as well as the nature of the substrate. For example, majority of Gomphidae and *Orthetrum* group of the family Libellulidae, live more or less in the mud. According to Kumar & Prasad (1977c) larvae of *Calicnemia miles* live in semiterrestrial conditions on damp soil with thick carpet like growth of mosses and fungi which grow near waterfalls on vertical hill rocks of Western Himalayas Larvae of *Anisopleura lestoides* remain concealed in crevices among small stones and pebbles in shallow water in small streams with current (Kumar and Prasad 1977c). Larvae of *Rhinocypha quadrimaculata* and *Rhinocypha trifasciata* remain under submerged stones and pebbles in the rapid flowing streams without any vegetation in the Western Himalayas. On the other hand larvae of *Rhinocypha biforata beesoni* remain hidden within the drifted debris in the shaded forest streams of Western Himalayas (Kumar & Prasad 1977 d).

Endophytics (Zygoptera and Aeshnids) require vegetation or floating debris in water in which to insert ova. Species belonging to the subfamily Gynacanthinae (Aeshnidae) prefer muds as ovipositing sites. Exophytics on the other hand, do not necessarily require the presence of vegetation although species of the primitave Tetratheminae of the family Libellulidae may lay eggs in fringe vegetations.

Since both imagos and larvae are insectivorous the nature of the surrounding environment's vegetation will be of less concern than in phytophagous species, except for those with inclinations to shades of forest conditions (Corbet, 1962).

Food and feeding behaviour : Odonate larvae feed on aquatic animals. According to Moore(1960) they feed on larvae of mayflies, aqautic beetles, bugs, fish fries and even earthworms which drop in water and show wriggling movements as they sink to the bottom.

Corbet (1962) has reported that *Aeshana umbrosa* and *Calopteryx maculata* larvae catch larvae of *Simulum venustum* : he continues that the gut contents of *Pantala flavescens* and *Anax junius* contain chironomid larvae. Larvae of *Pseudagrion salisburyense* attack Chironomid larvae and oligochaete worms in South Africa. Sebastian *et. al.* (1990) have tried to control the populations of *Aedes aegypti* with the aid of larvae of *Crocothemis servilia servilia* in Myanmar (Burma). In Dum Dum Park area (near Calcutta, India) larvae of *Bradinopyga geminata, Brachythemis contaminata* and *Crocothemis servilia* developed in open containers, for aquarium fishes, have been observed to attack mosquito larvae and oligochaete worms. Fish fries and seeds have been attacked in the absence of invertebrate foods (Mitra 1997, 1998)

Foods of larvae vary according to the positions of the larvae, in their habitats, sizes of preys and hunger of the larvae. They detect their preys by means of their eyes and mechano-receptors. They catch their prey by shooting the labium or palpi. Aravind Kumar (1996 : pers. Comm.) has made comparative studies on stomach contents and forage ratio of Zygopteran and anisopteran larvae in the Santhal Parganas of Bihar (India). Roy (1998) has observed that Rotifera, Cladocera, Rhizopoda and several aquatic insects form the maximum quantity (Percentage) of foods of *Ischnura* sp. indet; while in the guts of *Paragomphus lineatus* and an indeterminate species of Cordulegaster, Rhizopods are less in quantity than Rotifera, Cladocerans, Copepods and other aquatic insects and animal tissues. Roy (*op. cit*) contended that "...Due to utilization of food present at various trophic levels of the food chains, they have regulatory impact in the management of the aquatic ecosystems as well as their mere presence indicates healthy and non contaminated aquatic systems. Kumar & Kumari (1998) have studied the population density and species diversity of anisopteran and zygopteran larvae in a fish pond. They have concluded, " ... species diversity of anisopterans larvae varied from 0.337 to 1.909 bits with minimum and maximum values in July and November 1996 and from 0.650 to 1.933 bits with minimum and maximum values in March and November 1997 respectively." In case of Zygopteran larvae, the species diversity (H) varied from 0.721 to 1.970 bits with minimum and maximum values in January and April 1996 and from 0.672 to 1.901 bits with minimum and maximum values in February and October 1997 respectively; concentration of food in different months preferred by Anisoptera and Zygoptera is responsible for the ratio." Mukherjee (1971) cited following birds as predators of larvae, Cattle Egret (*Bubuleusibis coromandus*), Eastern Large Egret (*Egreta alba moesta*), Smaller Egret (*Egrrettai intermedia*), Little egret (Egretta g. grazetta).

Effects of pollutants on larvae : Serveral scholars have started studies on the effects of pollutants on the ecology of larvae. Subramanian and his colleagues are engaged in studying the tannery effluents on larvae of Odonata. Bhanu & Subramanian (1998) have recorded that last three larval instars of *Pantala flavescens* died without moulting when they were reared in sublethal concentration of tannery effluents. In various concentrations of effluents the haemocytes reduced in number and they believed that the reduction in numbers of hameocytes might have restricted the transport of moulting hormones from sites of the secretions to the target tissues. Subramanian & Muraleedharan (1998) have opined that the effluents have caused gills lesions in the leaflets of the rectal gills and have interfered with

respiration by depressing Oxygen uptake in the experimental larvae. Subramanian & Prabha (1998) have contended that tannery effluents, as a metabolic stressor, have probably inhibited moulting in the larvae.

Evolutionary ecology : Lack (1965) has defined evolutionary ecology, concerning those features of a species or populations that are evolutionary adaptations (i.e. have survival value) are not merely the consequences of population dynamics. Evolutionary adaptations actually appear in Hutchinson's (1957) 'Fundamental niche' The fundamental niche of species or populations corresponds to the state of environment which would permit the species to exist indefinite period.

It has been observed that the crepuscular habits of *Bradinopyga geminata, Gynacantha dravida* and some other species help them to elude predators. Larval habitats play a very important role in the distribution of Odonata, and their survival in different ecological conditions.

Ecology and geographical distribution : Eeological conditions preferred by an individual organism or by a population help in the formation of territory. Territorial limits depend upon some intrinsic factor of an individual as well as members of a population. The limits of territory may play some roles in the distribution of species or subspecies as the case may be in local conditions. For examples, *Neurothemis intermedia intermedia* (Rambur) occurs almost throughout India. Its link populations, *viz. Neurothemis intermedia atalanta* Ris is distributed in the South western peninsula of India and north east India; while *Neurothemis intermedia degener* Selys in distributed in North West Bengal (Ganga Plain) Sikkim (Eastern Himalaya) and Assam (Bhrahmaputra valley). Collection data for several years indicate that the zones of occurrences of these populations are although very close but do not overlap and no intermediates form has yet been discovered. Taking into consideration of Dobzhansky's (1951) contention that reproductive isolation is the main criteria for species determination, taxonomic status of these three are questionable. Fraser (1934) has reported that *Rhinocypha perforata limbata* Selys and *Rhinocypha perforata beatifica* Fraser occur in different parts of Assam. Fraser (*op. cit*) has reported "... given sufficient materials it might be possible to construct a series showing a gradual merging of one to the others. From the present it seems better to consider the *perforata* series as one species with a typical form and two subspecies" However, till date no intermediate form to construct a series has been discovered. Similarly, *Rhinocypha biforata delimbata* Selys, and *Rhinocypha biforata abbreviata* Fraser both occur in Assam but there is no overlapping zone and intermediate population. *Echo margarita tripartita Selys* is endemic to Meghalaya, distributed in Central and South parts of Khasi Hills, Mawpat, Mawrapat, Maudsynram, Shillong, Umsning. *Echo margarita margarita* Selys is distributed in North East India, Bangladesh and Burma. In Meghalaya it is distributed only in Cherrapunji, the place which gets almost the highest rainfall in the world. Regarding territorial limitations in India Odonata, Fraser (1933) has observed, " Inspite of their great powers of flight dragonflies are peculiarly local and this applies to all the rarer and more uncommon forms in particular some of which will be found confined

to a very short stretch of river or a small patch of marshy land in forest. Thus *Disparoneura apicalis* has been found only a short stretch of Cauvery River at Fraserpet, Coorg, barely half a mile extent. The same applies to *Platysticta decanensis*, a species similarly confined to a small stream in the Cochin forests; again to *Mortomagrion varali*, confined to a few acres about the Vihar Lake near Bombay, and many other instances can be cited. Prolonged search for the species in many other localities has been quite fruitless" He has continued to say, "In addition to their local distribution, dragonflies are very seasonal, this again applying especially in the uncommon forms, which are usually single brooded and appear for a but a short space of a few weeks" He also says, "Quite a number of species are strictly confined to a certain altitudes, a zone lying between 2000 and 3500 feet yeilding the richest fauna ... Isolated mountain groups have developed a peculiar fauna of their own, resembling islands in this respect" Pinhey (1978) has reported that different species of african Chlorocyphidae in adjacent sections of the same stream in Uganda adhereing to their own limit with minimal encroachment. Paulson (1973, 1974) has clearly described the reproductive isolation in Odonata especially in *Epitheca sepia* (Gloyd) and *E. stella* (Williamson) he has also cited the importance of temporal isolation. Ponds in Calcutta and Dum Dum Park have been surveyed for more than 30 years. Several species of *Ischnura, Ceriagrion* and *Pseudagrion* have been observed to coexist side by side in the same pond. Moreover, Mitra and Lahiri (1972) have reported interspecies tandem flight in *Pseudagriion microcephalum* and *Pseudagrion rubriceps*. Bick and Bick (1981) have also cited examples of interspecies tandem flight, which has been possible, no doubt, due to coexistence in the same ecosystems. The reproductive isolation in latter cases has been possible due to mechanical dis-advantage. Apparently this cast doubts on the Gause's principle.

Ecology and distribution of common species : Common species occur in different ecological conditions. For example, *Bradinopyga geminata* occur in Rajasthan desert, Himalayan region, Assam region as well as in other parts of India. This is also the case with other common species. And sometimes their place of origin cannot be traced. For instance *Opeas gracile* (Hutton), a garden land snail on which the present writer has made some contributions (Mitra and Biswas 1974 Mitra et. al. 1976) is so widely distributed through human agencies, now authorities are in confusion about its original homeland. The migratory Odonates are examples of such cases. Recently *Crocothemis servilia* has been able to establish itself in North America (Paulson 1978 a, b). Peters (1981) has opined that wide range of distribution of major lowland species indicates their high adaptability and viability more than their counterparts in the mountain ranges.

Adaptability and distribution of Odonata : Generally females select oviposition sites, suited to adult structure and ecological preferences in addition to larval considerations. The ability to withstand adverse breeding conditions is a measure of potentiality for distribution. Several species are adapted to deserts, bush, high altitudes as well as saline coastal zone. On January 23, 1988, I have seen a female *Pseudagrion rubriceps* making attempts for laying eggs in water between boulders in Kanyakumari sea (Cape comorin) in Tamil Nadu coast of the Bay of Bengal. Some species accept new habitats also. For instance, the Asian

species, *Crocothemis servilia servilia* has adapted well in the ecosystems of Florida in North America(USA) (Paulson 1978 a, b). Leaving aside the recent incidence, in the past, too, geographical distributions of species have extended in the same way, which might have taken place either by storm or vortices (Blackman & Pinhey 1967) or otherwise (Mitra, 1975). Kiauta (1983) has conjectured that *Crocothemis servilia* has originated in South Asia; and in 1984 he has shown that Chlorocyphidae originated in Indonesian zone of Malayasian region and used to occur in Triassic period in middle east and Europe. But now the family is absent in middle east and Europe. Now the family occurs in the Oriental region only. Lieftinck (1954) has cited a number of species having reached Malayasia from the places north of the Malayasian region. Lieftinck (1984) has hypothesised that *Calicnemia* species have spread to different parts of the oriental region from the Himalayas.

A few species, namely *Pantala flavescens* which occurs both in new and old world is capable of rapid metamorphosis in temporary rain water puddles. African species *Brachythemis leucosticta* and *Bradinopyga cornuata* are also capable of rapid metamorphosis in adverse conditions. The wide distribution of smaller species of Zygoptera, viz. *Agriocnemis* and *Ischnura* is considered to be assisted through wafting of teneral emergents to new areas probably by air vortices (Blackman & Pinhey 1967; Pinhey 1978) and by other means (Mitra; 1975). Dragonflies of open pools or small streams are not necessarily static but show tendencies at times to move from one area to other in water. Corbet (1962) has compiled the available data of distances travelled from water by exceptional individuals before emergence. The greatest distance he has cited is 45 meters. Pinhey (1978) has opined that sometimes these are transient moves and in other cases they become established. According to Balinsky (1967) insufficient local rainfall may sometimes play a part in such movements.

Endemics of different major ecosystems in India : Diversity in physiography of India has been formed, as in other areas during different geological epochs. The peninsula has been developed during the cambrian period. Since that epoch in earth's history it has never been submerged beneath the sea except temporarily and locally (Wadia 1966). The Andaman and Nicober islands have first appeared from ocean bed about 110 million years ago, during the Mesozoic period and have undergone several periods of partial submergence and elevation since their appearances (Karunakaran,1962). The Himalayas has appered in the Tertiary, when the Tethys sea has been filled up and Indo-Gangetic plain has been formed.

With the appearance of the Himalayas, the environment of India has undergone changes and the subcontinent has been turned into a specially isolated continent/geographical area wherein several endemics have evolved in different ecosystems. At present following major ecosystems have been recognised, and they have their own endemics. Followings are habitats of several types of taxa.

1. Hill and montane forms

A few examples of endemics which are confined in the Western Ghats, Himalayas and hills of North east India are : *Drepanosticta carmaichaeli* Laidlaw, *Drepanosticta*

polychromatica Fraser, *Coeliccia renifera* (Selys), *Calicnemia mortoni* Laidlaw, *Calicnemia sudhaae* Mitra, *Ceriagrion coeruleum* Laidlaw, *Megalestes irma Fraser, Megalestes lieftincki* Lahiri, *Lestes Praemorsa sikkima* Fraser, *Indolestes cyaneus* (Selys), *Bayadera longicauda* Fraser, *Bayadera hyalina* Selys, *Bayadera kali* Cowley, *Bayadera indica* (Selys), *Anisopleura subplatystyla* Fraser, *Rhinocypha spuria* Selys, *Rhinocypha vitrinella* Fraser, *Orolestes durga* Lahiri, *Coeliccia prakritiae* Lahiri, *Epiophlebia laidlawi* Tillyard, also occur in Nepal, *Paragomphus lindgreni* (Fraser), *Davidius aberrans senchalensis* Fraser, *Cephalaeschna orbifrons* Selys, *Periaeschna unifasciata* Fraser, *Chlorogomphus fraseri* St. Quentin, *Chlorogomphus selysi* Fraser, *Macromia flavovittata* Fraser etc.

2. Nonmontane forest forms

Examples of species and subspecies , confined in forest of foot hills and plains of India are : *Elattoneura campioni cacharensis* Fraser, *Disparoneura quadrimaculata* (Rambur), *Caconeura gomphoides* (Rambur), *Prodasineura odoneli* (Fraser), *Copera superplatypus* Fraser, *Coeliccia bimaculata* Laidlaw, *Coeliccia schmidti* Asahina, *Coeliccia rotundata* Asahina, *Coeliccia rossi* Asahina, *Rhinocypha immaculata* Selys, *Phaenandrogomphus aureus* (Laidlaw), *Gomphidia williamsoni* Fraser, *Gomphidia leonorae* Mitra, *Burmagomphush hasimaricus* Fraser, *Merogomphus martini* (Fraser), *Asiagomphus odoneli* (Fraser), *Onychogomphus duaricus* Fraser, *Onychogomphus saundersi* selys, *Onychogomphus cacharicus* Fraser, *Megalogomphus flavicolor* (Fraser), *Gynacantha odoneli* Fraser, *Macromia pallida* Fraser.

3. Insular forms

Species and subspecies confined in the Andaman and Nicobar group of islands are as follows. (Laccadives and Minicoy groups have no endemic.) *Libellago lineata andamanensis* (Fraser), *Libellago lineata blanda* (Selys), *Drepanosticta anandalei* Fraser, *Pseudagrion andamanicum* Fraser, *Gomphidia ganeshi* Chhotani, Lahiri & Mitra, *Oligoaeschna andamani* Chhotani, Lahiri & Mitra,

4. Xerophilic forms

Species and subspecies confined mainly in the arid zones are : *Rhodischnura nursei* (Morton), *Sympetrum decoloratum* (selys).

5. Paraxerophilic forms

Species and subspecies confined/occuring in semiarid zones of North and central India are : *Lestes nigriceps* Fraser, *Elattoneura nigerrima* (Laidlow) *Elattonneura nihari* Mitra.

Species occurring in physiography based ecosystems

Himalayan ecosystems : The Himalayas act as a barrier for some species to come in and go out of the country. But some species can do cross the barrier. For example, *Pantala flavescens* has been recorded from an altitude of 3900 m. The mountain is usually divided

into the western Himalayas, from Uttar Pradesh (Uttaranchal) to Kashmir; central Himalayas, in the kingdom of Nepal, and the eastern Himalayas which includes Darjeeling hills of West Bengal, Sikkim, Arunachal Pradesh state (excluding the Tirap and parts of Lohit divisions,) of India,and the Kingdom of Bhutan.

1. Fauna of Eastern Himalayas : It lies within 26°40'N. ----29° 30'N. and 88° 0'E—97°5'E. Excepting the extreme eastern part, the Himalayas is out of the influence of the monsoon. Rapid change in the topography and altitudes play important roles in changing the climatic conditions within short distances. There is a contrast in temperarature and rainfall between sheltered valleys, foothills and mountain tops. The premonsoon showers begin towards the end of March, the monsoon proper continues from May to September. Rains during winter are a regular feature. June and July are considered as the wettest months.

The fauna is composed largely of tropical elements derived from the fauna of of Indo-malayan subregion of the Oriental region. It is presumed that after the elevation of the Himalayas, Odonata from different parts or the Oriental region reached the mountains and constitute the present fauna. Hence it is reasonable to think that both hills and forests of the mountains play a great role in the formation of barriers as well as in specieation. Followings taxa have been recorded from different areas of the estern Himalayas :

Fauna of Sikkim : *Bayadera indica* (Selys), *Bayadera longicauda* Fraser, *Anisopleura comes* Selys, *Anisopleura lestoides* selys, *Anisopleura subplatystyla* Fraser, *Rhinocypha quadrimaculata* Selys, *Rhinocypha fenestrella* selys, *Megalestes major* Selys, *Megalestes irma* Fraser, *Burmargiolestes laidlawi* Lieftinck, *Calicnemia eximia* (Selys), *Calicnemia miles* (Laidlaw),*Calicnemia miniata* (Selys), *Calicnemia mortoni* (Laidlaw), *Calicnemia pulverulans* Selys, *Protostosticta himalica* Laidlaw, *Aciagrion hisopa* (Selys), *Aciagrion olynpicum* Laidlaw, *Aciagrion approximans* Selys, *Aciagrion pallidum* Selys, *Ceriagrion fallax* Ris, *Ischnura senegalensis* (Rambur), *Ischnura aurora aurora* Brauer, *Enallagma parvum* Selys, *Agriocnemis pygmaea* (Ramber), *Paragomphus lineatus* (Selys), *Anisogomphus bivittatus* (Selys), *Anisogomphus orites* Laidlaw, *Megalogomphus smithi* (Selys), *Onychogomphus schmditi* Fraser, *Gynacantha bayadera* Selys, *Anax nigrofasciatus nigrolineatus* Fraser, *Periaeschna magdalena* Martin, *Cephaleschna acutifrons* Martin, *Petaliaeschna fletcheri* Fraser, *Gynacanthaeschna sikkima* Karsch, *Anotogaster nipalensis* Selys, *Anotogaster basalis palampurensis* Fraser, *Chlorogomphus preciosus preciosus* (Fraser), *Chlorogomphus mortoni* Fraser, *Lyriothemis bivittatus* (Rambur), *Othetrum brunneum* (Fonscolonbe), *Orthetrum anceps* (Schneider), *Othetrum taeniolatum* (Schneider), *Othetrum cancellatum cancellatum* (Linn.), *Orthetrum triangulare triangulare* (Selys), *Othetrum glaucum* (Brauer), *Othetrumg luzonicum* (Brauer), *Othetrum sabina sabina* (Drury), *Othetrum pruinosum neglectum* (Rambur), *Othetrum testaceum* (Burmeister) *Othetrum japonicum internum* Mac Lachlan, *Palpopleura sexmaculata sexmaculata* (Fabricius), *Diplacodes nebulosa* (Fabricius), *Diplacodes trivialis* (Rambur), *Crocothemis servilia servilia* (Drury), *Neurothemis intermedia intermedia* (Rambur), *Neurothemis intermedia atalanta* Ris, *Neurothemis intermedia degener* Selys, *Neurothemis*

fulvia (Drury),*Sympetrum hypomelas* (Selys), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Acisoma panorpoides panorpoides* (Rambur), *Bradinopyga geminata* Rambur, *Pantala flavescens* (Fabricius), *Camacinia gigantea* (Brauer).

Fauna of Darjelling Himalayas (West Bengal) : *Bayadera indica* (Selys), *Anisopleura comes* Selys, *Anisopleura lestoides* Selys, *Euphaea ochracea ochracea* Selys, *Rhinocypha cuneata* Selys, *Rhinocypha ignipennis* Selys, *Rhinocypha guadrimaculata* Selys, *Rhinocypha bifasciata* Selys, *Rhinocypha trifasciata* Selys, *Rhinocypha bifenestrata* Fraser, *Philoganga montana* (Selys), *Lestes praemorsa decipiens* (Kirby), *Lestes praemorsa sikkima* Fraser, *Indolestes cyaneus* Selys, *Megalesttes major* Selys, *Burmargiolestes laidlawi* lieftinck, *Coeliccia renifera* (Selys), *Calicnemia eximia* (Selys), *Calicnemia miles* (Laidlaw), *Calicnemia miniata* (Selys), *Calicnemia mortoni* (Laidlaw), *Protosticta himalaica* Laidlaw, *Drepanosticta carmaichaeli* Laidlaw, *Drepanosticta polychromatica* Fraser, *Ceriagrion coeruleum* Laidlaw, *Ceriagrion olivaceum* Laidlaw, *Himalagrion exclamatione* Fraser, *Aciagrion olympicum* Laidlaw, *Aciagrion hisopa hisopa* (Selys), *Aciagrion pallidum* Selys, *Ischnura aurora aurora* Brauer, *Epiophlebia laidlawi* Tillyard, *Onychogomphus striatus* Fraser, *Onychogomphus biforceps* Selys, *Onychogomphus risi* (Fraser), *Paragomphus lineatus* (Selys), *Paragomphus lindgreni* (Fraser), *Davidius aberrans senchalensis* Fraser, *Davidius assamensis* Laidlaw, *Cyclogomphus heterostylus* Selys, *Anisogomphus occipitalis* (Selys), *Anisogomphus bivittatus* (Selys), *Burmagomphus pyramidalis pyramidalis* (Laidlaw), *Perissogomphus stevensi* Laidlaw, *Anax nigrofasciatus nigrolineatus* Fraser, *Oligoaceschna speciosa* Karube, *Oligoaeschna martini* (Laidlaw), *Periaeschna unifasciata* Fraser, *Cephalaeschna masoni* (Martin), *Cephaleschna acutifrons* Martin, *Cephalaeschna orbifrons* Selys, *Polycanthagyna ornithocephala* (Mac Lachlan), *Aeshna petalura petalura* Martin, *Anotogaster nipalensis* Selys, *Chlorogomphus preciosus preciosus* (Fraser), *Chlogogomphus atkinsoni* (Selys), *Chlorogomphus fraseri* St. Quentin, *Chlogogomphus selysi* Fraser, *Cordulegaster brevistigma brevistigma* (Selys), *Neallogaster hermione* (Fraser), *Macromia flavovittata* Fraser, *Macromia flavicincta* Selys, *Agrionopters insignis* (Rambur), *Pseudotramea prearteri* Fraser, *Lyrothemis bivittata* (Rambur), *Cratilla lineata* (Brauer), *Potamarcha congener* (Rambur), *Orthetrum anceps* (Schneider) *Orthetrum sabina sabina* (Drury), *Orthetrum japonicum internum* MacLachlan, *Orthetrum triangulare triangulare* (Selys), *Orthetrum glaucum* (Brauer), *Orthetrum pruinosum neglectum* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius). *Neurothemis fulvia* (Drury), *Brachythemis contaminata* (Fabricius), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Rhyothemis variegata variegata* (Linn.) *Pantala flavescens* (Fabricius).

Fauna of Arunachal Pradesh (Himalayan part) : *Echo margarita margarita* Selys, *Matrona basilaris basilaris* Selys. *Matrona basilaris nigripectus* Selys, *Neurobasis chinensis chinensis* (Linn.), *Vestalis gracilis gracilis* (Rambur), *Anisopleura lestoides* Selys, *Bayadera indica* (Selys), *Euphaea ochracea ochracea* Selys, *Rhinocypha cuneata* Selys. *Rhinocypha immaculata* (Selys), *Rhinocypha quadrimaculata* Selys, *Rhinocypha hilarye miaoa* Lahiri & Sinha, *Rhinocypha fenestrella fenestrella* (Rambur), *Rhinocypha ignipennis* Selys, *Libellago lineata lineata* (Burmeister), *Lestes dorothea* Fraser, *Lestes praemousus praemorsus* (Selys),

Orolestes durga Lahiri. *Megalestes lieftincki* Lahiri. *Megalestes major*, Selys, *Calicnemia eximia* (Selys), *Calicnemia pulverulans* (Selys), *Calicenemia bimaculata* Laidlaw, *Coeliccia prakritiae* Lahiri, *Coeliccia renifera* (Selys), *Copera vittata*? *serapica* (Selys), *Ceriagrion azureum* (Selys), *Ceriagrion coromandelianum* (Fabricius), *Ceriagrion fallax cerionomelas Lieftinck*, *Ceriagrion olivaceum* Laidlaw, *Pseudagrion australasiae* Selys, *Pseudagrion rubriceps rubriceps* Selys, *Aciagrion pallidum* Selys, *Aciagrion approximans* (Selys), *Enallagma parvum* Selys, *Ischnura aurora aurora* (Brauer), *Ischura rufostigma mildredae* Fraser Selys, *Enallagma parvum* Selys, *Agriocnemis clauseni* Fraser. *Agriocnemis lacteola* Selys, *Agriocnemis pieris* Laidlaw. *Agriocnemis pygmea pygmaea* (Rambur), *Argiocnemis rubescens rubeola* Selys, *Anormogomphus heteropterus* Selys, *Phaenandrogomphus aureus* (Ladilaw), *Onychogomphus biforceps* (Selys), *Onychogomphus cacharicus* Fraser, *Onychogomphus schmidti* Fraser. *Paragomphus lineatus* (Selys), *Ictiogomphus pertinax* (Selys), *Ictinogomphus rapax* (Rambur), *Anax guttatus* (Burmeister), *Cordulegaster brevistigma brevistigma* (SELYS), *Hylaeothemis fruhstorferi apicalis* Fraser, *Tetrathemis platyptera* Selys, *Cratilla lineata*? *claverti* Foerster. *Orthetrum anceps* (Schneider), *Orthetrum brunneum brunneum* (Fonscolombe), *Orthetrum glaucum* (Brauer), *Orthetrum japonicum internaum* Mac Lachlan, *Orthetrum luzonicum*, (Brauer), *Orthetrum pruinosum neglectum* (Rambur), *Orthetrum sabina Sabina* (Druty), *Orthetrum taeniolatum* (Schneider), *Ortheturm testaceum testaceum* (Burmeister), *Orthetrum triangulare trinagulare* (Selys), *Lathrecista asiatica asiatica* (Fabricius), *Potamarcha congene*r (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Crocothemis servilia servilia* (Drury), *Diplacodes trivilis* (Rambur), *Indothemis limbata limbata* Selys, *Neurothemis fulvia* (Drury), *Neurothemis intermidia intermidia* (Rambur), *Neurothemis tullia tullia* (Drury) *Sympetrum commixtum* (Selys), *Sympetrum hypomelas* ((Selys), *Sympetrum orientale* (Selys), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Trithemis pallidinervis* (Kirby), *Rhyothemis variegata variegata* (Linn.), *Pantala flavescens* (Fabricius), *Tholymis tillarga* (Fabricius), *Aethriamanta brevipennis brevipennis* (Rambur), *Urothemis signata signata* (Rambur).

Fauna of Western Himalayas

Major part of the Western Himalayas lies in Jammu and Kashmir (31°.0' 36°.0'N. & 72°.0' - 80°.0'E.), Himachal Pradesh (31°.30'N. & 77°.0'E). and Garhwal and Kumaon Hills (now known as Uttaranchal) in Uttar Pradesh (28°.30'N. & 73°.77'E.). Physically the Western Himalalayas is diverse in character and in places such as Kashmir a flat alluvial valley occurs. The mean winter temperature at 2200m. is 7°C and the summer mean about 18° C, but in valleys the temperature ranges from 32° - 37°C. The average rainfall per annum is 2000 mm in most of the Western Himalayas, 85% of which falls during period of Suth-West monsoon (Kumar & Prasad, 1981). Kumar and Prasad (1981) included several controversial taxa. Those controversial taxa have been excluded here. Many of them have been synonymised by the author at different times.

Fauna of Kashmir : *Platycnemis latipes dealbata* Selys , *Ischnura forcipata* Morton, *Ischnura inaramata* Calvert, *Enallagma cyathiagerum* Charpentier, *Sympecma paedisca annulata* Selys, *Lestes barbara* (Fabricius), *Rhinocypha quadrimaculata* Selys , *Enallagma*

fatima (Charpentier), *Ophiogomphus reductus* Calvert. *Aeshna mixta* Latreille. *Aeshna juncea* (Linn.), Anax parthenope (Selys), *Hemianax ephippiger* (Burmeister), *Cordulegaster brevistigma brevistigma* (Selys), *Selysiothemis nigra* (Vander Linden), *Libellula quadrimaculata* Linn., *Ortheturm burnneum brunneum* (Fonscolombe), *Orthetrum japonicum internum* Mac Lachlan, *Ortheturm cancellatum cancellatum* (Linn.), *Otheturm triangulare triangulare* (Selys), *Sympetrum commixtum* (Selys), *Sympetrum haematoneura* Fraser, *Sympetrum meridionale* (Selys), *Pantala flavescens* (Fabr.).

Fauna of Himachal Pradesh : *Copera ciliata* (Selys), *Copera marginipes* (Rambur), *Copera vitta* (Selys), *Calicnemia eximia* Selys, *Calicnemia miles* Laidlaw, *Coeliccia renifera* (Selys), *Coeliccia didyma didyma* (Selys), *Pseudagrion rubriceps rubriceps* Selys, *Pseudagrion decorum* (Rambur), *Ceriagrion coromandelianum* (Fabrious), *Ceriagrion cerinorubellum* (Brauer), *Ceriagrion fallax cerinomelas* Lieftinck, *Cercion calamorum dyeri* (Fraser), *Ischnura forcipata* Morton, *Ischnura aurora aurora* (Brauer), *Ischnura rufostigma* ssp., Ischnura *senegalensis* senegalensis, *Megalestes major* Selys, *Lestes viridulus* Rambur, *Indolested cyaneus* (Selys), *Rhinocypha quadrimaculata* Selys, *Rhinocypha unimaculata* Selys, *Rhinocypha trifasciata trifaciata* Selys, *Libellago lineata lineata* (Burmeister), *Bayadera indica* (Selys), *Anisopleura comes* Selys, *Neurobasis chinensischinensis* (Linn.), *Anisogomphus bivittatus* (Selys), *Onychogomphus M-flavum* Selys, *Onychogomphus modestus* (Selys), *Paragomphus linratus* (Selys), *Anormogomphus heteropterus* Selys, *Burmagomphus sivalikensis* Laidlaw, *Ictiogomphus rapax* (Rampur), *Cephalaeschna orbifrons* Selys, *Aeshna ornithocepala* Mac Lachlam, *Polycanthagyna erythromelas* (Mac Lachlan), *Anax imperator Leach*, *Anax immaculifrons* Rambur, *Anax guttatus* (Burmeister), *Anax parthenope* (Selys), *Hemianax ehpipiger* (Burmeister), *Anotogaster basalis basalis* Selys, *Cordulegaster parvistigma* (Selys), *Chlorogomphus olympicus* Fraser, *Macromia moorei moorei* Selys, *Potamarcha congener* (Rambur), *Orthetrum burnneum brunneum* (Fonscolombe), *Orthetrum taeniolatum* (Schneider), *Orthetrum anceps* (Scheider), *Orthetrum luzinoum* (Brauer), *Orthetrum japonicum internum* MacLachlan, *Orthetrum cancellatum cancelllatum* (Linn.), *Orthetrum chrysis* (Selys), *Ortheturm glaucum* (Brauer), *Orthetrum sabina sabina* (Drury), *Orthertrum triangulare triangulare* (Selys), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Brachydiplax sobrina* (Rambur), *Acisoma panorpoides panorpoides Rambur*, *Crocothemis servilia servilia* (Drury), *Brachythemis contaminata* (Fabricius). *Diplacodes trivialis* (Rumbur), *Diplacodes nebulosa* (Fabricius), *Neurothemis fulvia* (Drury), *Neurothemis intermidia intermedia* (Rambur), *Neurothemis tullia tullia* (Drury), *Sympetrum commixtum* (Selys), *Sympetrum hypomelas* (Selys), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rumber), *Trithemis pallidinervis* (Kirby), *Trithemis kirbyi kirbyi* Selys, *Rhyothemis variegata variegata* (Lineaes), *Rhyothemis triangularis* Kirby, *Zyxomma petiolatum* Ramber, *Tholymis tillarga* (Fabricius), *Tramea basilaris burmisteri* Kirby, *Tramea virginia* Rambur.

Fauna of Uttar Pradesh Himalayas (Uttaranchal) : *Drepanosticta carmichaeli* (Laidlaw), *Caconeura autumnalis* Fraser, *Disparoneura compioni* Fraser, *Copera marginipes* (Rambur), *Copera vittata* ssp., *Calicnemia eximia* Selys, *Coeliccia renifera* Sleys, *Pseudagrion rubicraps* Selys, *Pseudgrion decourm* Rambur, *Psudagrion laidlawi* Fraser, *Pseudagrion spencei* Fraser

Ceriagrion coromandlianum (Fabricius), *Ceriagrion cerinorubellum* (Brauer), *Ceriagrion fallax cerionmelas* Lieftinck, *Cercion celamorum dyeri* (Fraser), *Ischnura forcipata* Morton, *Ischnura aurora aurora* (Brauer) *Ischnura rufostigma* ssp., *Ischnura senegalensis* (Rambur), *Aciagrion pallidum* Selys, *Rhodischnura nursei* (Morton), *Enllagma parvum* Selys, *Agriocnemis pygmaea* (Rambur), *Agriocnemis clauseni* Fraser, *Agriocnemis corbeti* Kumar & Prasad, *Megalestes major* Selys, *Lestes viridula* Rambur, *Lestes praemorsa praemorsa* Selys, *Lestes thoracica Laidlaw, Indolestes cytaneus* Selys, *Indolestes davenporti* Fraser, *Rhinocypha quadrimaculata* Selys, *Rhinocypha unimaculata* Selys, *Rhinocypha trifasciata trifasciata* Selys, *Rhinocypha biforata beesoni* Fraser, *Rhinocypa spuria* Selys *Rhinocypha immaculata* Selys, *Libellago lineata lineta* (Burmeister) *Bayadra indica* (Selys), *Anisopleura lestoides Selys, Anisopleura comes* Selys, *Neurobasis chinensis chinensis* (Linnaeus), *Anisogomphus M-flavum Selys, Onychogomphus bistrigatus* (Selys), *Onychogomphus duaricus* Fraser, *Lamelligomphus biforceps (Selys), Paragomphus lineatus* (Selys), *Anormogomphus kiritschenkoi* Bartenef, *Anormogomphus heteropterus* (Selys), *Davidius aberrens aberrans* (Selys), *Davidius kumaonensis* Fraser, *Burmagomphus sivalikensis* Laidlaw *Brumagomphus hasimaricus* Fraser *Ictinogomphus rapax* (Rambur), *Gynacanthaeschna sikkiam* (Karsch) *Gynacantha khasiaca MacLadhlan, Anax immaculifrons* Rambur, *Anax guttatus* Burmister, *Anax nigrofasciatus nigrolineatus* Fraser, *Anax parthenope (Selys), Hemianax ehippiger* (Burmeister), *Anotogaster basalis basalis* Selys, *Cordulegaster brevistigma brevistigma* (Selys), *Cordulegaster brevistigma folia* Fraser *Chlorogomphus atkinsoni* (Selys), *Macromia moorei morrei* Selys *Epophthalmia vittata* Burmeister, *Terathemis platyptera* Selys, *Hylaeothemis gardeneri* Fraser, *Cratilla lineata? calverti* Foerster, *Potamarcha congener* (Rambur), *Orthetrum brunneum brunneum* (Fonscolombe), *Orthetreum taeniolatum* (Schneider), *Orthetrum anceps* (Schneider), *Orthetrum luzonicum* (Brauer), *Orthetrum japonicum internum* MacLachlan, *Ortheturm glaucum* (Brauer), *Orthetrum triangulare triangulre* (Selys), *Palpoleeura sexmaculata sexmaculata* (Fabricius) *Brachydiplax sobrina* (Rambur), *Acisoma panorpordes panorpoides* Rambur, *Crocothemis servilia servilia* (Drury), *Neurothemis intermedia intermedia* (Ramubr), *Neurothemis tullia tullia* (Drury), *Bradinopyga geminata* (Rambur), *Sympetrum commixtum* (Selys), *Sympetrum haematoneura* Fraser, *Sympetrum hypomelas* (Selys), *Trithemis aurora* (Burmesister) *Trithemis festiva* (Rambur), *Trithemis pallidinervis* (Kirby), *Trithemis kribyi kribyi* Selys, *Zygonyx torida isis* Fraser, *Rhyothemis variegala variegata* (Linnaeus) *Zyxomma petiolatum* (Rambur), *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* Kirby, *Tramea virginia* Rambur.

Fauna of Meghalaya-Mikir hill region : The area (23^0.47' -26^0.10'N & 89^0.0 - 92^0.47E) is about 470 million years old; belongs to archaean, Creataceous, Tertiary and Quarternary ages. This was partially submerged during the Mesozoic and rose again with the upliftment of the Himalayas during the Tertiary. The area is traversed by 6 to 8 main rivers. The climate varies from place to place, from subtropical to temperate at higher elevation. The southern part receives maximum rainfall per year (1550-3000 cm). Following species have been recorded from the area : *Philoganga montana* (Selys), *Libellago lineata lineata* (Burmeister), *Rhinocypha biforata beatifica* Fraser, *Rhinocypha*

biforata delimbata Selys, Rhinocypha ignipennis Selys, *Rhinocypha immaculata* Selys, *Rhinocypha quadrimaculata Selys, Rhinocypha spuria* Selys, *Rhinocypha vitrinella* Fraser, *Anisopleura subplatystyla* Fraser, *Anisopleura vallei* St. Quentin, *Anisopleura lieftincki* Prasad and Ghosh, *Bayadera hyalina* Selys, *Bayadera kali* Cowley *Bayadera indica* (Selys), *Euphaea ochracea ochracea* (Selys), *Euphaea ochracea burnnea* Selys, *Echo margarita tripartita* Selys, *Matrona basilaris basilaris* Selys, *Matrona basilaris nigripectus* Selys, *Neurobasis chinensis chinensis* Linnaeus, *Vestalis gracilis gracilis* (Rambur), *Vestalis smaragdina smaragdina* (Selys), *Megalestes major* Selys, *Megalestes raychaudhuri* Lahiri, *Indolestes indica* Fraser, *Orolestes durga* Lahiri, *Lestes concinus* Selys, *Lestes dorothea* Fraser, *Lestes garoensis* Lahiri, *Elattoneura atkinsoni* (Selys), *Elattoneura campioni campioni* (Fraser), *Prodasineura autumnalis* (Freaser), *Copera ciliata* Selys, *Copera marginipes* (Rambur), *Copera vittata serapica* Selys, *Calicnemia imitans* Lieftinck, *Calicnemia mukherjee* Lahir, *Calicnemia eximia* (Selys), *Caliccnemia pulverulans* Selys, *Coeliccia bimaculata* Laidlaw, *Coeliccia fraseri* Laidlaw, *Coeliccia sarbottama* Lahiri, *Coeliccia didyma didyma* (Selys), *Coeliccia vacca* Laidlaw *Indocnemis kempi* Laidlaw, *Ceriagrion azureum* (Selys) *Ceriagrion coromandelianum* (Fabricius), *Ceragrion fallax cerionomelas* Lieftinck, *Cerigrion olivaceum* Laidlaw, *Pseudagrion australasiae* Selys, *Pseudagrion spencei* Fraser, *Pseudagrion rubriceps rubriceps* selys, *Aciagrion approximans* Laidlaw, *Aciagrion pallidum* Selys, *Enallagma parvum* Selys, *Ischnura aurora aurora* (Hagen), *Ischnura rufostigma rufostigma* Selys, *Agriocnemis clauseni* Fraser, *Argiocenmis lacteola* Selys, *Agriocnemis pygmea* (Rambur) *Argiocnemis rubescens rubeloa* Selys, *Anisogomphus caudalis* Fraser, *Anisogomphus orites* Laidlaw, *Burmagomphus vermicularis* (Martin), *Dividius malloyri* Fraser, *Dubitogomphus bidentatus* (Fraser) *Asiagopmphus personatus (Selys), Megalogomphus bicornutus* (Freaser), *Heliogomphus spirillus (Fraser), Heliogomphus selysi* (Fraser), *Merogomphus maritini* (Fraser), *Nihonogomphus indicus* Lahiri, *Onychogomphus meghlayanus* Lahiri, *Onychogomphus duraicus* Fraser, *Onychogomphus maculivertex* (Selys). *Onychogomphus medestus* (Selys), *Paragomphus lineatus* (Selys), *Paragomphus echinoccipitalis* (Fraser), *Perissogomphus stevensi* Laidlaw, *Stylogomphus inglisi* Fraser, *Phaenandrogomphus aureus* (Laidlaw), *Oligoaeschna khasiana* Lieftinck, *Oligoaeschna decorata* Lieftinck, *Oligoaeschna martini* (Laidlaw), *Periaeschna flinti assamensis* Asahina, *Periaseschna nocturnalis* Fraser, *Periaeschna magdalena* Martin, *Cephalaeschna biguttata* Fraser, *Planaeschna intersedens* (Martin), *Petaliaeschna fletcheri* Fraser, *Tetracanthagyna waterhousei* Maclachlan, *Aeshna petalura petatura* Martin, *Anax guttatus* (Burmeister), *Gynacantha bayadera* Selys, *Gynacantha basiguttata* Selys, *Gynacantha khasiaca* MacLachlan, *Chlorogomphus campioni* (Fraser), *Hermicordulia asiatica* Selys, *Somatochlora daviesi* Lieftinck, *Idionyx imbricata* Fraser, *Idionyx intricata* Fraser, *Macromia moorei moorei* Selys, *Tetrathemis platyptera* Selys, *Lyriothemis tricolor* Ris, *Lyriothemis bivittata* (Rambur), *Orthetrum glaucum* (Brauer), *Orthetrum japonicum intrenum* MacLachlan, *Orthetrum luzonicum* (Brauer), *Orthetrum sabina sabina* (Drury), *Orthetrum pruinosum neglectum* (Rambur), *Ortheturm triangulare* (Selys), *Potamarcha congener* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Brachydiplax sobrina* (Rambur), *Nannophya pygmaea* Rambur, *Acisoma sanorpoides panorpoides* Rambur,

Brachythemis contaminata (Fabricius), *Crocothemis servilia servilia* (Drury), *Diplacodes trivialis* (Rumber), *Diplacodes nebulosa* (Fabricius), *Neurothemis fulvia* (Driury), *Neurothemis intermedia intermedia Neurothemis intermedia atalanta* Ris, *Neurothemis tullia tullia* (Rambur Drury), *Sympeturm orientale* (Selys), *Sympetrum hypomelas* (Selys), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Trithmis pallidinervis* Kirby, *Zygonyx iris iris* Selys, *Zygonyx iris intermedia* Lahiri, *Onychothemis testacea ceylanica* Ris, *Rhyothemis variegata variegata* (Linnaeus), *Tholymis tillarga* (Fabricius), *Hydrobasileus crocues* (Brauer), *Pantala flavesceus* (Fabricius), *Urothemis signata signata* (Rambur), *Tramea basilaris burmeisteri* Kirby.

Fauna of Purbanchal : The region is encompassed within 21°57'N -28°.23'N and 91°.23'E -97°.25'E incorporating Nagaland (Naga Hills, Cachar Hills, Northern Patkai Hills) Manipur, Mizoram (Lushai and Mizo Hills), Tripura and Lohit districts of Arunachal Pradesh. This region may still be encountered as the treasure house of natural vegetation, the variation of altitude, climate as well as soil includes the forest types ranging from the tropical evergreen to temperate evergreen to conifers. Following species have been recorded, *Neurobasis chinensis chinensis* (Linn.), *Vestalis gracilis gracilis* (Rambur), *Vestalis smaragdina smaragdina* Selys, *Echo margarita margarita* Selys, *Matrona basilaris nigripectus* Selys, *Anisopleura comes* Selys, *Schmidtiphaea schmidti* Asahina, *Euphaea ochracea ochracea* Selys, *Euphaea guerini masoni* Selys, *Libellago lineata lineata* (Burmeister), *Rhinocypha spuria* Selys, *Rhinocypha quadrimaculata* Selys, *Rhinocypha immaculata* Selys, *Rhinocypha perforata betifica* Fraser, *Lestes nodalis* Selys, *Lestes garoensis* Lahiri, *Orolestes durga* Lahiri, *Megalestes major* Selys, *Calicnemia miles* (Laidlaw), *Calicnemia sudhaae* Mitra, *Copera superplatypes* Fraser *Copera marginipes* (Rambur), *Copera vittata assamensis* Laidlaw, *Copera ciliata* (Selys), *Coeliccia didyma didyma* (Selys), *Coeliccia rotundata* Asahina, *Coeliccia schimidti* Asahina, *Pseudagrion australasie* Selys, *Pseudagrion rubricceps rubriceps* Selys, *Ceriagrion coromandelianaum* (Fabricius), *Ceriagrion praetermissum* Lieftinck, *Ceriagrion fallax cerionmelas* Lieftinck, *Ceriagrion olivaceum* Laidlaw, *Ceriagrion azureum* (Selys), *Cercion malayanum* (Selys), *Aciagrion approximans* (Selys), *Aciagrion pallidum Selys, Ischnura senegalensis (Rambur), Ischnura aurora aurora* Brauer, *Ischnura rufostigma rufostigma* Selys, *Ischnura fufostigma anandalei* Laidlaw, *Agriocnemis pygmaea pygmaea* (Rambur), *Agriocnemis splendidissima* Laidlaw, *Agriocnemis femina femina* (Brauer), *Mortonagraion aborense* (Laidlaw), *Onychargia atrocyana* (Selys), *Paragomphus lineatus* (Selys), *Ictiongomphus rapax* (Rambur), *Gynacantha subinterrupta* Rambur, *Anax nigrofasciatus nigrolineatus* Fraser, *Urothemis signata signata* (Rambur), *Amphithemis curvistyla* (Selys), *Lathrecista asiatica asiatica* (Fabricius), *Potamarcha congener* (Rambur), *Ortheturm brunneum brunneum* (Fonscolombe), *Orthetrum anceps* (Schneider), *Orthetrum luzonicum* (Brauer), *Orthetrum sabina sabina* (Drury), *Orthetrum japonicum internum* Mac- Lachlan, *Orthetrum triangulare triangulare* (Selys), *Orthetrum glaucum* (Brauer), *Orthetrum pruinosum neglectum* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Brachydiplax sobrina* (Rambur), *Acisoma panorpoides panorpoides* Rambur, *Diplacodes trivialis* (Rambur), *Indothemis limbata limbata* (Selys), *Crocothemis servilia servilia* (Drury), *Bradinopyga geminata* (Rambur), *Brachythemis contaminata* (Fabricius), *Neurothemis fulvia* (Drury), *Neutothemis fluctuans* (Fabricius),

Neurothemis intermedia intermedia (Rambur), *Neurothemis tullia tullia* (Drury), *Sympeturm hypomelas* (Selys), *Rhodothemis rufa* (Rambur), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Trithemis pallidinervis* (Kirby), *Zygonyx iris iris* Selys, *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea viriginia* (Rambur).

Fauna of peninsular uplands : Such areas represent rocks of ancient Gondwana land Palaeozoic and Vindhyan system. This part of India was formed during the Cambrian period. Since that epoch in earth's history this area has never been submerged beneath the sea, except locally and temporatily (Wadia 1966). Drainage in the area is by rivers originated in the upland itself. The forest types very from place to place—evergreen to dry deciduous.

The Western Ghats : The ghat is about 1600 km long. It extends from the river Tapi to cape comorin. The western most part is hilly and guarded by the Arabian sea, the high peaks are Salen (1604m), Kalsubhai (1654m.) Mahabalwshwar (1490m.), Annaimalai (2695m.), Nilgiri (2600m.) stands bvewtween the Eastern Ghat and the Western Ghats. The annual rainfall varies from 200 to 400cm. Rivers are fast flowing, capable of producing hydroelectricity.

Fauna of the Western Ghats Nilgiris and Decan plateau

Neurobasmis chinensis chinensis (Linnaeus), *Vestalis gracilis gracilis* (Rambur), *Vestalis gracilis montana* Fraser, *Vestalis apicalis apicalis* Selys, *Euphaea dispar* Rambur, *Euphaea fraseri* (Laidlaw), *Euphaea cardinalis* (Fraser), *Libellago lineata indica* Fraser, *Esme mudiensis* Fraser, *Esme longistyla* Fraser, *Caconeura gomphoides* (Rambur), *Caconeura ramburi* Fraser, *Melaneura bileanata* Fraser, *Disparoneura quadrimaculata* (Rambur), *Disparoneura apicalis* Fraser, *Ellatoneura nigerrima* Laidlaw, *Elattoneura tetricia* Laidlaw, *Elettoneura souteri* Fraser, *Prodasineura verticalis anandalei* Fraser, *Phylloneura westermami* (Selys), *Esme cyanovittata* Fraser, *Lestes elatus* Selys, *Lestes viridulus* Rambur, *Lestes praemorsa praemorsa* Fraser, *Lestes dorothea* Fraser, *Lestes patricia* Fraser, *Lestes malabarica* Fraser, *Indolestes davenporti* (Fraser), *Indolestes pulcherrimus* Fraser, *Onychargia atrocyana* Selys, *Ischnura aurora aurora* (Brauer), *Ischnura senegalensis* (Rambur), *Mortonagrion varalli* Fraser, *Agriocnemis pieris* Laidlaw, *Agriocnemis splendidissima* Laidlaw, *Enallagma parvum* (Selys), *Aciagrion pallidum* (Selys), *Aciagrion hisopa hisopa* Selys, *Aciagrion occidentale* Laidlaw, *Ceriagrion coromandelianum* (Fabricius), *Ceriagrion rubiae* Laidlaw, *Ceriagrion auranticum* Fraser, *Criagrion cerinorubellum* Selys, *Pseudagrion decorum* (Rambur), *Pseudagrion microcephalum* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Pseudagrion hypermelas* Selys, *Pseudagrion indicum* Fraser, *Pseudagrion malabaricum* Fraser, *Cercion calamorum dyeri* (Fraser), *Copera marginipes* (Rambur), *Copera vittata vittata* (Selys), *Copera vitta decanensisi* Laidlaw, *Protosticta gravelyi* Laidlaw, *Protosticta saguinostigma* Fraser, *Protosticta hearseyi* Fraser, *Protosticta antilopoides* Fraser, *Platysticta decanensis* Laidlaw, *Macromia irata* Fraser, *Macromia binocellata* Fraser, *Macromida ida* Fraser, *Macromia ellisoni* Fraser, *Macromia bellicosa* Fraser, *Macromia miniata* Fraser, *Macromia donaldi* (Fraser), *Idionyx corona* Fraser, *Idionyx burliyarensis* Fraser, *Ictinogomphus rapax* (Rambur), *Gomphidia T-nigram* Selys, *Gomphidia fletcheri* Fraser, *Macrogomphus*

annulatus (Selys), *Macrogomphus wynadicus* Fraser, *Davidioides maritini* Fraser, *Heliogomphus promelas* (Selys), *Microgomphus torquatus* (Selys), *Microgomphus souteri* Fraser, *Cyclogomphus ypsilon* Selys, *Cyclogomhus wilkinsi* Fraser, *Burmagomphus pyramidalis* Laidlaw, *Burmagomphus laidlawi* Fraser, *Burmagomphus cauvericus* Fraser, *Asiagomphus nilgiricus* (Laidlaw), *Onychogomphus nilgiriensis nilgiriensis* Fraser, *Onycogophus nilgiriensis anaimalaicus* (Fraser), *Onychogomphus acinaces* Laidlaw, *Onychogomphus malabarensis* (Freser), *Onychogomphus striatus* Fraser, *Paragomphus lineatus* (Selys), *Merogomphus longistigma tamaracherriensis* Laidlaw, *Merogomphus longistigma longistigma* (Fraser), *Merogomphus hannygtoni* Fraser, *Merogomphus superbus* Fraser, *Hemianax ephippiger* (Burmeister), *Anax immaculfrons* Rambur, *Anax guttatus* (Burmeister), *Anax parthenope parthenope* Selys, *Anaciaeschna jaspedia* (Burmeister), *Gynacantha dravida* Lieftinck, *Gynacantha baydera* Selys, *Chlorogomphus xanthoptera* (Fraser), *Chlorogomphus campioni* (Fraser), *Hemicordulia asiatica* Selys, *Epophthalmia vittata cyanocephala* (Selys), *Epophthalmia frontalis frontalis* Selys, *Macromia cingulata* Rambur, *Macromia flavicincta* Selys, *Macromia indica* Fraser, *Macromia anaimalaiensis* Fraser, *Idionyx nilgiriensis* (Fraser), *Idionyx galeata* Fraser, *Idionyx saffronata* (Fraser), *Idionyx nadaganensis* Fraser, *Idionyx travancorensis* Fraser, *Idionyx minima* Fraser, *Tetrathemis platyptera* Selys, *Hylaeothemis fruhstorferi* (Karsch), *Epithemis marie* (Laidlaw), *Lathercista asiatica asiatica* (Fabricius), *Criatilla lineata calverti* Forst, *Potamarcha congener* (Rambur), *Orthtrum chrysis* Selys, *Ortheturm teaniloatim* (Schnieder), *Orthetrum luzonicum* (Braber), *Orthetrum sabina (Drury), Orthetrum glaucum* (Brauer), *Ortheturm pruinosum neglectum* (Rambur), *Orthetrum triangulare triangulare* (Selys), *Zyxomma petiolatum* (Rambur), *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Rhyothemis variegata variegata* (Linnaeus), *Rhyothemis triangularis* Kirby, *Hydrobasilieus coceus* (Brauer) *Tramea basilaris burmeisteri* Kirby, *Tramea limbata similata* (Desjardin), *Urothemis signata signata* (Rambur), *Palpopleura sexmaculata sexmaculata* (Fabricius), *Brachydiplax sobrina* Rambur, *Acisoma panorpoides panorpoides* Rambur, *Diplacodes trivialis* Rambur, *Diplacodes nebulosa* (Fabricius), *Diplacodes lefevbrei* Rambur, *Indothemis limbata* (Salys), *Indothemis carnatica* (Fabricius), *Crocothemis servilia servilia* (Drury), *Bradinopyga geminata* (Rambur), *Neurothemis tullia tullia* (Drury), *Neurothemis intermedia intermedia* Rambur, *Trithemis pallidinervis* (Kirby), *Zygonyx torrida isis* Fraser, *Zygonyx iris* Selys, *Onychothemis testacea ceylanica* Ris, *Zyxomma petiolatum,* (Rambur), *Neurothemis fulvia* Drury, *Brachythemis contaminata* (Fabricius), *Rhodothemis rufa* (Rambur), *Sympetrum fonscolmbei* (Selys), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Trithemis kirbyi kirbyi* Selys.

Fauna of the central upland :

The area divides the southern part the Himalayas into the Northern, mainly the plains and the southern peninsula. Following species are known from the area: *Disparoneura quadrimaculata* (Rambur), *Elattoneura nigerrima* (Laidlaw), *Ellatoneura nihari* Mitra, *Copera marginipes* (Rambur), *pseudagrion microcephalum* (Rambur), *Pseudagrion hypermelas* Selys, *Pseudragrion decorum* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Ceriagriion coromandelianum* (Fabricius), *Ceriagrion olivaceum* Laidlaw, *Cercion clamorum dyeri* (Fraser),

Cercion malayanum (Selys), *Ischnura aurora aurora* (Brauer), *Ischnura senegalensis* (Rambur), *Rhodischnura nursei (Morton), Enallagma parvum* Selys, *Aciagrion pallidum* Selys, *Agriocnemis pygmaea pygmaea* (Rambur), *Lestes umbrinus Selys, Lestes viridulus* (Rambur), *Rhinocypha bisignata Selys, Onychogomphus grammicus* (Rambur), *Ictinogomphus rapax* (Rambur), *Potamarcha congener* (Rambur), *Orthertrum taeniolatum* (Schneider), *Orthetrum sabina sabina* (Drury), *Orthetrum cancellatum* (Rambur), *Acisoma panorpoides panorpides* Rambur, *Diplacodes trivialis* (Rambur), *Indothemis carntica* (Fabricius), *Crocothemis servilia Servilia* (Drury), *Brachythemis contaminata* (Fabricius), *Trithemis aurora* (Burm.), *Neurothemis intermedia intermedia* (Rambur), *Bradinopyga geminata* (Rambur), *Tramea basilaris burmeisteri* Kirby.

The Chhotanagpur region :

It has irregular bounderies, and the extreme ends lie between 20°.0'N.—25°.30'N.and 83°.47'–87°.40'E. The area is known as the state of Jharkhand. This upland experiences a typical monsoon climate having seasonal rhythm. Following spceies have been recorded from the area.

Neurobasis chinensis chinnesis (Linnaeus), *Vestalis gracilis gracilis* (Rambur), *Vestalis apicalis apicalis* Selys, *Lestes nodalis* selys, *Lestes umbrinus* Selys, *Disparoneura quadrimaculata* (Rambur), *Copera marginipes* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Ceriagrion coromandeliamum* (Fabricius), *Aciagrion pallidum* Selys, *Ischnura seneglaensis* (Rambur), *Ischnura aurora* Brauer, *Enallagama parvum* Selys, *Agriocnemis pygmaea* (Rambur), *Nihonogomphus pulcherrimus* (Brauer), *Paragomphus lineatus* (Selys), *Ictinogomphion rapax* (Rambur), *Ictinogomphus pertinax* (Selys), *Epopthalmia vittata vittata* Burm, *Latherceista asiatica* (Fabricius), *Potamarcha congener* (Rambur), *Orthetrum brnnueum brnnueum* (Fabricius), *Orthetrum taeniolatum* (Schneider), *Orthetrum sabina sabina* (Drury), *Ortheturm pruinosum neglectum* (Rambur), *Palpopleura sexmachlata* (Fabricius), *Diplacodes trivialis* (Rambur), *Indothemis carnatica* (Fabricius), *Crocothemis servilia servilia* (Drury), *Bradinopyga geminata* (Rambur), *Brachythemis contaminata* (Fabricius) *Neurothemis intermedia intermedia* (Rambur), *Sympetrum hypomelas* (Selys), *Trithemis aurora* (Burmesister), *Trithemis festiva* (Rambur), *Trithemis pallidinervis* (Kirby), *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* Kirby.

Fauna of the Eastern Ghats :

The Eastern Ghats is comprised of a number of dissociated hills. The average height ranges from 450 --600m. , the highest peak is the Mahendragiri, (about 1500m). Main rivers end in the Bay of Bengal. The annual average rainfall varies from 100 200 cm. Following species occur in the area:

Caconeura gomphoides (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Pseudagrion microcephalum* Rambur, *Ceriagrion coromandelianum* (Fabricius), *Ceriagrion cerinorubellum* (Brauer), *Ceriagrion rubiae* Laidlaw, *Ceriagrion olivaceum* Laidlaw, *Cercion calamorum dyeri* (Fraser), *Ischnura sengealensis* (Rambur), *Ischnura elegans elegans* (Vander Linden), *Ischnura aurora aurora* (Brauer), *Ischnura rufostigma rufostigma* Fraser, *Enalllagma parvum*

Selys, *Rhodischnura nursei* Morton, *Aciagrion pallidum* Selys, *Agriocnemis lacteola* Selys, *Agriocnemis pygmaea pygmaea* (Rambur), *Onychargia atrocyana* Selys, *Lestes elatus* Hagen, *Lestes viridulus* Rambur, *Lestes nodalis* Selys, *Lestes umbrinus* Selys, *Lestes thoracicus* Selys, *Neurobasis chinensis chinensis* (Linn.), *Vestalis gracilis gracilis* (Rambur), *Vestalis apicalis apicalis* Selys, *Rhinocypha quadrimaculata* Selys, *Rhinocypha bisignata* Selys, *Anormogomphus heteropterus* Selys, *Paragomphus lineatus* Selys, *Ictinogomphus rapax* (Rambur), *Gynacantha bayadera* Selys, *Anax guttatus* (Burmeister), *Epopthalmia frontalis frontalis* Selys, *Macrodiplax cora* Brauer, *Urothemis signata signata* (Rambur), *Aethriamanta brevipennis brevipennis* Rambur, *Cratilla lineata calverti Forst*, *Orthetum sabina sabina* (Drury), *Orthetrum glaucum* (Brauer), *Orthetrum pruinosum neglectum* (Rambur), *Lathrecista asiatica asiatica* (Fabricius), *Potamarcha congener* (Rambur), *Brachydiplax sobrina* (Rambur), *Acisoma panorpoides panorpoides* Rambur, *Dilacodes nebulosa* (Fabricius), *Diplacodes trivialis* (Rambur), *Crocothemis servilia servilia* (Drury), *Bradinopyga geminata* (Rambur), *Brachythemis contaminata* (Fabricius), *Neurothemis fulvia* (Drury), *Neurothemis intermedia intermedia* (Rambur), *Trithemis pallidinervis* (Kirby), *Rhyothemis variegata* (Linn.), *Zyxomma petiolatum* Rambur, *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* (Kirby), *Tramea virginia* (Rambur), *Tramea limbata similata* (Rambur), *Indothemis limbata limbata* (Selys), *Indothemis limbata sita* Campion.

Island fauna

Anadaman and Nicobars as well as Lacca-Mincoy group shows insular ecosystems. Only *Tholymis tillarga* has so far been recorded from Laccadives. Andaman and Nicobars support both endemic and nonendemic forms. They are as follows :

Libellago lineata andamanensis (Fraser), *Libellago aurantica* (SELYS), *Libellago lineata blanda* (Selys), *Vestalis gracilis gracilis* (Rambur), *Lestes malabarica* Fraser, *Lestes praemorsua praemorsus* Selys, *Drepoanosticta annadalei* Fraser, *Prodasineura verticalis andmamanensis* (Fraser), *Copera marginipes* (Rambur), *Copera vittata? serapica* Hagen, *Pseudagrion pruinosum pruinosum* (Burmeister), *Pseudagrion andamanicum* Fraser, *Pseuidagrion willioamsoni* Fraser, *Aciagrion pallidum* Selys, *Ceriagrion olivaceum* Laidlaw, *Ceriagrion cerinorubellum* (Brauer), *Ceriagrion auranticum auranticum* Fraser, *Ischnura senegalensis* (Rambur), *Argiocemis rubescens rubeola* Selys, *Gomphidia ganeshi* chhotani *et al*, *Anax guttatus* (Burmeister), *Oligoaeschna andamani* Chhotani *et al* *Gynacantha dravida* Lieftinck, *Gynacantha subinterrupta* Rambur, *Gynacantha bayadera* Selys, *Anaciaeschna jaspedia* Burmeister, *Epothalmia vittata vittala* Burmeister, *Agrionoptera insignis insignis* (Rambur), *Nesoxenia lineata* (Selys), *Lathrecista asiatica asiatica* (Fabricius), *Potamarcha congener* (Rambur), *Orthetrum chrysis* (Selys), *Orthetrum sabina sabina* (Drury), *Brachydiplax chalybea chalybea Brauer*, *Diplacodes trivialis* (Rambur), *Acisoma panorpoides panorpoides* (Rambur), *Neurothemis intermedia intermedia* (Rambur), *Neurothemis fluctuans* (Fabricius), *Brachythemis contaminata* (Fabricius), *Crocothemis servilia servilia* (Drury), *Trithemis festiva* (Rambur), *Trithemis aurora* (Burmeister), *Trithemis pallidinervis* (Kirby), *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea transmarina euryale* Selys, *Tramea virginia* (Rambur), *Rhyothemis varigata variegata* (Linn.), *Rhyothemis phyllis phyllis* (Sulzer), *Camacinia gignatea* (Brauer), *Zyxomma obtusum* Albarda.

Fauna of Indo-Ganga-Brahmaputra Plain :

It represents a continuous monotonous flat riverine ecosystem. In the west lie the Thar desert and the arid zones. This is followed by drier upper Ganga plain in Uttar Pradesh, Middle Ganga Plain in Bihar and Lower Ganga Plain in West Bengal (and Bangladesh); finally ending in the Bay of Bengal. The Brahmaputra valley is fed by the river Brahmaputra which together with tributraies and branches of the main Ganga river ends in West Bengal. Following species have so far been recorded.

Fauna of desert (Thar) and the arid zones : In the past this area was under the Tethys sea. With the upliftment of the Himalayas the area has become land and gradually the part of the desert of the middle east. The area contains fossils of various species of aquatic animals. Following is conspectus of Odonata recorded from the area. *Ceriagrion coromandelianum* (Fabricius), *Pseudagrion decorum* (Rambur), *Pseudagrion rubriceps rubriceps* Selys, *Engallagma parvum* Selys, *Ischnura aurora aurora* (Brauer), *Ischnura senegalensis* (Rambur), *Rhodischnura nursei* (Morton), *Agriocnemis pygmaea* (Rambur), *Copera marginipes* (Rambur), *Lestes umbrinus* Selys, *Lestes viridulus* Rambur, *Anormogomphus kiritschenkoi* Bartenef, *Ictinogomphus rapax* (Rambur), *Hemianax ehpippiger* (Burmeister), *Sympetrum decoloratum* Selys, *Orthetrum prunionsum neglectum* (Rambur), *Orthetrum sabina sabina* (Drury), *Orthetrum taeniolatum* (Schneider), *Acisoma panorpoides panorpoides* Rambur, *Brachythemis contaminata* (Fabricius), *Bradinopyga geminata* (Rambur), *Crocothemis servilia servilia* (Drury), *Diplacodes nebulosa* (Fabricius), *Diplacodes trivialis* (Rambur), *Diplacodes lefebvrei* (Rambur), *Brachydiplax sobrina* (Rambur), *Trithemis aurora* (Burmeister), *Trithemis festiva* (Rambur), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* Kirby, *Selysiothemis nigra* (Vander Linden).

Gaga basin : *Neurobasis chinensis chinensis* (Kinneaus), *Caliphaea confusa* Hagen, *Anisopleura lestoides* Selys, *Bayadera indica* (Selys), *Rhinocypha quadrimaculata* Selys, *Rhinocypha bifasciata* Selys, *Lestes viridulus* Rambur, *Lestes umbrinus* Selys, *Lestes platystylus* Rambur, *Lestes thoracicus* Laidlaw, *Prodasineura odoneli* Fraser, *Disparoneura quadrimaculata* (Rambur), *Calicnemia purverulans* Selys, *Copera marginipes (Rambur), Copera superplatypes* (Fraser), *Copera vittata serapica* (Selys), *Copera ciliata (Selys), Pseudagrion microcephalum* (Rambur), *Pseudagrion australasiae* Selys, *Pseudagrion malabraicum* Fraser, *Pseudagrion decorum* Selys, *Pseudagrion hypermelas* Selys, *Pseudagrion rubriceps rubriceps* Selys, *Pseudagrion spencei* Fraser, *Ceriagrion coromandelianuum* (Fabricius), *Ceriagrion fallax cerinomelas* Lieftinck, *Ceriagrion azureum* (Selys), *Cercion calamorum dyeri* (Fraser), *Cercion malayanum* (Selys), *Aciagrion hisopa hisopa* (Selys), *Aciagrion approximans* (Selys), *Aciagrion pallidium* Selys, *Ischnura senegalensis* (Rambur), *Ischnura aurora aurora* (Brauer), *Ischnura elegans elegans* (Vander Linden), *Ischnura forcipata* Morton, *Ischnura rufostigma rufostigma* Selys, *Enallagma parvum* Selys, *Argiocnemis rubesens rubeloa* Selys, *Agriocnemis lacteola* Selys, *Agriocnemis pieris* Laidlaw, *Agriocnemis clauseni* Fraser, *Agriocnemis nana* (Laidlaw), *Agriocnemis splendidissima* Laidlaw, *Agriocenemis pygmaea pygmea* (Rambur), *Agriocnemis femina femina* (Brauer),

Mortonagrion aborense (Laidlaw), *Onychargia atrocyana* Selys, *Paragomphus lineatus* (Selys), *Macrogomphus montanus* Selys, *Ictinogomphus rapax* (Rambur), *Ictinogomphus atrox* (Selys), *Ictinogomphus angulosus* (Selys), *Ictinogomphus pertinax* (Selys), *Gomphidia leonoraae* Mitra, *Gomphidia williamsoni* Fraser, *Onychogomphus saundersi* Selys, *Onychogomphus grammicus* (Rambur), *Onychogomphus duaricus* Fraser, *Macrogomphus seductus* Fraser, *Anormogomphu heteropterus* Selys, *Anisogomphus orites* Laidlaw, *Burmagomphus hasimaricus* Fraser, *Burmagomphus sivalikensis* Laidlaw, *Merogomphus martini* (Fraser), *Asiagomphus odoneli* (Fraser), *Platygomphus dolabratus* Selys, *Megalogomphus flavicolor* (Fraser), *Gynacantha bainbriggei* Fraser, *Gynacantha biharica* Faser, *Gynacantha dravida* Lieftinck, *Gynacantha basiguttata* Selys, *Gynacantha bayadera* Selys, *Gynacantha rammohani* Mitra & Lahiri, *Gynacantha khasiaca* Mac Lachlan, *Gynacantha odoneli* Fraser, *Anax imperator imperator* Leach, *Anax guttatus* (Burmeister), *Periaschna magalena* Martin, *Teracanthagyna waterhousei* Mac Lachlan, *Cephaleschna acutifrons* Martin, *Cephalaeschna orbifrons* Selys, *Macromia moorei moorei* Selys, *Epophathalmia vittata vittata* Burmeister, *Epophthalmia vittigera bellicosa* Lieftinck, *Hemicordulia asiatica* Selys, *Agrionoptera insignis* (Rambur), *Urothemis signata signata* (Rambur), *Aethrianmanta brevipennis brevipennis* (Rambur), *Macrodiplax cora* (Brauer), *Tetrathemis platypera* Selys, *Lathercista asiatica asiatica* (Fabricius), *Cratilla lineata lineata* (Brauer), *Potamarcha congener* (Rambur), *Orthetrum taeniolatum* (Schneider), *Orthetrum luzonicum* (Brauer), *Orthetrum sabina sabina* (Drury), *Orthetrum glaucum* (Brauer), *Brachydiplax sobrina* (Rambur), *Brachydiplax farinosa* Kruger, *Brachydiplax chalybea chalybea* Brauer, *Acisoma panorpoides panorpoides* Rambur, *Diplacodes trivialis* (Rambur), *Diplacodes nebulosa* (Fabricius), *Indothemis carnatica* (Fabricius), *Crocothemis servilia* (Drury), *Crocothemis erythraea erytheraea* (Brullé), *Bradinopyga geminata* (Rambur), *Brachythemis contaminata* (Fabricius), *Neurothemis fulvia* (Drury), *Neurotheims intermedia intermedia* (Rambur), *Neutrothemis tullia tullia* (Drury), *Trithemis aurora* (Burmiester), *Trithemis pallidinervis* (Kirby), *Zygonyx iris iris* Selys, *Rhyothemis variegata variegata* (Linn.), *Rhyothemis plutonia* Selys, *Zyxomma petiolatum* Rambur, *Tholymis tillarga* (Faricius), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* Kirby, *Onychothemis testacea ceylanica* Ris, *camcinia gigantea* (Brauer).

Fauna of Brahmaputra valley including fauna of indeterminate localities of "Assam"

Neurobasis chinensis chinensis (Linn.), *Caliphaea confusa* Hagen, *Vestalis gracilis gracilis* (Rambur), *Anisopleura comes* Selys, *Anisopleura lestoides* Selys, *Libellago lineata lineata* (Burmiester), *Rhinocypha cuneata* Selys, *Rhinocypha quadrimaculata* Selys, *Rhinocypha fenestrealla fenestrella* Rambur, *Rhinocypha unimaculata* Selys, *Rhinocypha perforata limbata* Selys, *Lestes dorothea* Fraser, *Lestes praemorsus decipiens* (Kirby), *Burmargiolestes laidlawi* Lieftinck, *Protosticta himalaica* Laidlaw, *Calicnemia eximia* (Selys), *Coeliccia renifera* (Selys), *Coeliccia rossi* Asahina, *Coeliccia bimaculata* Laidlaw, *Copera marginipes* (Rambur), *Pseudagrion australasiae* Selys, *Pseudagrion rubriceps rubriceps* Selys, *Ceriagrion coromandelianum* (Fabricius), *Ceriagrionf fallax cerinomelas* Lieftinck, *Ceriagrion olivaceum*

Laidlaw, *Aciagrion pallidum* Selys, *Aciagrion azureum* Fraser, *Ischnura aurora aurora* Brauer, *Ischnura rufostigma rufostigma* Selys, *Enallagma parvum* Selys, *Argiocnemis rubescens rubeola* Selys, *Agriocnemis dabreui* Fraser, *Agriocnemis lacteola* Selys, *Agriocnemis clauseni* Fraser, *Agriocnemis splendidissima Laidlaw, Argriocoemis pygmaea (Rambur), Agriconemis femina femina* (Brauer), *Mortonagrion aborense* (Laidlaw), *Onychargia atrocyana* Selys, *Paragomphus echinoccipitalis* Fraser, *Macrogomphus seductus* Fraser, *Gomphidia t-nigrum* Selys, *Ictinogomphus rapax* (Rambur), *Davidius davidi assamensis* Laidlaw, *Anisogomphus occipitalis* (Selys), *Anisogomphus bivittatus* (Selys), *Gynacantha bainbriggei* Fraser, *Gynacantha aranaudi* Asahina, *Anax guttatus* (Burmeister), *Anax parthenope parthenope* Selys, *Anaciaeschna jaspedia* (Burmeister), *Periaeschna magdalena* Martin, *Cephalaeschna masoni* (Martin), *Cephaleschna acutifornos* Martin, *Gynacanthaeschna skkima* (Karsch), *Anotogaster nipalensis* Selys, *Chlorogomphus atkinsoni* (Selys), *Macromia moorei moorei* Selys, *Epophthalmia vittigera bellicosa* Lieftinck, *Hemicordulia asiastica* Selys. *Urothemis signata signata* (Rambur), *Aethriamanta brevipennis brevipennis* (Rambur) *Lyriothemis bivittata* (Rambur), *Lyriothemis cleis* Brauer, *Lathrecista asiatica asiatica* (Fabricius), *Potoamarcha congener* (Rambur), *Orthetrum brunneum brunneum* (Fonsocolombe), *Orthetrum luzonicum* (Brauer), *Orthetrum sabina sabina* (Drury), *Orthetrum triangulare triangulare* (Selys), *Ortherum glaucum* (Brauer), *Ortherum Pruinosum neglectum* (Rambur), *Plapopleura sexmaculata sexmaculata* (Fabricius), *Brachydiplax sobrina* (Rambur), *Brachydiplax farinosa* Kruger, *Brachydiplax chalybea chalybea* Brauer, *Acisoma panorpoides panorpoides* Rambur, *Diplacodes nebulsoa* (Fabricius), *Diplacodes trivialis* (Rambur), *Indothemis limbata limbata* (Selys), *Crocothemis servilia servilia* (Drury), *Crocothemis erythraea erythraea* (Brulle), *Brachythemis contaminata* (Fabricius), *Neurothemis fulvia (Drury), Neurothemis fluctuans* (Fabricus), *Neurothemis intermedia atalanta* Ris, *Neurothemis tullia* (Drury), *Sympetrum hypomels* (Selys), *Sympetrum orientale* (Selys), *Trithemis aurora* (Brumeister), *Trithemis festiva* (Rambur), *Trithemis pallidinervis* (Kirby), *Zygonyx iris iris Selys, Rhyothemis variegata variegata* (Linnaeus), *Rhyothemis plutonia* (Rambur), *Rhyothemis obsolescens* Kirby, *Tholymis tillarga* (Fabricius), *Pantala flavescens* (Fabricius), *Tramea limbata similata* (Rambur), *Camcinia gigantea (Brauer), Lyriothemis acigastra* (Selys), *Agrionoptera insignis insignis* (Rambur), *Amphithemis vacillans* (Selys), *Nannophya pygmaea* Rambur.

ECOLOGY AND FAUNAL AFFINITIES

Peters (1981) opined that lowland odonates have higher adaptive ability and vitalities than those of mountain forms. Generally Odonates are confined in area or areas, selected by adult preferences as well as suitable for larval structures. For instance, *Zygonyx* only breed in swift montance streams, and their larvae are adapted, by a flat limpet-like abdomen, to cling to rocks while the body is generaly streamlined. The most restricted endemics are considered to be a few palaeogenic relicts with extra-Indian associations. In India Megapodagrionidae is represented by a single species of *Burmargiolestes laidlawi* (the other

species *B. malanothorax* is confined in Indo-Chaina). In Africa Megapodagrionidae is represented by species of *Neurolestes* and two species of *Nesolestes* and in the coastal forests of east Africa, a species of *Amphipodagrion* and one of *Coryphagrion* have continetal connecion. In southern Africa, the *Synestidae* and *Syncordulia* and in India Hemicordulia have got Australjan relation. In Malawi of south Africa occurs *Teinobasis malawinensisi* which has relation in Madagascar and Asia (Pinhey, 1978). There are others in equatorial Africa; on the Cameroon-Nigerian border the only African member of Perilestidae, *Nubiolestes diotima* has got South American relation. One of the two species of African Amphipterygidae, *Pentaphlebia stahli* has got Oriental, Australian and American relatives. *Philoganga* of India has got Indo-Chinese connections, and relatives from African, Austrilia, Central and South America. *Zygonyx* iris of India has got African connection. *Sympetrum fonscolombe* has got Palaearctic connection. It occurs in Kashmir and top of hills of Western Ghats.

In addition to the cases of endemics,cases of widely distributed species can also be explained in a similar way. For example, *Agriocnemis femina femina* occurs in India mainaland, Nicobar, China, Indo-malayan sub-region, Austrilia and Cuba. It has a link-population in Micronesia. *Agriocnemis pygmaea* occurs in the Oriental region, Ethiopean region, and Austrilian region. It has connection in Seychelles islands.

DISCUSSION

Odonata species are primitive insects and they bear morphological as well as some ecological features of their ancestors including the features of other neuropteroid insects. They can be termed as "Missing link group/order" Among species of Odonata *Epiophlebia laidlawi* Tillyard and *E. superstes* Selys are considered as missing links. *E. Laidlawi* occurs in the Himalayas (Darjeeling and Nepal) and Nepal -Tibet border; while *E. superstes* occurs in Japan only. These ancient species from where they segregated is not known. On the other hand *Anax nigrofasciatus nigrolineatus* Fraser and *A. n. nigrofasciatus* Oguma cite interesting features in segregation or branching of the stock, *A. nigrofasciatus nigrolineatus* occurs in West Bengal (Darjiling) Sikkim, Bhutan, Nepal, China and Thailand. Its link population *A. n. nigrofasciatus* occurs in China, Japan, Korea, Taiwan. It is presumed here that two populations evolved separately and in the high altitudes of the Himalayas where the area of China and the Himalayas meet. In this way examples of discontinuous distributions and probable areas of segregations of closely allied forms can be increased. This proves that in the byegone age with the rise of the Himalayas how closely allied forms evolved with the change of geography and climate, finally the whole ecosystems. The wide distribution of most of the species of the old world reminds us the power of adaptation of different species to different environments. Kiauta (1984) cited the chlorocyphids occurring in the South and south-eastern parts of the old world, but their fossil ancestors used to occur in the european regime during the Tertiary periods. He opined that chlorocyphids radiated from the Indonesian region. Indian forms might have reached the country from Sumatra -Java areas, and *Libellago lineata andamanensis* Fraser and *L. l. blanda* Selys have evolved independently.

If anyone looks to the seventyseven species of Sikkim recorded since 1891 will find that *Megalestes irma* Fraser is endemic to the state; *Aciagrion olympicum* Laidlaw, *Anisopleura subplatystyla* Fraser, *Bayadera indica* (Selys), *Calicnemia mortoni* (Laidlaw), *Burmargiolestres laidlawi* lieftinck, *Onychogomphus bistrigatus* Selys, *Anotogaster basalis palampurensis* Fraser occur only in the Himalayas while *Anax immaculifroms* Rambur is rare in the Himalayas. Other species are ubiquitous occurring in different parts of the old world. *Neurothemis Intermedia Intermedia* Rambur, *N. i. atalanta* Ris and *N. i. degener* Selys occur in different ecosystems present in Sikkim. Studies on the occurrence of species in particular season, their distribution patterns as well as their ecology help to measure the degree of primitiveness of a particular population.

In India five hundred species and subspecies occur, of which 40% is endemic and 60% is nonendemic. It proves that the ecosystems of India, guarded by the Himalayas, the Thar desert, the oceans, how much important in the formation of new taxa. In India three major zoo-centres have so far been recognised, *viz.*, North-Eastern part, the Western Ghats and the Andaman Nicobar group of Islands. The Ganga basin which is not a zoo-centre but supports maximum number of species, since it provides sufficient number of breeding areas. Arunachal Pradesh, a rain forest area, contains nearly ninty species and subspecies but only one endemic, while the Andaman-Nicobar group supports only fortyseven species and subspecies with six endemics. Although both are rain forest areas but due to lack of sufficient breeding grounds in the islands the species number is fairly less than Arunachal Pradesh. Due to sufficient number of breeding areas Calcutta, a city, supports nearly sixty species without any endemic forms. The vegetation also plays important role in the diversity of dragonfly species. For instance, in the Sal forest areas of the central India where forest floor does not support bushes and other small trees population of Odonata become less diversified. Because dragonflies prefer to remain near water and bushes for their roost and rest. Moreover, bushes provide shelter to smaller insects which are prey of dragonflies. Although, relation between plants and odonates have not been studied seriously but it can be conjectured that small trees play very important roles in the diversification of dragonflies of a particular ecosystem. Therefore, it is conjectured that both vegetation and water play very important roles in the diversity of dragonflies in an ecosystem. Peters (1981) contended that odonates of low lands have more vitality than high landers. Hence the plain dwellers occur in diversified ecosystems.

Urbanisation and industrialization also play significant roles in the diversity as well as vitality of dragonflies. Effect of urbanisation and industrialization in the lives of dragonflies is easily understood by studying the fauna of Alahabad and Calcutta. During the period from 1920 to 2000 Alahabad lost 2 species, viz., *Lestes umbrinus* Selys and *Platygomphus dolabratus* Selys; while Calcutta lost 5 species during the period from 1917 to 2000. Effects of industrial effluents on the lives of dragonflies have been shown by Subramanian and Prabha (1998).

Adaptability of Dragonflies although varies from species to species but some are highly

adaptable to new environments. For instance the establishment of *Crocothemis servilia servilia* (Drury) in United States of America (Florida) reveals that dragonflies sometimes do not feel disturbed even if they are shifted from their original homeland.

Ecological conditions sometimes act as areas of speciation and sometimes play negative roles. For instance the Eastern Ghats, the Chhotanagpur upland though faitrly hilly but does not have any endemic form. It is because they are in connection with the Ganga plain. Hence the fauna of these regions got opportunity to have genetic exchange and reduce the population effects for the formation of new forms. Actually they act as the corridors for the exchange (Mitra 2000). Among other zoo-centers of India the hilly tracts and forests of eastern India help in the speciation due to isolation; similar is the case with the western ghats and the Andamans and Nicobars. Andaman and Nicobar fauna bears affinities with the fauna of Indian mainland, Myanmar and Sumatra. The south Indian fauna bears affinities with the fauna of Ceylon (Sri Lanka). The north-east Indian fauna is the product of fauna of Indo-Burma (Mayanmar) frontier, Indo-chinese elements, India-China border as well as the old gondwana fauna. Each border line area has been divided into a number of small ecological pockets which help in speciation (Mitra 1999).

SUMMARY

The paper deals with a review on ecology of Odonata in general with additions of new facts on ecology of Indian Odonata recorded recently.

The paper also cites lists of species and subspecies occurring in physiography based different ecosystems of India—Eastern Himalayas (Darjeeling, Sikkim, Arunachal Pradesh); Western Himalayas (Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh/Uttaranchal); Indo-Ganga- Brhmaputra plains (Ther desert, Ganga Basin, Brhmaputravalley); Meghalaya (Mikir Hills); Purvanchal (Naga Hills, Cachar Hills, Northern Patkai Hills, Lusai Hills, Mizo Hills, Manipur); Peninsular uplands (Western Ghats, Nilgiri Hills, Deccan plateau, Eastern Ghats, Chhota Nagpur plateau, Central upland), and Insular fauna.

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PLATES

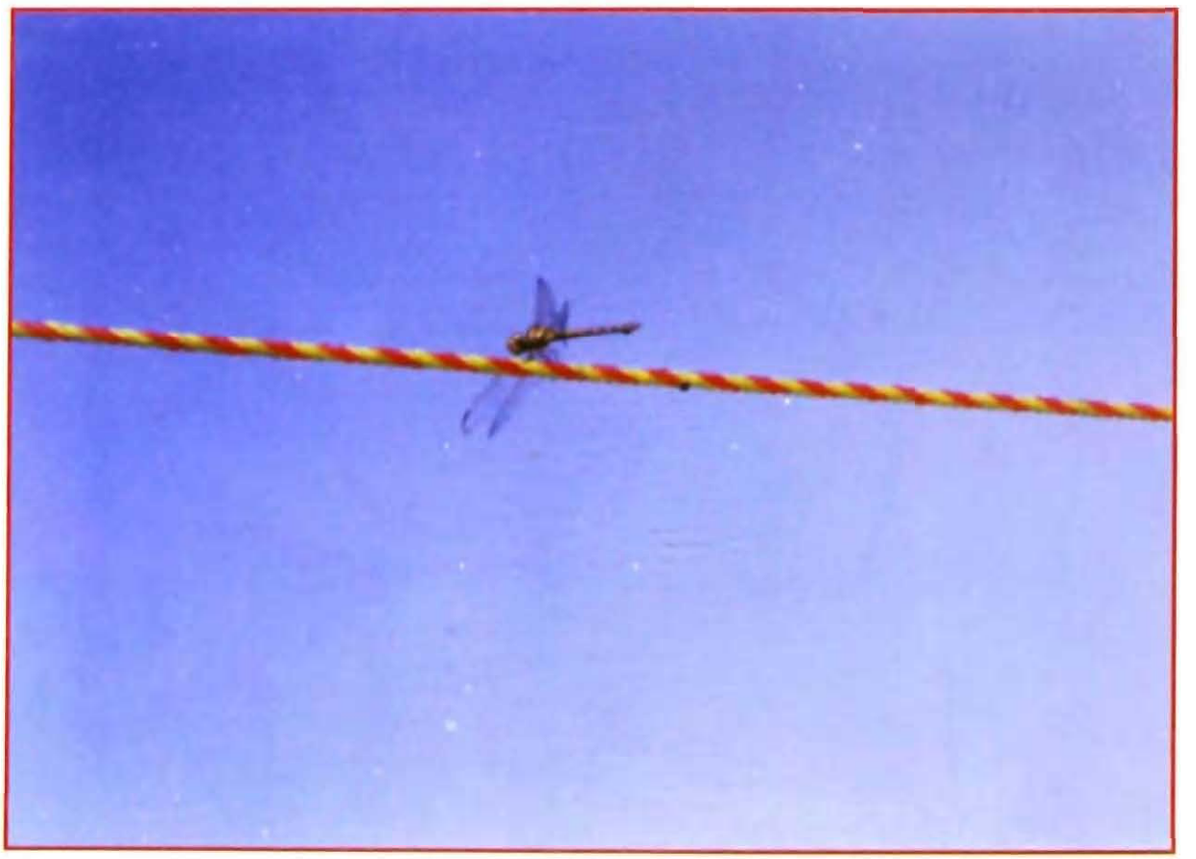
PLATE 1

Thermo-regulation of ***Lathrecista asiatica asiatica*** (Fabr.).

Breeding of ***Crocothemis servilia servilia*** (Drury).

PLATE 2

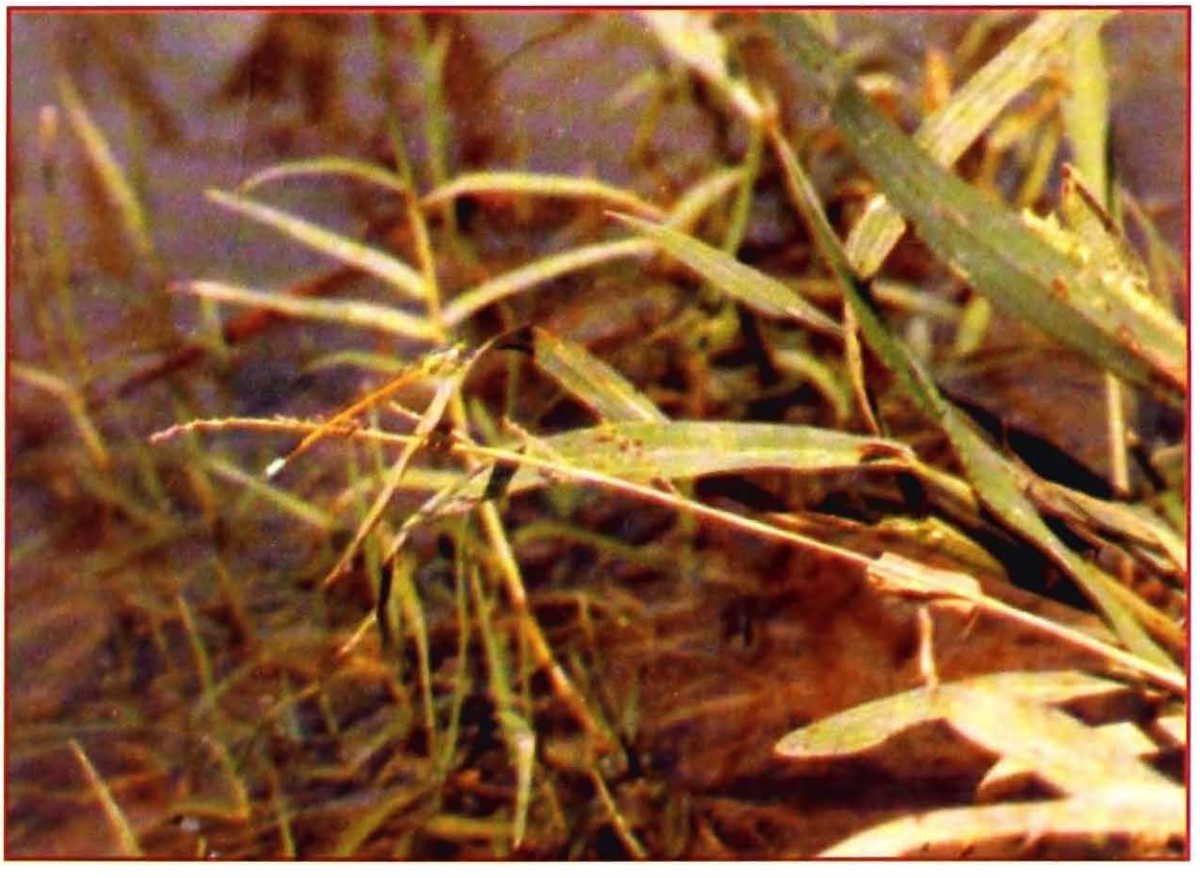
Thermo-regulation of ***Neurothemis intermedia intermedia*** (Ramb).



Posture of rest of ***Lathrecista asiatica asiatica*** (Fabricuis).

PLATE 3

Thermo-regulation of ***Orthetrum pruinosum neglictum*** (Ramb).



Thermo regulation of ***Ischnura aurora aurora*** (Brauer).

PLATE 4

a

b

Karyological subspecies of a) *Crocothemis servilia servilia* (Drury) and b) *C. s. marianae* Kiauta of Japan

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