Discussion

Inventory and systematic studies of the catfish superfamily Sisoroidea and family Bagridae has been carried out. Three families viz., Amblycipitidae, Akysidae and Sisoridae are presently included under the superfamily Sisoroidea. In northeast India, 59 sisorid catfish species under 20 genera are found. Maximum diversity is observed in the family Sisoridae which have 19 genera and 52 species. Genus *Glyptothorax* represents maximum number of 13 species including many new species. *Bagarius* is found to be the largest sized and erethistids the smallest sized representative of the superfamily. Family Bagridae is next to Sisoridae to have diverse forms consisting of 29 species under eight genera.

The catfish fauna of northeast India may be subdivided into four drainages-based geographic units:

1) The Brahmaputra drainage, that flows in the Ganga-Himalayan foothills, upper Brahmaputra and middle Brahmaputra ecoregions.
2) The Barak-Meghna drainage that flows in the Ganga-delta & plain ecoregion.
4) The Chindwin-Irrawaddy drainage in the Sittang-Irrawaddy ecoregion.
Diversity of the catfishes under study among the major drainages of northeast India are summarised below:

<table>
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<th>Brahmaputra</th>
<th>Barak-Meghna</th>
<th>Kaladan</th>
<th>Chindwin-Irrawaddy</th>
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<td>Family</td>
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<td>Endemic species</td>
<td>38</td>
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Fig. 7.1. Freshwater ecoregions of Eastern Himalaya (redrawn after Abell et al., 2008)

Catfishes are found to have a varying degree of distribution, some of which are restricted to a particular area. It can well be explained by the distribution pattern of certain catfishes, notably of *Glyptothorax*, *Hara*, *Mystus* and Glyptosternoids. Although the genus *Glyptothorax* has a wide distribution over a vast geographical area, the distribution of each of these rheophilic species is restricted to a particular region and they are not likely to occur
outside of it (Ng & Rachmatika, 2005). Of the 13 species of Glyptothorax recognized from northeast India in the present study, six species, viz., G. botius, G. cavia, G. ngapang, G. pantherinus, G. striatus and G. telchitta are endemic to the Brahmaputra drainage; two species, G. ventrolineatus and G. ngapang to the Chindwin-Irrawaddy and three species, viz, G. ater, G. caudimaculatus and G. chintuipuiensis to the Kaladan drainage. Species having similar characters, (i.e., presence of prominent tubercles, narrow caudal peduncle and absence of a depression in the thoracic adhesive apparatus), viz., G. ngapang is distributed in the Chindwin basin while G. botius and G. telchitta, in the Brahmaputra drainage.

Similarly, Batasio batasio, B. tengana, Conta conta, C. pectinata, Myersglanis blythii, Oreoglanis majusculus, Pareuchiloglanis kamengensis, Parachiloglanis hodgarti, and Rita rita are restricted in the Brahmaputra; Hara koladynensis, Pseudecheneis koladynae and Batasio convexirostrum in the Kaladan; Mystus bleekeri, Erethistes pusillus, Peudolaguvia spicula, Gagata cenia in the Barak-Meghana and Akysis prashadi, A. manipurensis, Mystus falcarius, M. ngasep, M. rufescens, Gagata dolichonema and Batasio affinis only in the Chindwin drainage. Another nine species viz., Sisor barakensis, S. rabdophorus, Gogangra viridescens, Glyptothorax cavia, G. manipurensis, Exostoma barakensis, Eretistoides montana, Mystus carcio and Olyra kempi are syntopically occurring in both the Brahmaputra and the Barak-Meghana drainages. However, species like Neotropius atherinoides is common to all the drainages. Some reports of restricted distribution in a particular basin other than its neighbouring drainages may be due poor exploration. Occurrence of Oreoglanis species in Salween-Irrawaddy and absence of the species in Chindwin drainage may be given as an example.

Abell et al. (2008) presented a global map of 426 freshwater ecoregions based on the distribution and compositions of freshwater fish species. He stated that the eastern Himalayan region (the region which covers the entire northeast India) has a species richness consisting of around 500 fish species.
The present work discovered six new species from the Kaladan drainage. The river is separated from the Ganga-Brahmaputra drainage by the Chittagong hill tract in the west and from the Chindwin-Irrawaddy by the Arakan Yoma hill range in the east. Thus the endemity of certain fish species in the region is highly expected. But the ichthyofauna of this drainage is poorly explored. It may be because of inaccessibility and differences in sampling intensities that Kaladan drainage was not featured more strongly in the freshwater fish richness map of Abell et al. (2008). Although Kar & Sen (2007) listed 42 species of fishes from Kaladan, they neither gave description of the species nor mentioned where the collections were eventually deposited. Thus it needs further verification.

The evolution of catfishes strictly follow vicariance hypothesis. A vicariance event is also supported by the geological evidence for large-scale changes in drainage systems (Brookfield, 1998; Clark et al., 2004; Zeitler et al. 2001). The drainage evolution can be summarized in four stages: a) Upper Yangtze, Middle Yangtze, Upper Mekong and Upper Salween rivers drained into the South China sea through the paleo Red River, b) Capture/reversal of the Middle Yangtze river redirected drainage away from the Red River into the East China sea through the lower Yangtze river, c) Capture of the Upper Yangtze river into the lower Yangtze river, and of the Upper Mekong and Upper Salween rivers into their modern drainage position. The Tsangpo River was also captured to the south through the Irrawaddy River, d) Capture of the Tsangpo River through the Brahmaputra River into its modern drainage position. The distribution of Glyptothorax can be cited as an example. Although, the genus is considered to have a very wide distribution, each species of the genus are found to have restricted distribution.

A detailed taxonomy and other relevant findings of each genus under study are discussed below:
Amblycipitidae

*Amblyceps*. The catfish genus *Amblyceps* is characteristic in having the epiphyseal commissure of the supraorbital sensory canals immediately anterior to, and not passing through the epiphyseal bar; the anterior cranial fontanel narrowing abruptly along its posterior and offering epiphyseal commissure bony support from frontal; pinnate like rays along anterior margin of the procurrent and medial caudal-fin rays; the anterior nostril situated immediately anterior to the base of the nasal barbel and both lips with double folds (Chen & Lundberg, 1995).

Of the seven species of *Amblyceps* found in Indian region, five of them are found in northeast India. According to Chen & Lundberg (1995), presence of pinnate like rays on anterior margin of several procurrent rays just anterior to upper and lower branched rays of caudal fin is generic character of the genus, with the exception of a character not known in *A. murraystuarti* Chaudhuri. Ng & Kottelat (2000) and Ng (2001) reported indochinese species of *Amblyceps* to differ from those found in the Indian subcontinent in having poorly developed (vs. well developed) pinnate-like rays along median caudal fin. The character is prominent among *A. arunachalensis* and *A. tuberculatum* of northeast India. *A. mangois* has pinnate like rays along median caudal-fin rays only. Ng (2005d) treated *A. arunachalensis* as junior synonym of *A. mangois* based on original description and illustrations. Vishwanath & Linthoingambi (2007a) after examining holotype and fresh specimen of the former from type locality showed that both species are distinct in the character of eyes, interorbital space, caudal peduncle, number of vertebrae and length of caudal lobed and hence treated *A. arunachalensis* valid. Reports on the fishes of Manipur by Chaudhuri (1912), Hora (1921a, 1936), Menon (1953) & Menon (1954) did not include any representative of the genus. *Amblyceps mangois* as reported from Chatrickong River, a tributary of Chindwin basin in Manipur by Vishwanath *et al.* (1998) become misidentification and thus Linthoingambi & Vishwanath 2008 described it as *A. tuberculatum*. 
During the osteological studies, peculiar features in the structures of mesethmoid, position of anterior and posterior fontanels and shape of the supraoccipital spine are found which contradict the statement of Tilak (1963b) and (1966)

**Akysidae**

*Akysis*. *Akysis* species are small catfishes usually with tuberculate skin and (usually) a pattern of yellow patches on a brown body found in swift forest streams and large rivers throughout Southeast Asia (Ng & Kottelat, 2004).

The genus has been poorly studied, mainly due to difficulty in obtaining specimens and subsequent poor representation in museum collection. There are 21 species of *Akysis*, of which 15 are found in the mainland Southeast Asia (Ng & Kottelat, 1998; 200; Ng & Tan, 1999), and the rest in Sundaic Southeast Asia. Only three species are found in Indian region. Its distribution in northeast India (westwards and towards Chindwin has been confirmed and reported by Vishwanath *et al.* 2007. Two species viz., *A. manipurensis* and *A. prashadi* are reported from northeast India (Vishwanath et.al 2007).

Ng & Kottelat (1998) reported the genus to have two groups based on the morphology of the mouth and the nostrils: Pseudobagarius group and Variegatus group. *A. manipurensis* and *A. prashadi* belongs to Vareigatus-group as they have snout slightly protruding beyond apex of the lower jaw, anterior and posterior nostrils are relatively smaller and located further apart with a distance between the base of the nasal barbel and anterior nostril, located at tip of a short tube. In *A. manipurensis*, the nasal bone has short shelf-expansion on its dorsal surface. The complete fusion of the three bones of the lower lobe of caudal fin elements is also found in the species. Both the above characters are considered as derived and thus *A. manipurensis* become more advanced than the *A. prashadi*.
Sisoridae
The family is represented by maximum number of genera and species in northeast India.

Sisorinae. The genera included under this subfamily are Bagarius, Gagata, Gogangra, Nangra and Sisor. Based on several morphological and anatomical characters, a phylogenetic tree of the genus under this subfamily has been established. Four clades are obtained where Sisor and Gagata share a common clade showing a close phylogenetic relationship while Gogangra is found separating from other genera.

Bagarius. The catfish genus Bagarius is considered as the largest sized members of the family Sisoridae attaining a length of up to 2 meters. It differs from all other sisorid catfishes by two distinct characters: a) premaxillary bone of each side evidently composed of two ossifications instead of a single ossification and b) dentition of lower jaw markedly heterodont. Bagarius are one of the widely distributed catfish in South and Southeast Asia. So far four valid species of Bagarius has been reported (Ferraris, 2007). Roberts (1983) reported B. bagarius as a relatively small, primarily entomophagous species, apparently not exceeding 200 mm SL while B. yarrelli as the giant Bagarius species feeding mainly on prawns and fish and is distributed widely in India, Burma, Thailand, Laos, Kampuchea, northern and southern Vietnam, Sumatra, Borneo and Java. But H.H. Ng. (per. comm.) considers B. yarrelli from north eastern India to be actually B. bagarius and what Roberts identified as B. bagarius is an undescribed species (pending publication). He considered that the B. yarrelli in SE Asia (including Myanmar) is not conspecific with whatever found in the Indian subcontinent and it might be an unnamed species.

Gagata, Gogangra and Nangra. de Pinna (1996) stated that the three genera, Gagata, Nangra and Gogangra share a number of derived characters for sisorids that indicate the formation of a natural group. However he uncovered
many characters which distinguished the three genera from each other (Roberts and Ferraris, 1998). The present work on osteology of the three genera observed differences in the structures of mesethmoid, anterior and posterior fontanels, supraoccipital spine and in absence and presence of lateral fontanels which clearly distinguished the three genera among one another.

**Gagata.** The genus is diagnosed in having compressed head; depressed snout; small conical teeth in lower jaw; branchiostegal membranes broadly fused to isthmus; no serrations on anterior margin of pectoral spine; no well developed maxillary barbel membrane; outer and inner mental barbels close together with their origins nearly parallel, in a transverse line; short nasal and maxillary barbels; palatal teeth absent (Thomson & Page, 2006).

Seven valid species of *Gagata* are known of which three species viz. *G. cenia*, *G. gagata* and *G. dolichonema* are reported from northeast India. *G. gasawyuh* has been considered a junior synonym of *G. dolichonema* by Ferraris (2007). Hamilton (1822) described *G. cenia* from rivers in the northern part of Bengal. Originally, He (1996) described *G. dolichonema* from Yunan, China. Vishwanath & Darshan (2009) reported the first record of *G. dolichonema* from headwaters of Chindwin, India.

**Gogangra.** The genus *Gogangra* is characteristics in having- pectoral girdle with rugose coracoid process covered with thin skin; widely separated outer and inner mental barbels; origin of inner mental barbels anterior to origin of outer mantel barbels; absence of lateral cranial fontanel; live specimens with viridescent or silvery supraopercular mark.

Among the two valid species viz., *Gogangra laevis* and *G. viridescens*, the latter is found in northeast India. Roberts, 2001 stated that the genus is a monotypic sisorid catfish known from the Ganges and Brahmaputra River drainages in India, Nepal and Bangladesh. The genus was given the name *Gangra* by Roberts & Ferraris (1998), but as pointed out by Roberts (2001), the
Nangra. *Nangra* is distinguished from all sisorids by having maxillary barbels that extend beyond the pectoral fin base; very long nasal barbels; presence of palatal teeth and smooth anterior margin of pectoral spine. Among the five valid species, two species of *Nangra* viz. *N. assamensis* and *N. nangra* are reported from northeast India.

The identity of *N. nangra* was somewhat problematic in light of conflicting information provided in Hamilton (1822) and the lack of type specimens. As he didn’t save any types, several workers have tried to match Hamilton’s description and illustration with the species collected from the Ganga basin. Day (1877) proposed *Nangra buchanani* as a substitute for *Pimelodus nangra* Hamilton, 1822, to avoid the tautonomy caused by his proposal to used *Nangra* as a generic name. It appears not to be a strict replacement name, and specimens from several localities mentioned in the account must be considered syntypes of *N. buchanani*.

Sisor. The genus is distinguished from all other sisorid genera in possessing the following synapomorphies (de Pinna, 1996): mandibular laterosensory canal absent, vertebrae with transverse processes, anterior margin of pectoral spine with serrations, bony plates on surface of body, and first principal caudal fin ray enlarged and elongated as a filament.

The type genus of *Sisoridae*, *Sisor* Hamilton is highly unusual and is the only Asian catfish with bony plates on the surface of the body (which otherwise occurs only in higher Loricarioids and the Doradidae in south America, and the Douminae in Africa) (Ng, 2003). Five valid species of *Sisor* are reported of which three species viz. *S. barakensis*, *S. chennuah* and *S. rhabdophorus* are found in northeast India. While revising the genus, Ng (2003) redescribed *Sisor rhabdophorus* Hamilton and designated a neotype from
Bhagirathi River, Gangetic basin, West Bengal, India. He also described *S. chennuah* from Brahmaputra basin.

**Glyptosterninae.** The representing genera of this subfamily are *Exostoma*, *Glyptosternon*, *Glyptothorax*, *Myersglanis*, *Oreoglanis*, *Pareuchiloglanis*, *Pseudecheneis* and *Pseudolaguvia*. Their phylogenetic relationships are also established on the basis of different morphological and anatomical characters. Seven clades are obtained in which *Exostoma* and *Glyptosternon* share a common clade showing a very close relationship while *Oreoglanis* and *Pseudolaguvia* are found to have distant relationship.

Glyptosternoid fishes are highly adapted to the torrential environment and occur only in the basin system around the Qinghai-Tibet plateau. They have a very wide distribution, from the Kabul River, the Indus River, the Yarlung Zangbo River, the Irrawaddy River, the Salween River and the Mekong River to the upper reaches of the Yangtze River. But most of the glyptosternoid species and genera appear only to the east Himalaya.

**Vicariance fish distribution and speciation of glyptosternoid catfishes.** The phylogenetic and biogeographical research indicates that glyptosternoid fishes originate from *Glyptothorax*-like ancestors under the strong stress of fast running water environment due to the interval uplift of the Qinghai-Tibet plateau (He et al., 2001). The development of such fishes can be arranged into three phases: 1. After the ancient Indian plate touched the Eurasian plate in Cenozoic era, this area gradually uplifted. This made the plateau appear and the plain uplift higher and higher. The *Glyptothorax*-like ancestor that adapted to the environment of large rivers was obligated to live in a very different environment and modified gradually as the primitive glyptosternoid fishes. This period lasted a very long time, allowing this ancestor to become distributed over a very wide area: in the west it can be found in the head water of river Kabul, Indus and Oxus; in the east we can find it in tributaries of the
Jinshajiang River. In this phase, the plateau was not very high, the climate was moist and warm, so the wide distribution of glyptosternoid fishes can be established. 2. The second uplift allows speciation resulting in the appearance of the genus *Euchiloglanis*, allopatrically distributed in small tributaries of Brahmaputra Basin and Jinshajiang River. The second uplift of the plateau produced harsher environment. This phase may have been very short as not much speciation occurred. 3. The third uplift, the so called post HimalayaS orogenic movement, by its largest scale and altitude, enormously affected speciation within the glyptosternoid fishes. In two billion years since the beginning of the Quarternary, this region rose over three thousand meters implying an average uplift rate. There is no center of origin of Glyptosternoid fish and its ancestor occurred in a wide area, stretching from river Kabul, Indus, Ganges, Yarlung Zangbo to Jinshajiang.

The shape of the lower lip is considered to be a chief characteristic in identifying genera of Glyptosternoid catfishes (Zhou et al. 2007). Several modification in lip structure and paired fins (Fig. 7.2) are found in these species for adaptation to hill stream mode of life. Glyptosternoid catfishes are not good at swimming over long distances and bottom living (Hora & Silas, 1952). This suggests that population in different rivers or in different sections of the same river could easily form variable populations with different body

Fig. 7.2. Ventral view of *Oreoglanis majusculus* showing lip and paired fin
types. The origin of Glyptosternoid fishes is predicted to be in the later Pliocene (Chu, 1979). In *Exostoma* and *Glyptosternon*, the distance between the vent and the anal-fin origin is 30-33% the distance between the pelvic-fin and anal-fin origins. However as the present study reveals that the position of vent is variable in *Pareuchiloglanis*, this character may be useful only for discriminating between species.

**Glyptothorax.** They are the most diverse catfishes of the family sisoridae, with about 71 valid species (Ng & Freyhof, 2008), widely distributed since before Pleistocene, before the Qinghai-Tibet uplift prior to the evolution of glyptosternoids (He et al., 2001), yet stenotopic (Ng & Rachmatika, 2005). Thirteen valid species including new species viz., *G. ater*, *G. botius*, *G. caudimaculatus*, *G. cavia*, *G. chintuipuiensis*, *G. chindwinica*, *G. granulus*, *G. manipurensis*, *G. ngapang*, *G. pantherinus*, *G. striatus*, *G. telchitta* and *G. ventrolineatus* are reported from northeast India in the present study. Hora (1923) referred to the genus to be still in process of adaptation to life in hill streams and the specific characters in them are not yet properly fixed. He divided the genus into two groups viz. *G. manipurensis* and *G. pectinopterus* group. *G. manipurensis* group has well developed adhesive apparatus only on the chest which is longer than broad; head and body not greatly depressed; spines of dorsal and pectoral fins strong and osseous. *G. pectinopterus* group has equally well developed adhesive organ on the outer rays of the paired fins; head and body greatly flattened; dorsal spine weaker and pectoral spine showing indentations along outer border; adhesive apparatus on the thorax considerably reduced and broader than long.

The consistency in the shape of the thoracic adhesive apparatus has made it a very useful character for diagnosing *Glyptothorax* species and the similarities in the branching pattern, the shape and organization of the ridges have been shown to be a useful secondary character (Ng & Kottelat, 2008). In the present study, *Glyptothorax* species occurring in Ganga-Brahmaputra and
Chindwin-Irrawaddy drainages are divided into three subgroups based on the characters of their thoracic adhesive apparatus. In subgroup 1, the skin ridges on either side of the apparatus extend and meet posteriorly to enclose a central depression as a circular pit (Jiang et al. 2011). The ridges are arranged in two rows, the inner converging towards and the outer radiating away from the depression, imparting a frond like pattern to the apparatus (Ng & Kottelat, 2008). *G. cavia*, *G. chindwinica* and *G. burmanica* belong to this subgroup (Fig. 7.3a).

![Fig. 7.3. Thoracic adhesive apparatuses of a. Glyptothorax chindwinica, b. G. granulus and c. G. panterinus.](image)

In subgroup 2, the apparatus has a shallow depression which opens posteriorly and not wholly enclosed by ridges (Fig. 7.3b). Ridges are also absent in the depression. There are variations in the shape, arrangement and distribution of ridges of the apparatus in this sub group. Majority of the *Glyptothorax* species viz. *G. alakanandi*, *G. annandalei*, *G. brevipinnis*, *G. caudimaclatus*, *G. chimtuipuiensis*, *G. conirostris*, *G. dikrogensis*, *G. dorsalis*, *G. garhwali*, *G. gracilis*, *G. granulus*, *G. indicus*, *G. manipurensis*, *G. ngapang*, *G. pectinopterus*, *G. saisii*, *G. striatus*, *G. trilineatus* and *G. ventrolineatus* belong to this subgroup. In subgroup 3, the central depression is absent in the thoracic adhesive apparatus (Fig. 7.3c). Ridges of skin radiate from posteromedial...
extent of the apparatus providing a slight depressed area due to the laterally 
raised ridges. Skin ridges are present all over the apparatus. *G. botius, G. panda, 
G. telchitta* and *G. pantherinus* fall in this subgroup. *Glyptothorax* species having 
central depression in the form of pit is found to have more advantage to 
hillstream mode of life.

Large variations in osteological characters of the premaxilla, Weberian 
lamina, infraorbital series, the shapes of the vomer and frontal have been 
observed among the members of the genus suggesting the paraphyly of 
*Glyptothorax*. The study shows that structure of premaxilla in most of the 
examined species have a pair of medially located proximal elements and 
another pair of distal elements in addition to proximal elements. Gauba (1966) 
recorded the premaxilla of *G. cavia* as being generally segmented or fused to 
form an enormously broad band that extends a considerable distance 
posteriorly across the palate. However, he fails to notice the numerous 
individual toothplates tightly attached by connective tissue. The posterior 
portion of weberian lamina is found to be extended laterally to the level of the 
lateral margin of its anterior portion except in case of *G. cavia* and *G. 
chindwinica* in which the lateral extension of the posterior portion of the 
weberian lamina is long and reaches almost to the distal tip of the 
parapophysis of the fifth vertebrae. The number of infraorbital bones is found 
to be variable. *G. botius* has six infraorbital bones; of which sixth is longest 
while the fifth, the shortest. Both *G. ngapang* and *G. chindwinica* have nine 
infra-orbital bones, while *G. cavia* has ten. In the remaining species, there are 
eight bones in the series. The third infra-orbital in *G. ngapang* bears a broad 
ventral laminar process. Both *G. cavia* and *G. chindwinica* have a larger and 
broader body of the lacrimal when compared to other species examined. The 
orbital notch of the *Glyptothorax* is formed at the lateral margin of frontal as a 
shallow depression, forming an arc smaller than a semicircle. *G. honghensis* 
(Zhou & Zhou, 2005), *G. fukiensis* (Diogo et al., 2002) and *G. major* (de Pinna, 
1996) have also shallow orbital notches. However, in *G. cavia* and *G.
chindwinica, the notch is deep and forms an arc larger than a semicircle. In all the species examined (except G. cavia and G. chindwinica), the anterior margin of the head of the vomer is concave resulting in the formation of a thin lateral process and another sharply pointed medial anterior tip. In G. cavia and G. chindwinica, the head of vomer is very large and broad with roughly convex anterior margin.

Based on several anatomical and morphological characters, a phylogenetic tree of the Glyptothorax species of northeast India has been able to established. 12 clades are obtained and the degree of similarities among the species could be known.

Pseudecheneis. Catfishes of the genus Pseudecheneis are rheophilic and bottom dwellers. They are easily diagnosed by the presence of a thoracic adhesive apparatus consisting of transverse ridges separated by grooves, respectively called laminae and sulcae (de Pinna, 1996; Roberts, 1998).The swimming capacity of Pseudecheneis is poor and their mobility is limited. The population of Pseudecheneis among river systems and/or in the same river system are easily isolated due to lack of individual migration and gene exchange, which is the main reason resulting in the speciation.

Zhou and Zhou (2005) studied the phylogenetic relationships of 6 recorded species in the genus and hypothesized that it may have evolved in the late Pliocene and further commented that with the uplift of the Qinghai-Xizang plateau, base on the ancient geography, this genus might have differentiated four times.

According to Saxena & Chandy (1966), among the sisorids, only Glyptothorax and Pseudecheneis use the outer ray of the pelvic fins in perching and consequently this ray is broad and flat. In Pseudecheneis, this has resulted in extreme modification, the utility of which has been emphasized by Hora (1923). The pelvic fins, besides being used for perching also assist in crawling movements.
So far, eight valid species of *Pseudecheneis* are known of which four species, viz., *P. sireni*, *P. sulcata*, *P. koladynae* and *P. ukhrulensis* are found in northeast India. Talwar and Jhingran, 1991; Chu & Mo, 1999 consider *P. sulcata* to be the most widely distributed glyptosternine catfish, being reported to occur in Ganga, Brahmaputra, Salween, Irrawaddy and Mekong river drainages. However, Ng (2006d) restricted the species to the Brahmaputra drainage only. Kar & Sen (2007) also listed *P. sulcata* as present in the Koladyne River. Since *Pseudecheneis* species have restricted distribution and it has already been mentioned that the identification as *P. sulcata* of some specimens from neighbouring drainages requires confirmation (Ng & Edds, 2005), the identity of the species reported by Kar & Sen (2007) needs verification.

Osteology of the genus has been carried out. Posterior fontanel is reduced in *P. koladynae* in comparison to the other species present in northeast India which is an advanced character. Differences in the structure of neural spine, facial bone, cleithral bone, presence and absence of dorsal fin spur, number of vertebrae after anal fin insertion are observed in the study.

A phylogenetic tree has also been established on the basis of different morphological and anatomical characters. Three clades are obtained where *P. sulcata* and *P. sireni* are in the same clade while *P. koladynae* and *P. ukhrulensis* are found to be with different clades.

**Conta, Erethisites, Erethistoides, Hara and Pseudolaguvia.**

de Pinna (1996) removed several taxa from Sisoridae and placed them into the family Erethistidae. Those were the taxa within the genera *Conta, Erethisites, Erethistoides, Hara and Pseudolaguvia*, together with the subsequently named genera, *Ayarnangra* and *Caelatoglanis*. But Ferraris (2007) has put these genera under the family Sisoridae considering them as a natural group along with *Glyptothorax* and possibly others, but not the glyptosternoid genera. He reported two species each of *Conta* and *Erethisites* and seven of *Erethistoides*.
Eight valid species of *Hara* are reported by Ng & Kottelat (2007) while Ng (2009) recognized eleven valid species of *Pseudolaguvia*. Among the above valid species, two of *Conta*, one of *Erethistes*, two of *Erethistoides*, three of *Hara* and seven of *Pseudolaguvia* viz., *Conta* *conta*, *C. pectinata*; *Erethistes* *pussillus*; *Erethistoides* *Montana*, *E. senkhiensis*, *E. sicula*; *Hara* *hara*, *H. jerdoni*, *H. koladynensis*; *Pseudolaguvia* *ferrula*, *P. shawi*, *P. ferruginea*, *P. flavida*, *P. vigrulata*, *P. ribeiroi* and *P. specula* are found in northeast India. Considering the utility of the pectoral spine morphology as a useful diagnostic character for distinguishing the erethistid genera to be doubtful, Ng (2005) identified two new unambiguous synapomorphies diagnostic for erethistoides.

1. Neural spine of the first eight post-weberian vertebrae strongly depressed, inflected posteriorly, and positioned in a groove formed by prezygapophysis of the vertebrae immediately posterior. The neural spines of the corresponding vertebrae immediately posterior. The neural spine of the corresponding vertebrae in other erethistid genera is not as strongly depressed, and not strongly deflected posteriorly.

2. An enlarged maxilla that is almost as long as the palatine. The maxilla is half or less than half the length of the palatine in other erethistids.

Further the genus *Conta* is diagnosed in having an elongated caudal fin lobe, *Erethistes* in having pectoral spine with divergent serrations, *Hara* in having internally serrated pectoral spine; coracoid with ventral anterior process and *Pseudolaguvia* in having a thoracic adhesive apparatus with a median depression.

Thomson & Page (2006) consider the genus *Erethistes* and *Hara* to be synonyms. Ng (2006e) using both morphological and molecular characters indicates that *Hara* (including *Erethistes* is paraphyletic) dividing it into three clades: 1) *H. filamentosa*+*H. mesembrina*, 2) *H. jerdoni*+*H. minuscula*, 3) *E. pusillus*+all other species of *Hara*. However the three clades were not recovered in the analysis of the morphological dataset alone and no morphological
synapomorphies could be found to diagnose the three clades. Thus, *Hara* and *Erethistes* can be treated as distinct genera. Ng & Kottelat (2007) also consider *H. serrata* and *H. saharsai* to be junior synonym of *Hara*. *Hara serrata* described from the Jiri River, a tributary of the Barak River, itself a tributary of the Brahmaputra River which is within the recorded range of *H. hara* is diagnosed as a distinct species based on the serrated anterior edge of the dorsal spine. But Ng & Kottelat (2007) examined that *H. hara* also has anteriorly serrated dorsal spine. Thus no other characters could be found to distinguish the two species.

**Bagridae.** Bagridae was previously recognized to contain many phylogenetically heterogenous taxa. However (Mo, 1991) restricted it to the Bagrus-like group which includes a single African genus Bagrus and 15 Asiatic genera eg. *Rita*, *Batasio*, *Nanobagrurus*, *Pseudobagrurus*, *Peltobagrus*, *Olyra*, *Neotropius*, *Hemibagrurus*, *Mystus* and *Sperata*. Among them, the genera *Rita*, *Batasio*, *Olyra*, *Neotropius*, *Hemibagrurus*, *Mystus* and *Sperata* are found in north east India. The family was composed of four subfamilies, the Bagrinae, Ritinae, Batasinae (Tilak, 1967) and Bagrichthydae (Jayaram, 1966b). The genus *Olyra* which has been put under the family Bagrinae has now been kept under the separate subfamily Olyrinae.

The taxa of the family Bagridae are diagnosed by a) presence of a unique, well developed muscle, retractor posttemporalis stretching between the cranium and posttemporal, b) long, ventrally turned Mullerian process, c) presence of a prominent posterior process of the posttemporal, d) dorsomedian limb of the posttemporal being thickened and bearing a prominent posterior surface on which a thick layer of the epaxial muscle attaches, e) large, crescentic vomerine head and f) well developed posttemporal fossa with a posterolateral opening.

Based on different 12 morphological and anatomical characters, a phylogenetic relationship among the genera of the family has been
established. Among the genera under study, *Neotropius* and *Mystus* are found to have close phylogenetic relationship while *Olyra*, *Neotropius* and *Rita*, *Sperata* are found to have distant relationship.

**Rita.** The species of this genus are found in large rivers throughout the Indian subcontinent and Myanmar, and are capable of reaching sizes to 1500mm TL (Talwar and Jhingran, 1991), although mature specimens of 200-300mm SL are more commonly encountered (Ng, 2004). The genus is diagnosed by the following synapomorphies (Mo, 1991): single pair of mandibular barbels, elongated weberian apparatus firmly sutured to the basioccipital, and the sensory canal on the post-temporal enclosed within the bone. Six valid species of *Mystus* are known of which only the single species, *Rita rita* is recognized from northeast India.

*Rita* has been recognized as a monophyletic group and as a sister group of *Nanobagrus* on the basis of its having seven ventral fin rays, a fenestral space between the preopercular and hyomandibular and dorsal fin possessing five free proximal radials.

**Mystus.** Fishes of the genus *Mystus* are small to medium-sized bagrid catfishes occurring in South Asia. Roberts (1994) recognized *Mystus* to have an elongate cranial fontanel reaching up to the base of the occipital process, long maxillary barbel, very long adipose fin, 11-30 gill rakers on the first gill arch and 37-46 total vertebrae, about equally divided between abdominal and caudal regions. So far 33 valid species of *Mystus* are listed of which 10 species viz., *M. bleekeri, M. carcio, M. cavasius, M. dibrugarensis, M. falcarius, M. ngasep, M. pulcher, M. rufescens, M. tengara* and *M. vittatus* are found in northeast India.

*Pimelodus carcio* was described by Hamilton (1822) from northern parts of Bengal. Day (1877) synonymised *Pimelodus carcio* with *Macrones vittatus* (now *Mystus*). Misra (1976), Sharma & Dutt (1983), Roberts (1992), Menon (1999), Jayaram (2006) and Ferraris (2007) also considered it as a synonym of
the *Mystus vittatus*. Jayaram & Sanyal (2003) also treated it as a synonym of *M. tengara*.

The present study obtained *Mystus* specimens (92) from Brahmaputra River, Assam and its characters are found to be consistent with the original description of *M. carcio*. Thus, *Mystus carcio* is redescribed and is found to be distinguished by its small size maturing at 44.0 mm SL; shorter adipose-finbase, pelvic fin reaching anal-fin origin vomerine tooth-patch interrupted at midline & pectoral girdle with coracoid shield exposed ventro-laterally below pectoral fin.

Osteology of skull of *M. falcarius* has been carried out and it has been compared with those of *M. carcio* and *M. tengara*. Differences in the vomerine tooth-patch and extension of posterior fontanel are found in the study.

*Hemibagrus*. This genus lacks uniquely shared derived features and is diagnosed by having (i) a depressed head and (ii) large, thin and plate-like metapterygoid. Among the 36 valid species, three species viz., *H. menoda*, *H. microphthalmus* and *H. peguensis* are found in northeast India.

Although no unique synapomorphies have been discovered, these species, which were previously included in *Mystus*, are provisionally assigned in this genus for two reasons. Firstly they are phylogenetically more closely related to *Bagrus* and *Aorichthys* (*Sperata*) than to the species of *Mystus*. Secondly, they are morphologically and biogeographically identical in contrast to all the other bagrid taxa. The fishes of this group occur only in Southeast Asia, west to Burma and northward to South China. In the phylogenetic analysis of the present study, *Hemibagrus* is found to be closely related to *sperata* while it has distant relationship with *Mystus*.
**Neotropius.** *Neotropius* has been recognized as a well defined monophyletic group. It is characterized by having separate patches of vomero-palatine teeth, short and aor shaped adipose fin, prominently producing premaxilla and anal fin with more then 24 rays. *N. atherinoides* is the only species of the genera found in northeast India. It was previously synonymised with *Pseudetutropius* (Tilak, 1964). But during the phylogenetic analysis, they are treated as distinct genera.

**Batasio.** The genus has been recognized as monophyletic on the basis of having large sensory pores on head and much narrower mental region. Mo (1991) hypothesized it as second basal taxon of the Bagridae. The median branch of canal on the frontal is also lost in *Batasio*. The absence of ectopterygoid and development of long transverse bar-like entopterygoid is a synapomorphic character of the genus.

Ng (2006b) recognized 16 valid species of *Batasio* of which 6 valid species viz. *B. batasio, B. fasciolatus, B. niger, B. spilurus, B. tengana* and the new species, *B. convexirostrum* are recognized from northeast India. Caudal bone osteology of *B. convexirostrum* reveals the fusion of primary and secondary hypuropophysis which is one of the diagnostic characters of the Bagrid family.

**Olyra.** The genus *Olyra* is a highly specialised member of the family Bagridae. Hora (1936) proposed the family Olyridae to accommodate the genus because of its distinct morphological difference from the Asiatic bagrids and amblicipitids. However Mo (1991) included the genus to family Bagridae because of the following synapomorphies: exclusion of the prootic from the trigemino-facial foramen, great reduction of posterior process of supraoccipital; absence of ectopterygoid; posteriorly shifting of dorsal fin and eel-shaped body. Ferraris (2007) reported eight valid species of *Olyra* of which three species, viz., *O. horae, O. kempi* and *O. longicaudata* are found in northeast India.
Northeast region of India has the highest diversity of catfish fauna when compared to other parts of the country. Out of the 12 families of catfish recognized from India, 10 families are found in northeast India. According to the IUCN assessment map of the Eastern Himalaya, maximum richness and endemicity of fish species are found in the northeast India. The most threatened species are also found in this region, particularly in the Barak and Chindwin basin in Manipur and the adjoining areas (Vishwanath et al., 2010).

As much as 27% of fish species are found to be data deficient. The reasons are: approximately half of the species under this category have been described recently; the species were described either from older material that had been misidentified, or from recent collections made in poorly sampled areas. In many cases, the descriptions are based on only one or a handful of specimens. Given the small numbers of type species and the fact that the type series of these species are typically obtained from only a single locality, adequate information on the biology and distribution of these species for an accurate assessment is lacking.

Dudgeon et al. (2006) have identified five major interactive threats to the freshwater ecosystem, viz., flow modification, habitat degradation, overexploitation, species invasion and water pollution. In addition, global climate change is another threat to the life of fishes, particularly to those inhabiting in the coldwater regimes.

Northeast India is considered to be the “future power house of the country”. The proposal of hydroelectric power project in several regions of northeast India by NHPC (National Hydroelectric Power Cooperation) and that of Kaladan multipurpose project will create a great conflict with freshwater biodiversity affecting the fish fauna. With the development of the
Tipaimukh high dam hydro-electric project, there will be flow modification and flooding of the Barak basin in the western part of Manipur. Habitats of several hill stream fishes will be disturbed and upstream and downstream parts of the river will be fragmented.

Since the region harbours many threatened or endemic species, it is necessary to take up immediate conservation measures. Some of the conservation strategies are given below:

1. The restoration of natural flow regimes should be adopted by dam and river management authorities, and technologies to mitigate the impact of barrages to migratory species implemented.
2. Local communities should be encouraged to participate in the conservation of fishes and their habitats, including awareness programmes on the status and importance of fishes and their habitats.
3. Fish sanctuaries for the protection of threatened species or vulnerable habitats should be established in suitable areas.
4. Domestic and international legislation should be implemented against destructive fish harvesting techniques such as dynamiting, poisoning and electric fishing.
5. Research and training in fish taxonomy should be promoted, and resources made available to ensure that workers have access to current international research.
6. There should be sustainable utilization of fish resources.