

## Fishing in the Siang belt of Arunachal Pradesh, India: Learning Traditional Ecological Knowledge of *Adi* and *Galo* communities

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Received 03 February 2015, revised 1 March 2016, updated 07 June 2016

This research was carried out with the *Adi* and *Galo* tribes of East Siang and West Siang districts of Arunachal Pradesh, India to understand fishing methods employed by them using stones and boulders occurring in the river beds of small tributaries of the Siang River in the study area. The identified sustainable fishing technique is locally known as *Lipum* and practised by these communities. The capture of fish ranged from 4-10 kg per *Lipum* and one person could make 3-4 different *Lipum* structures per day. *Lipum* is prepared during winter season (in the month of November and December) and to undertake fishing during January and February. To prepare the *Lipum*, stones are placed in a circle with a diameter ranging from 1.5 m to 2.3 m, and arranged to produce a structure around 0.7 - 1.2 m high, depending upon water depth. Care is taken so that the *Lipum* remains submersed in water throughout the winter season. The *lipum* acts as a shelter for the fishes as it provides congenial environment to the fishes, where different types of algae grows as well as water flow becomes slow inside the structure. During harvesting of fish from the *lipum*, the entire structure is surrounded with the *ishir* with an opening in the top. The *edir* is fixed with the *ishir* in the bottom in such a way so that the fish is unable to escape. Gradually the stones are removed from the *lipum* and the fishes are scooped up. This fishing technique has been sustainable for subsistence communities like *Adis* and *Galos*. However, recent socio-political changes such as fishing with the use of electrical means like use of generator, battery, blasting, poisoning, etc., are affecting the dynamics of this practice. There is need to incorporate such Traditional knowledge practices in conservation and state fishing regulations.

**Keywords:** *Lipum*, Traditional fishing, *Adi* and *Galo* tribes, Siang river

**IPC Int. Cl.<sup>8</sup>:** A01K 69/00, A01K 71/00, A01K 73/00, A01K 74/00, A01K

Fishing is an age old practice of human civilization; various methods of catching fish have been employed since the prehistoric times and fishing gear has evolved in different parts of the world, giving rise to diverse methods today. Several different types of nets, traps and hooks are used to catch fish. Key methods of trapping fish on stationary gear such as fish traps or set nets, and attracting fish to hooks using baits, artificial lures or other means, such as light, are practiced globally. In India different types of tradition fishing methods, namely use of different plants and plant products, *jeng* fishing in Assam, *bheta* fishing, use of catamarans in Tamil Nadu, dinghies in Bengal and Orissa, hunting using weapons such as spears and harpoons are common. In places, particularly in North eastern India people are still using traditional fishing methods. North eastern India is known to be one of the hotspots of fish biodiversity<sup>1</sup>. Fish have long been

an integral component of diet for tribal communities there, including in Arunachal Pradesh, which is predominantly non-vegetarian. Per capita fish consumption in this region is around 11 kg / person, compared with a desired level of 21 kg. The region's people experience a 50-55 % shortfall in fish consumption, an amount met by procurement from outside the region<sup>2</sup>. Fish are an indispensable item of food for the *Adi* and *Galo* tribes of Siang belt of Arunachal Pradesh and fishing is a subsidiary occupation from time immemorial. The *Adi* and *Galo* tribes implement unique traditional knowledge in their fishing. Indigenous knowledge on use of different plant parts, *viz.* leaves, roots, barks, fruits, etc., or whole plant by different tribes of Arunachal Pradesh for fishing and hunting was also reported<sup>3</sup>.

Networks of numerous rivers, streams, and natural water bodies in the Siang area provide a vast scope for fisheries activities. Fishing is also a favourite leisure time of people in the Siang belt. Use of fish

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traps is a common traditional fishing method all over the world<sup>4</sup>. Siang and other small rivers passing through East Siang and West Siang districts are quite rich in fish species and the local tribal people employ a number of unique fishing methods based on their very own indigenous traditional knowledge to catch these fishes for their daily diet. They use different types of fish trap devices, of which *Lipum*, also known as *engo lingkum* in *Adi* dialect (*engo* means fish and *lingkum* means house of stone), is one of the oldest techniques for catching riverine fishes. Here, we describe *lipum* fishing and discuss, its scientific rational, sustainability and the socio-economic implications of its use among the districts' tribal communities.

## Methodology

### Study area

Arunachal Pradesh is the largest state in North East India, surrounded by Bhutan to the West, China to the North and North east and Myanmar to the East. Out of the 17 districts in the state, the Siang belt is situated in the South eastern side adjoining Assam. East Siang district is located between 27.30° to 29.42° North latitude and 94.42° to 95.35° East longitude with an altitude of 133 m in Ruksin to 752 m in Riga. West Siang district is located between 28.15 -29.15° North latitude and 94.0 - 95.0° East longitude with an altitude of 100 m in the foothills of Likabali to 2000 m in Mechuka and Monigong Blocks. The Siang belt features hillocks, hills, and small to big rivers including the mighty Siang, commonly known in Assam as the Brahmaputra. There are number of tribes and sub-tribes each with their own dialects, culture, beliefs, dress and food habits living in mutual harmony in the region. Among them *Adi* and *Galo* are the major tribal peoples. Rice and fish are the prime source of nutrition for these people; the long rainy season spell (Fig. 1) in the hilly terrain supports paddy cultivation as well as traditional harvesting of different species of fish.

A survey was conducted in different locations of the Koyu, Sille, Sido-Dobung and Ledum rivers of East Siang district and the Ego, Kidi, Heei, Heipu and Siyom rivers of West Siang. Information on *Lipum* fishing was collected through field surveys and interviews with local *gaon burah* (village level community heads), fishermen of *Adi* and *Galo* tribal people from November, 2012 to February, 2013. All together 45 field surveys involving 108 persons

(88 male and 20 females) in age group between 36- 68 yrs were conducted. Open-ended questions were asked, to elicit responses on Traditional knowledge fishing practices and processes. Before the main interviews, the interview schedule was pilot tested to ensure its effectiveness. Participatory Rural Appraisal (PRA) methodology<sup>5</sup> was adopted to collect qualitative data on *Lipum* fishing. This technique allowed investigation of more detailed aspects of *lipum* fishing techniques and how these worked. *Lipums* from each river were observed and catching efficiency assessed. After data collection, a brief overview of our findings was sent back to each participating community and to obtain their feedback to validate our assessment. Prior Informed Consent (PIC) was obtained from the community leaders of respective villages for documenting and publishing information on *Lipum* fishing<sup>6</sup> activities.

## Results

### Construction of *Lipum*

Freshwater river fish of Siang river tributaries are known to live in stone depressions during the winter (i.e. November to February). Because of this, tribal people construct artificial dwelling places, *Lipum*, for these fish by stacking up stone in circles of around 2 m diameter and 0.8-1.0 m height (Table 1). At the bottom centre of the *lipum*, a depression is made with a special hollow as a suitable dwelling place (known as *likam*) for the fishes. Flat to oval shaped stones of 10-30 cm diameter, locally available, are collected and arranged in a circular fashion in such a way that the bigger stones are placed at the base and gradually smaller stones are placed on top of them. At the top of this structure, bunches of fern plant, locally known as

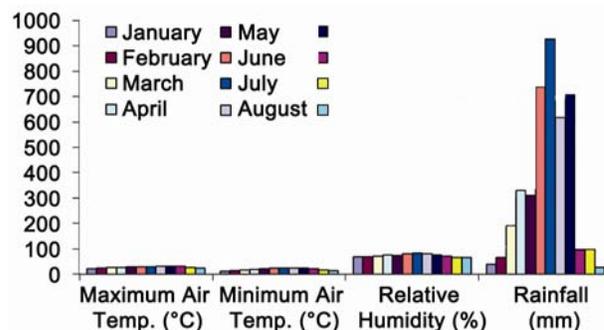


Fig.1—Graphical representation of monthly average (2008-2012) weather condition of Pasighat (28°4'N Latitude, 95°22'E Longitude and 152 m MSL Altitude), Arunachal Pradesh.

Source: Section of Agrometeorology, College of Horticulture and Forestry, CAU, Pasighat

Table 1—Diameter and height of the *Lipum* surveyed in different rivers of Arunachal Pradesh

River	Dia (m)	Ht. (m)	Dia (m)	Ht. (m)	Dia (m)	Ht. (m)	Dia (m)	Ht. (m)	Dia (m)	Ht. (m)	Dia (m)	Ht. (m)
Villages of East Siang District under study												
Koyu	Rina		Koyu		Rotte		Tabi Ripo		Kakki		Average	
	1.85	0.80	2.20	1.00	2.00	1.00	1.90	0.80	2.10	0.90	2.01	0.90
Sido-Dobung	Sido		Kora		Mane		Tene		Sipu		Average	
	1.70	0.80	2.10	1.05	1.85	0.95	2.20	1.10	2.00	0.95	1.97	0.97
Ledum	Ledum		Niglok		Ngorlung		Sille		Oyen		Average	
	1.90	0.75	2.20	1.00	2.25	1.15	1.75	0.85	1.80	0.75	1.98	0.90
Simang	Ditam		Riga		Boleng		NA		NA		Average	
	2.00	0.85	1.85	0.75	1.95	0.80					1.93	0.80
Villages of West Siang District under study												
Ego	Padi		Dali		Ego		Dari		Zirdo		Average	
	2.10	0.90	2.00	1.00	1.90	1.10	2.15	1.15	2.10	1.05	2.05	1.04
Kidi	Desi		Pagi		Regi		Nyigam		Nyodu		Average	
	1.75	0.80	2.15	1.05	1.95	0.95	2.20	1.00	2.20	1.05	2.05	0.97
Heei	Gori		Soi		Tare		Sago		Lipunamchi		Average	
	1.85	0.75	2.15	1.00	1.95	0.80	1.65	0.75	1.50	0.70	1.82	0.80
Heipu	Angu		Bagra		Dooji		Darka		Doke		Average	
	2.00	0.85	1.85	0.75	2.25	1.15	2.10	0.95	1.85	0.90	2.01	0.92
Siyom	Kabu		Bane		Biru		Eyieue		Logum		Average	
	2.30	1.20	2.25	1.15	1.95	0.80	1.75	0.80	1.90	0.85	2.03	0.96
	Dia(Mean± SD) m						Ht. (Mean± SD) m					
	1.99±0.18						0.92±0.14					

# Dia= Diameter in meter, Ht.= Height in meter

*ootaka* (*Botrychum lanuginosum* Wall. ex Hook & Grev), each around 1m long, are included, and held in place with another layer of stones. This vegetation provides partial shade inside the *lipum* and improves it as a habitat for the fish. A barrier of boulders is placed at 1-2 m distance on the upstream side of the *Lipum* to reduce the impact of the water currents on the structure. The *lipum* is left for more than one month, to house and acclimatize fishes and for the maximum number of fish to accumulate. One man can prepare 3-4 *lipums* per day and one family requires 20-30 such units in a season to meet their dietary requirements and provide supplemental livelihood. The success rate of this traditional technology depends mainly on the availability of fish in certain pockets of rivers as well as on the skill in constructing the *Lipum*. *Lipums* are in general constructed during day time preferably in the morning hours.

**Preparation of fishing gear**

***Ishir***

*Ishir* (in *Galo*) is prepared from split bamboo and cane, 1-1.5 cm width, and 2-3 mm thick and 8 m and

2 m in length, respectively. The splints are woven perpendicularly in a crisscross manner so that the mesh size remains between 3-5 mm, producing an *ishir* 8 m in length and 2 m in width. It is also called *dhari* (in Assamese) or *tarja* (in *Adi*). In some places, tribal people use a modification of an *ishir* called *chirago*<sup>7</sup> (in *Galo*), which is a big cylindrical basket of woven cane and bamboo. These devices are used to cover the *lipum* from all sides when the fish are harvested.

***Edir***

A basket-trap used in harvesting fish from the *lipum* is known as *edir* in *Galo* and *chepa* in Assamese (Fig. 2). It is a conical shaped bamboo sieve basket with a valve, tapering at one end<sup>8</sup>. There is an opening at the side of the trap with bamboo strips extended inwards so that the fish can easily enter the trap, but extended gill-like bamboo strips (locally known as *Dero*) prevent them from escaping. The opening of the trap faces towards the flow of the water. The diameter of the *edir* opening is 20-30 cm, while it varies in length from 60-100 cm.



Fig. 2(a-i)—Photographs of activities related to *Lipum*. (Photographs: S.M. Hussain & Toge Riba) (a) Constructed *Lipum*; (b) Harvesting of *Lipum*; (c) *Edir*; (d) Locally prepared eye-piece used during construction of *Lipum*; (e) Mixed haul of fishes harvested from *Lipum*; (f) Selling of smoked dried fish in local market; (g) Local method of fish cooking; (h) Fish cooking in bamboo stem; (i) Traditional Solar drying of fishes

#### Method of fish harvesting from *Lipum*

In harvesting fish from the *lipum*, the entire structure is surrounded with the *ishir* with an opening in the top. The *edir* is fixed with the *ishir* in the bottom in such a way so that the fish are unable to escape. Gradually the stones are removed from the *lipum* and the fishes are scooped up. Tribal people used to dismantle one *lipum* per week and to harvest 4-10 kg mixed species of fish per *lipum*. Generally the harvesting occurs early in the morning, as the fish exit the shelters during the day in search of food. Some of the harvested fish are consumed fresh by the family members, while the excess harvest is smoke-dried either for their own consumption later, or for sale in the local market. In any one village, 20-30 households prepare 400-500 such *lipums* in any river with a width of at least 10 m. A wide range of fish biodiversity can

be seen in the harvest from *lipum* prepared in different rivers of the Siang belt (Fig. 3). Similar fish biodiversity from rivers of Arunachal Pradesh has also been documented earlier<sup>9</sup>.

#### *Lipum* practice

*Lipum* fishing is practised more in the perennial rivers, viz. *Koyu*, *Sido-Dobung*, *Ledum*, *Simang*, *Ego*, *Kidi*, *Heei*, *Heipu* and *Siyom* flowing through a number of villages of East Siang and West Siang districts. Data recorded on the diameter and height of the *lipum* surveyed in various rivers at different village locations revealed that maximum diameter and height of a *lipum* constructed in the district was 2.3 m and 1.2 m, respectively, in the *Siyom* river flowing through *Kabu* village, whereas minimum diameter and height was 1.5 m and 0.7 m, respectively in *Heei*



Fig. 3—Commonly available fish biodiversity in *Lipum* of Siang Belt, Arunachal Pradesh.

(Photographs: S.M. Hussain & Toge Riba) (a) Local name: *Ngotup*, Sc. name: *Garra* spp; (b) Local name: *Ngolap*, Sc. name: *Macrornathus* spp; (c) Local name: *Orpu*, Sc. name: *Barilius barna*; (d) Local name: *Ringum*, Sc. name: *Acanthocobitis* spp; (e) Local name: *Reibo*, Sc. name: *Aborichthys* spp; (f) Local name: *Ngopi*, Sc. name: *Labeo dero*; (g) Local name: *Kadang, Ngori*, Sc. name: *Schizothorax* spp; (h) Local name: *Ngocho*, Sc. name: *Tor* spp; (i) Local name: *Orche*, Sc. name: *Semiplotus semiplotus*; (j) Local name: *Ribo*, Sc. name: *Schistura* spp; (k) Local name: *Ngopeeh*, Sc. name: *Garra* spp; (l) Local name: *Tayek*, Sc. name: *Amblyceps* spp

river flowing through *Lipunamchi* village (Table 1). Likewise, data recorded on fish catches indicated that a maximum catch of 10.0 kg per *Lipum* was obtained from the *Koyu* river, flowing through *Koyu* village of East Siang (Table 2). The lowest catch of fish, at 4.1 kg per *Lipum*, was recorded from the *Heei* river flowing through *Tare* village of West Siang. The results (Tables 1&2) clearly indicate that the quantity of fish catches was directly proportional to the

diameter and height of the *Lipum* (positive correlation of  $r = 0.45$  and  $r = 0.37$ , respectively).

**Scientific rationality of the *Lipum***

Fish aggregating devices (FAD) are the natural or artificial objects or structures placed at the bottom, suspended in the water column or kept afloat on the surface of the aquatic body to attract, aggregate and generate demersal, pelagic, resident or migratory

Table 2—Fish catches (Kg per unit) in the *Lipum* surveyed in different rivers of East Siang district

River	Fish harvest (Kg per <i>Lipum</i> )					Average
Villages of East Siang District under study						
Koyu	Rina	Koyu	Rotte	Tabi Ripo	Kakki	8.72
	8.0	10	8.7	7.9	9.0	
Sido-Dobung	Sido	Kora	Mane	Tene	Sipu	7.28
	6.2	8.0	5.8	9.1	7.3	
Ledum	Ledum	Niglok	Ngorlung	Sille	Oyen	5.62
	7.1	7.2	4.3	5.1	4.4	
Simang	Ditam	Riga	Boleng			7.70
	8.1	7.2	7.8	---	---	
Villages of West Siang District under study						
Ego	Padi	Dali	Ego	Dari	Zirido	8.08
	9.2	7.2	8.9	7.8	7.3	
Kidi	Desi	Pagi	Regi	Nyigam	Nyodu	6.06
	5.2	8.5	4.5	5.2	6.9	
Heei	Gori	Soi	Tare	Sago	Lipunamchi	5.32
	6.2	6.7	4.1	4.4	5.2	
Heipu	Angu	Bagra	Dooji	Darka	Doke	6.24
	4.2	4.8	7.8	8.1	6.3	
Siyom	Kabu	Bane	Biru	Eyieue	Logum	6.88
	8.2	7.9	6.3	6.6	5.4	

Mean± SD: 6.84±1.60

fishes. These structures attract fishes that congregate under and around them for the purpose of shade, shelter, food and breeding grounds<sup>10</sup>. A chief factor for success of *Lipum* fishing is the increase in water temperature inside the structure in winter season. Although a reduced flow of water in these hilly streams in the dry season, commencing from October, favours *Lipum* activities, the fish are attracted to *Lipum* only around November, when there is drastic reduction in air and water temperature. In addition, reduced water currents in the hilly rivers considerably influences fish characteristics. Adhesive organs of hill stream fishes helps themselves to attach the stones and withstand the rapid flow of water<sup>11</sup>. The rapid water flow over stone beds aerates the water and increases its dissolved oxygen<sup>12</sup>, and the downstream flow favours the micro-ecosystem of the *Lipum* structure in attracting fish<sup>13</sup>. Moreover, the *Lipum* also promotes algal growth and fosters the growth of several water insects, which are lucrative fish feed<sup>14</sup>.

#### Socioeconomic importance of *Lipum*

Preparing the *Lipum* incurs no real cost as it requires only locally available stones and no paid labour is engaged since family members undertake the construction process. After one *Lipum* is dismantled,

the same stock of flat stones can be used for another nearby. Some of the fish harvested from *Lipum* are consumed fresh by families, while the excess are sold in the local market either in fresh condition @ Rs. 120-180 per kg or traditionally smoke dried @ Rs. 400-500 per kg (Fig. 3). Similar kind of traditional drying and smoking practices for preservation of fishes at household level is also reported from neighboring state Assam<sup>15</sup>. As such, *Lipum* has become not only an integral part of *Adi* and *Galo* food security but also plays a pivotal role in community livelihoods. As well, the involvement of local people in activities related to *Lipum* helps secure generations of employment at the village level and also promotes their ancestral hobby of fishing using this traditional technique.

#### Discussion

Fishing is an important economic activity for the people of the Siang belt, especially those living below the poverty line. The socio-economic conditions and plentiful natural resources in the belt present a solid case for harnessing regular fish catches as well as enhancing potential untapped fishery resources. The implementation of fishing techniques is

influenced by different factors, including: physico-chemical parameters of the water body, abundance of fish species and available raw material for fabrication of the gear<sup>16</sup>. Location specific Indigenous Knowledge can assist in environmental sustainability. The *Lipum* technology is an example of a sustainable fishing technique. With this technology fish are caught live, and hence there is a possibility of releasing juvenile fish into a pond system for further growth. Few progressive growers collect seed of *mahseer* form *Lipum* for growing in their ponds. *Lipum* construction operations occur in the post monsoon season and harvesting of fishes is done at the onset of winter season which is the best time for fishing, after the breeding period of most fish, with lower chances of catching breeding fish. The method used is the result of experiences gained over a period of time and is related to the topography of the fishing ground, and the ecomorphology and behavior of the fish. In the recent past over-fishing, over-hunting and destruction of natural habitats through harmful fishing practices (dynamiting, agricultural pesticide, chemicals, etc.) have been common, and have threatened fish biodiversity and stream ecology as they destroy both target and non target species, along with their eggs and young. However, in Siang belt use of chemicals and electric fishing is banned by *Kebang* (local judiciary system) and local youth clubs. Creating awareness among the people about the benefits of indigenous knowledge systems and their potential role in resource utilization and management is increasingly important. Place-specific knowledge systems, combined with hands-on resource use and a long-term commitment to sustaining resources and ecosystems, are vitally important in restoring the planet to health<sup>17</sup>. The aquaculture sector in the Siang belt is under developed due to the challenging physicochemical properties and lack of initiatives and awareness among the tribal population of modern aquacultural techniques. The region's tribal populations prefer consuming local fish in their traditional ways such as by smoking, boiling with bamboo shoots, and cooking in bamboo stems. Fish is one of the major source of protein in their diets along with animal meat and bush meat including birds<sup>3</sup>. In light of available modern methods and techniques for fishing, the predominant local techniques of fishing, such as *Lipum*, needed to be upgraded to reduce labour and enhance fish production, with special consideration of the economy of rural poor.

### Conclusion and policy implications

The Traditional knowledge based fishing technology, *Lipum*, practised by the *Adi* and *Galo* tribes of the East Siang district of Arunachal Pradesh, is quite feasible in perennial tributaries and rivulets of the Siang river where the depth of the river is lower during the winter season. This method is also sustainable. It involves less labour than other fishing methods, and requires practically no investment. *Lipum* is one of the simplest and most common fishing techniques, providing food security for *Adi* and *Galo* tribal families. However, in the recent past, due to socioeconomic and political changes, such Traditional knowledge fishing practices have declined, replaced by mechanized fishing and use of chemicals, especially among certain influential people for getting maximum catch with the spent of minimum time. The sustainability of indigenous fish and traditional fishing cultures is in peril. These practices, if they are to continue, need to be refined and mainstreamed within overall biocultural conservation.

### Acknowledgement

Authors express their sincere thanks to the traditional knowledge holders and *Gaon Burah* of the villages under study for providing valuable information enriching this study. Special thanks are also due to Shri Nyato Riba, Secretary, Regi Village, Basar, West Siang District, Arunachal Pradesh and Shri Gumjum Ango, President, District *Gaonburah* Association, West Siang for sharing invaluable information on *Lipum* for documentation of the same. Financial and logistic support obtained from College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh through various projects and programmes under which this study was conducted, are thankfully acknowledged.

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