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Common Paddy Field Weeds: An Evaluation of Their Ethnomedicinal Potential among the Indigenous Apatanis of Ziro Valley, Arunachal Pradesh

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This study deals with the ethnomedicinal prospects of common weeds thriving in the wide array of terraced paddy fields used for rhizipisciculture by the Apatanis, a unique tribe indigenous to the remote Ziro valley in the Eastern Himalayas. Surveys were conducted in agricultural fields surrounding three villages in order to record the paddy field flora present on the partition bunds. Elderly villagers were also interviewed with the help of an interpreter to document their traditional knowledge about the medicinal uses of these weeds. A total number of 36 species of indigenous medicinal plants were recorded along with the local name, the plant parts used, the modes of preparation and administration of traditional herbal remedies and the illnesses treated. This easily accessible medicinal plant resource, ameliorating a wide range of common ailments, was found to be a reliable means for managing the primary healthcare of this indigenous agrarian community of the Eastern Himalayas.

Keywords: Apatanis, Arunachal Pradesh, Ethnomedicine, Paddy field weeds, Ziro valley

INTRODUCTION

The use of plant resources to ameliorate human illness and suffering is as ancient as humankind itself. In the developing world, indigenous and rural communities still depend on traditional, essentially herbal, medicine for their primary health care (Payyappallimana, 2010). Ethnomedicine, a branch of ethnobiology, is the scientific study of the beliefs and practices related to the traditional healing systems of indigenous and rural communities (Foster and Anderson, 1978). Natural products, often derived from plants used in folk medicine, have the potential to develop into novel drugs, or serve as models for developing more potent semi-synthetic drugs (Farnsworth, 1988; Plotkin, 1991). India's rich and ancient heritage of traditional medicine consists not only of the classical (codified) systems such as Ayurveda, Unani and Siddha, but also includes numerous oral, and therefore often poorly documented (non-codified), folk systems that are prevalent among the tribal and agrarian communities across the country (Singh, 2001). However, this intangible cultural heritage in the form of traditional wisdom and practices about indigenous medicinal plants is disappearing at an alarming rate (Ramirez, 2007). This problem is acute in the rapidly developing

countries with rich biological and cultural diversity as in India. Since this knowledge is orally-transmitted from one generation to the next generation, the disruption of traditional cultural landscapes and disinterest among the youth about local languages and customs—as a socio-cultural effect of modernization, industrialization and urbanization—are gradually eroding and pushing both the traditional ethnobotanical knowledge and the local ethnomedicinal plant resources to the verge of extinction.

Northeast India comprises of the states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. The population of this region is predominantly rural and mostly belonging to diverse indigenous ethnic groups. Their livelihoods depend on traditional agricultural practices which range from shifting to sedentary agriculture (Majumder *et al.*, 2011). Arunachal Pradesh is inhabited by 26 major tribes (Pandey *et al.*, 1999). The Ziro valley (1,058 km^2), located in a remote corner of Lower Subansiri district of Arunachal Pradesh, is home to the Apatani people. They dwell in traditional villages (*lemba*) surrounded by extensive paddy fields (33 km^2) on the terraced hill slopes (Nimachow *et al.*, 2010). The Apatanis, unlike their neighbouring tribes who practice slash-and-burn (*jhum*) cultivation, are settled agriculturists practicing wet-rice cultivation in the form of the unique and highly sophisticated indigenous farming system in the form of paddy-cum-fish (*jebi-aji*) cultivation (Rai, 2005). This is closely integrated with animal husbandry and social forestry (Nimachow *et al*., 2010). This rhizipisciculture, one of the most productive and efficient agricultural systems in this region, involves the traditional ecological knowledge-based sustainable management of their limited land, water, nutrient and forest resources to produce balanced food in the same plot, in the form of the local japonica rice (*Oryza sativa* var. *japonica*) cultivars (*viz. amo, mypia* and *pyapee*) and the introduced common carp (*Cyprinus carpio*), with finger millet (*Eleusine coracana*) on the earthen bunds (*agher*) separating the plots (*aji*) of the terraces (Saikia and Das, 2008). Although these plots are weeded (two to five per season) by the women with bamboo hoes, the bunds remain unattended and they harbour a rich diversity of weeds with little economic value. General Ethnonomedicinal investigations in this area were done earlier by Kala (2005), Srivastava *et al.* (2010), Khongsai *et al.* (2011), Yakang *et al*. (2013) and Ayam (2017). This objective of this study was to focus on the paddy field ecosystem and access the ethnomedicinal potential of the common weeds growing on the paddy field bunds of the Apatanis of Ziro valley.

MATERIALS AND METHODS

Study Area

This study was done in the traditional villages of Apatani people in the remote Ziro valley of the Easter Himalayas, located in Lower Subansiri district of Arunachal Pradesh. The altitude in this small hill area of central Arunachal Pradesh ranges from 1,524 to 2,738 m. Old Ziro and Hapoli, the twin urban centres, are situated respectively at the northern and southern ends of the valley. Three traditional rural communities of the Ziro block were randomly selected: Hong Lemba (27°33'16" N, 93°50'17" E, 5 km southeast of Old Ziro), Hari Lemba (27°33'42" N, 93°50'08" E, 2.5 km east of Old Ziro) and Hija Lemba (27°33'40" N, 93°49'55' E, 1 km south of Old Ziro) (Fig. 1).

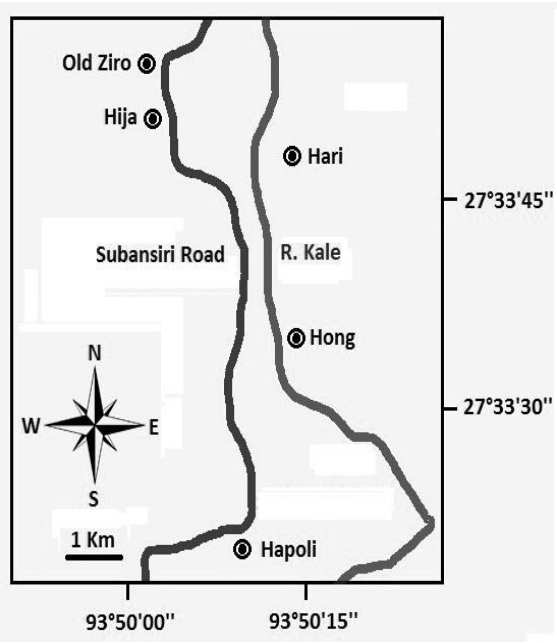

Fig. 1. Map of the study area showing the positions of the three rural localities investigated (and two urban centres) of Ziro valley, Lower Subansiri, Arunachal Pradesh.

Data Collection

Preliminary surveys were done during May (pre-monsoon) and October (post-monsoon), 2014, and the three above rural locations were randomly selected. Field surveys were done in the paddy fields in and around these locations before and after the monsoons, between 2015 and 2017, to enumerate the common weeds growing on the extensive earthen bunds separating the individual plots of the terraced paddy fields (Fig. 2a). Plants specimens were in general photographed in their natural habitats, their flowering twigs were collected for preparing herbarium samples, identified with the help of the standard literature (Polunin and Stainton, 1984; Stainton, 1998; Borthakur, 2018) and preserved as voucher specimens in the herbarium of the Department of Botany, Vivekananda College. Endangered and rare plants were only photographed. The elderly villagers, including the shamans (*nyibu*), were interviewed with the help of local interpreters (Fig. 2b-d). A total number of 18 village elders, 6 from each village, were randomly chosen, verbal permission obtained and their ethnobotanical knowledge of the documented common paddy field weeds was recorded. One-third of them were female, and the rest two-third male. The approximate age of all the interviewees was more than 60 years. Data on the ethnobotanical uses of the local rice filed flora was collected by informal personal interactions to record the local name of the plant (in the Apatani language), the plant parts used, the modes of preparation and administration of the herbal formulations and the disorders treated as part of their traditional medicinal practices.

Data Analysis

Detailed checklist of the botanically identified local medicinal plant species commonly found on the paddy field bunds was prepared and the scientific name, authority and family were validated by the International Plant Names Index (IPNI). The collected ethnomedicinal data was translated, tabulated and compared with the standard literature (Kala, 2005; Srivastava *et al*., 2010; Khongsai *et al*., 2011; Yakang *et al*., 2013; Ayam, 2017). Percentage proportions (%) of the diversity and uses of this ethnomedicinal plant resource was calculated with the help of Microsoft Excel 2010.

RESULTS AND DISCUSSION

Diversity of Ethnomedicinal Plant Resources

The results of the field surveys and interviews at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh, are briefly presented in Table 1 (Fig. 3) as an inventory of local ethnomedicinal weeds commonly found on the paddy field bunds. This is arranged in the alphabetical order of scientific names. Local names of these plants in the Apatani dialect.

Fig. 2. The Apatani people of Ziro valley, Lower Subansiri, Arunachal Pradesh. **a.** Terraced paddy fields with earthen bunds separating plots for rice and fish cultivation. **b.** An elderly Apatani woman. c. An elderly Apatani man. **d.** An Apatani shaman priest.

This investigation botanically identified and recorded in this remote area of the Eastern Himalayas, a total of 36 species of local vascular plants distributed among 24 genera and 14 families. The dominant plant families were Asteraceae (11 species), followed by Solanaceae (7 species) and Polygonaceae (4 species). Representing nearly half of these genera (46%) and species (61%), these families are known to be fairly common in this phytogeographical region (Polunin and Stainton 1984, Stainton 1998, Borthakur 2018). All the recorded plant species were terrestrial herbs with small size that could easily survive on the rice field bunds on the terraced slopes. These plant species were overwhelmingly dicots (94%), and only one

monocot: *Eleusine coracana* (Poaceae) a millet, and one pteridophyte: *Dicranopteris linearis* (Gleicheniaceae) a fern (Fig. 3d) were recorded. However, this finger millet is not a weed but a supplementary crop cultivated on the dry bunds, well-integrated into the wet rice cultivation. Like the japonica rice, several local cultivars of the finger millets (*viz. surpu ahare*, *surpu latha*, *sartii*, *ahki sarse*) have been documented before (Dollo *et al*., 2009).

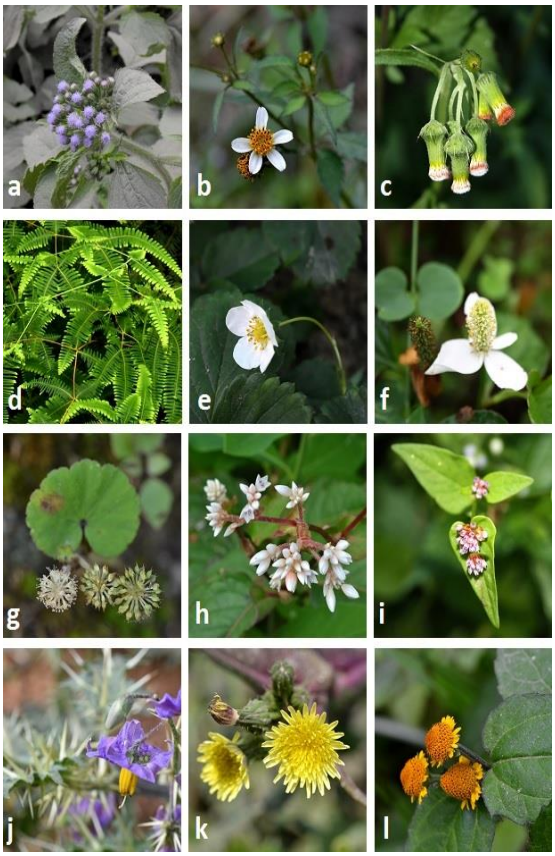

Fig. 3: Some of the ethnomedicinal plants recorded on the paddy field bunds at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh. **a.** *Ageratum conyzoides* (Asteraceae), **b.** *Bidens pilosa* (Asteraceae), **c.** *Crassocephalum crepidioides* (Asteraceae), **d.** *Dicranopteris linearis* (Gleicheniaceae), **e.** *Fragaria nubicola* (Rosaceae), **f.** *Houttuynia cordata* (Saururaceae), **g.** *Hydrocotyle javanica* (Araliaceae), **h.** *Persicaria chinensis* (Polygonaceae), **i.** *Persicaria nepalensis* (Polygonaceae), **j.** *Solanum virginianum* (Solanaceae), **k.** *Sonchus oleraceus* (Asteraceae), **l.** *Spilanthes acmella* (Asteraceae).

Biotic invasion is a serious problem for the conservation and sustainable use of global biological resources (Perrings *et al*., 2010). However, studies have also shown that invasive alien plants can also have positive social, economical and ecological contributions, such as their inclusion in folk medicine (Khan *et al*., 2011). Although these species were largely native to the Eastern Himalayas, but a significant presence of exotics (28%) was also recorded. In addition to the millet and ordinary weeds, the noxious alien weeds documented were *Ageratum conyzoides* (Fig. 3a), *Bidens pilosa* (Fig. 3b), *Cardamine hirsuta*, *Crassocephalum crepidioides* (Fig. 3c), *Solanum aculeatissimum*, *S. americanum* (tropical America), *Oxalis corniculata* (Europe), *Portulaca oleraceae* (South America), *Solanum macaonense* (the West Indies) and *Sonchus oleraceus* (Fig. 3k) (the Mediterranean). These have been documented earlier from the Indian Himalayan region (Chandra Sekar, 2012).

Table 1. Local ethnomedicinal plants of paddy field bunds and their uses documented at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh

Scientific Name (Family)	Local Name	Ethnomedicinal Uses
Ageratum conyzoides L. (Asteraceae)	*Pasu ayou*	Plant juice applied for conjunctivitis; plant powder taken for dysentery; leaf paste applied on external cuts and wounds to stop bleeding and on inflammations of skin
Artemisia indica Willd. (Asteraceae)	*Kukulyu*	Leaf paste applied for headaches and backaches; boiled leaf taken for asthma; leaf juice applied for burns and allergy of skin; leaf aroma inhaled for nose congestion and headaches
Begonia roxburghii A.DC. (Begoniaceae)	*Bekhoo*	Root and leaf juice taken for fever; leaf paste applied for itching of skin
Begonia thomsonii A.DC. (Begoniaceae)	*Lukhu*	Used as a reliable substitute for *B. roxburghii*
Bidens pilosa L. (Asteraceae)	*Hou bok*	Fresh leaf applied on external cuts and wounds to stop bleeding and taken for constipation; leaf juice applied on ulcers of skin, and used to treat ear and eye problems
Cardamine hirsuta L. (Brassicaceae)	*Paddii hamang*	Leaf juice taken for indigestion

Centella asiatica (L.) Urb. (Apiaceae)	*Ngilyang khiko*	Fresh plant taken for indigestion and impurity of blood; fresh leaf taken for stomach aches and constipation
Crassocephalum crepidioides (Benth.) S.Moore (Asteraceae)	*Gendatt hamang*	Leaf juice applied on external cuts and wounds to stop bleeding
Dicranopteris linearis (Burm.f.) Undrew. (Gleicheniaceae)	*Takho*	Fresh or boiled plant taken for indigestion
Elatostema sessile J.R.Forst. & G.Forst. (Urticaceae)	*Hippy hamang*	Root juice taken in case of vomiting
Eleusine coracana (L.) Gaertn. (Poaceae)	*Sarse*	Grain pate taken for flatulence and indigestion; grain ash taken with rice beer for cough and cold and chest congestion
Erigeron bonariensis L. (Asteraceae)	*Daglentado*	Leaf vapour inhaled for headaches
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita (Rosaceae)	*Aki jilyunn*	Plant juice taken in case of urinary problems
Gynura cusimbua (D.Don) S.Moore. (Asteraceae)	*Kochi hamang*	Leaf juice taken for indigestion and helminthiasis
Houttuynia cordata Thunb. (Saururaceae)	*Siiya hamang*	Plant juice taken for insomnia, loss of appetite, stomach aches and cardiac problems; fresh plant taken for jaundice; roasted plant taken for dysentery
Hydrocotyle javanica Thunb. (Araliaceae)	*Hiibyo*	Fresh leaf and root taken for indigestion
Laphangium affine (D.Don) Tzvelev (Asteraceae)	*Miang*	Plant infusion taken for chest congestion and fever
Laphangium luteoalbum (L.) Tzvelev (Asteraceae)	*Shutamento*	Leaves juice applied on external cuts and wounds to stop bleeding, on blisters of skin and taken for fever
Oxalis corniculata L. (Oxalidaceae)	*Okhui hamang*	Leaf and stem juice taken in loss of appetite and dysentery; fresh or boiled plant taken for loss of appetite
Perilla frutescens (L.) Britton (Lamiaceae)	*Timing*	Seed oil applied for headaches
Persicaria capitata (Buch.-Ham. ex D. Don) H.Gross (Polygonaceae)	*Hamang*	Flower paste applied for ant bites
Persicaria chinensis (L.) H.Gross (Polygonaceae)	*Rawang hamang*	Plant juice taken for chronic conditions and scurvy
Persicaria hydropiper (L.) Delarbre (Polygonaceae)	*Roring*	Root powder taken to induce abortion
Persicaria nepalensis (Meisn.) Miyabe (Polygonaceae)	*Luli hamang*	Leaf paste taken for indigestion; flower paste applied for ant bites
Plantago asiatica L. (Plantaginaceae)	*Mepi hamang*	Fresh or boiled leaf taken for constipation
Portulaca oleracea L. (Portulacaceae)	*Lai hamang*	Fresh stem and leaf taken for indigestion; stem, leaf and flower paste applied on rashes and allergy of skin
Solanum anguivi Lam. (Solanaceae)	*Byako*	Dried fruit chewed to overcome lethargy
Solanum aculeatissimum Jacq. (Solanaceae)	*Hadha bagul*	Smoke of burning fruits inhaled for toothaches and gum bleeding
Solanum kurzii Prain (Solanaceae)	*Byako*	Fresh fruit taken for cough and cold, stomach aches and helminthiasis
Solanum myriacanthum Dunal (Solanaceae)	*Siitii byako*	Dried seed chewed or smoke of seed inhaled for toothaches
Solanum americanum Mill. (Solanaceae)	*Haro hamang*	Fresh or boiled plant taken for liver ailments; fresh fruits taken for fever, diarrhoea and hydrophobia
Solanum virginianum L. (Solanaceae)	*Byako*	Fruit paste applied for toothaches and gum bleeding
Solanum xanthocarpum Schrad. et Wendl. (Solanaceae)	*Siitii byako sanii*	Fruit juice taken for throat aches
Sonchus brachyotus DC. (Asteraceae)	*Kochi hamang*	Root decoction used as tonic to restore health
Sonchus oleraceus (L.) L. (Asteraceae)	*Pakuhadu hamang*	Boiled leaf, leaf and stem infusion taken for indigestion
Spilanthes acmella (L.) L. (Asteraceae)	*Yakho hamang*	Root and flower paste applied for toothaches; leaf juice taken for throat aches; fresh leaf or leaf powder taken for constipation

NB: Local names are in the Apatani dialect.

Use of Ethnomedicinal Plant Resources

This rich and diverse ethnomedicinal plant resource of the paddy field bunds, documented near the three traditional Apatani villages in the Eastern Himalayas, were found to be used in the form of a plethora of traditional herbal remedies by the locals (Table 2). The plant parts used, as well as the diverse methods of preparation and application, and their therapeutic use are provided as well. The local traditional healers (shamans), who are the traditional knowledge holders of these communities, use the rich and diverse local plant resources of the Ziro valley and the adjoining forests to treat diverse diseases (Rawat and Choudhury, 1998). Most of these plant species are already known as to have ethnomedicinal value (Kala, 2005; Srivastava *et al*., 2010, Khongsai *et al*., 2011, Yakang *et al*., 2013, Ayam 2017).

Table 2. Percentage distribution of the plant part used of ethnomedicinal weeds growing on paddy field bunds at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh.

Plant part used			(%)
Whole plant			21 %
Vegetative Parts	Aerial Parts	Leaf	42 %
		Stem	6 %
	Underground Parts	Root	7 %
Reproductive Parts	Aerial Parts	Flower	5 %
		Fruit	12 %
		Seed	7 %

NB: Grains of *E. coracana* treated as seeds.

This investigation revealed the use of a total of seven diverse plant parts in these traditional herbal remedies (Table 2). The most commonly used plant organ that was recorded to be used was the leaf (42%). Use of aerials parts was predominant (90%) compared to the underground parts, *viz*. roots (10%). Other underground parts such as rhizome, bulb or tuber were not documented. Vegetative parts were more commonly used (70%) than the reproductive parts (30%). Preference for their use may be related to their availability. Whole plants were also frequently used (21%). The indigenous herbal formulations prepared from these plant parts involved 14 different modes (Table 3). These ranged from direct topical use and taking of fresh, i.e. natural, plant parts (23%), to the preparation of juice (30%), paste (21%), powder (3%), ash (2%), decoction (4%), infusion (1%) and oil (1%), or processing such as boiling (6%), drying (2%) and roasting (1%), and even the use of smoke (3%), aroma (2%) and vapour (1%).

There were six different route of administration (Table 4). This ranged widely such as oral (64%), topical (22%), buccal (8%) as well as nasal (3%), ocular (2%) and otic (1%). This study also revealed that these traditional herbal remedies were used to treat a total of 42 diverse and common medical conditions (Table 5).

Table 3. Percentage distribution of the mode of preparation of herbal formulations prepared from ethnomedicinal weeds growing on paddy field bunds at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh

Method of preparation	(%)
Juice	30 %
Fresh	23 %
Paste	21 %
Boiled	6 %
Infusion	4 %
Powder	3 %
Smoke	3 %
Dried	2 %
Ash	2 %
Aroma	2 %
Decoction	1 %
Roasted	1 %
Oil	1 %
Vapour	1 %

Table 4: Percentage distribution of the route of administration of herbal formulations prepared from ethnomedicinal weeds growing on paddy field bunds at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh

Route of administration	(%)
Oral	64 %
Topical	22 %
Buccal	8 %
Nasal	3 %
Ocular	2 %
Otic	1 %

The most commonly treated ailments were indigestion (14%), fever (7%), constipation (6%), toothache (6%) and appetite loss (5%). However, these ethnomedicinal plant species were also used to ameliorate common problems of the ear, eye, tooth, skin, heart, liver, gastrointestinal tract, urinary tract, joints as well as a wide range of other specific illnesses such as throat ache, headache, backache, stomach ache, vomiting, jaundice, diarrhoea, dysentery, insomnia, hydrophobia,

bleeding, itches, rashes, ulcers, asthma, cough and cold, nose blockade, chest congestion and even parasitic worm infestation and insect bites. It was noted that the dried fruits of *Solanum anguivi* is chewed as an energizer, whole plant juice of *Persicaria chinensis* is used as a drink to treat deficiency symptoms of scurvy and the root powder of *P. hydropiper* is a potent abortifacient.

Table 5: Percentage distribution of the diseases treated with ethnomedicinal weeds growing on paddy field bunds at the three localities of Ziro valley, Lower Subansiri, Arunachal Pradesh

Disease treated	(%)	Disease treated	(%)	Disease treated	(%)
Indigestion	14 %	Cough and cold	2 %	Eye problems	1 %
Fever	7 %	Gum bleeding	2 %	Flatulence	1 %
Constipation	6 %	Helminthiasis	2 %	Hydrophobia	1 %
Toothache	6 %	Liver ailments	2 %	Insomnia	1 %
Appetite loss	5 %	Skin itching	2 %	Jaundice	1 %
Dysentery	4 %	Throat ache	2 %	Lethargy	1 %
Headache	4 %	Abortion	1 %	Nose congestion	1 %
Skin allergy	4 %	Asthma	1 %	Scurvy	1 %
Skin bleeding	4 %	Backache	1 %	Skin blisters	1 %
Skin rashes	3 %	Blood impurity	1 %	Skin burns	1 %
Stomach ache	3 %	Cardiac problems	1 %	Skin inflammations	1 %
Ant bites	2 %	Conjunctivitis	1 %	Skin ulcer	1 %
Chest congestion	2 %	Diarrhoea	1 %	Urinary problems	1 %
Chronic conditions	2 %	Eye problems	1 %	Vomiting	1 %

CONCLUSION

The Apatanis, a unique indigenous community of an isolated area of the Eastern Himalayas—a biodiversity hotspot—practice an ingenious form of agriculture consisting of wet rice cultivation and pisciculture in the same plots of their terraced rice fields of Ziro valley, which is further integrated with animal husbandry and social forestry to achieve a remarkable community-based sustainable management of their limited natural resources. Their ecocultural landscape is dominated by agroecosystem of terraced farms used for the rice-fish cultivation. The network of extensive partition bunds separating the rice plots were found to harbour a rich plant resource in the form of a multitude of weeds with immense ethnomedicinal potential. This includes a fair amount of invasive alien plants with significant ethnomedicinal value. Therefore, this indicates the adaptability of the intangible cultural heritage of the locals in the form of traditional ecological knowledge and the socio-ecological resilience of their traditional healthcare system as well. This diverse ethnomedicinal plant resource was found to have the potential to be used to treat a wide range of common ailments. Although the village plantations and surrounding forests are the main source of indigenous medicinal plants for the locals, the myriad weeds thriving on the partition bund of the paddy fields adjoining the rural settlements are therefore a reliable source of local ethnomedicinal plants for this indigenous agrarian community of the remote Ziro valley, with the potential for the effective management of their primary healthcare.

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REFERENCES

Ayam VS. 2017. Ethnomedicine of wild plants of Ziro, Arunachal Pradesh. Interl J Res Studies Biosciences. 5: 1-12.

Borthakur SK, Baro D, Bawri A, Boro A. 2018. Flora of BTAD- Bodoland Territorial Area Districts, Assam, Vol. I-IV. EBH Publishers, Guwahati.

Chandra Sekar K. 2012. Invasive alien plants of Indian Himalayan region: diversity and implication. Ame J Plant Sci. 3: 177-184.

Dollo M, Samal PK, Sundriyal RC, Kumar K. 2009. Environmentally sustainable traditional and conservation in Ziro Valley, Arunachal

Himalaya, India. Natural Resource Management J Ame Sci. 5: 41-52.

Farnsworth N. 1988. Screening plants for new medicines. In: Biodiversity, (Wilson, E.O., ed.) National Academy Press, Washington DC. pp. 83-97.

Foster GM, Anderson BG. 1978. Medical Anthropology. John Wiley and Sons, New York.

Kala CP. 2005. Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. J Ethnobiology Ethnomedicine. 1: 1-8.

Khan MASA, Sultana F, Rahman MH, Roy B, Anik SI. 2011. Status and ethno-medicinal usage of invasive plants in traditional health care practices: a case study from northeastern Bangladesh. J For Res. 22: 649-658.

Khongsai M, Saikia SP, Kayang H. 2011. Ethnomedicinal plants used by different tribes of Arunachal Pradesh. Indian J Traditional Knowledge. 10: 541-546.

Majumder M, Shukla AK, Arunachalam A. 2011. Agricultural practices in northeast India and options for sustainable management. Sustainable Agri Reviews. 5: 287-315.

Nimachow G, Rawat JS, Dai O, Loder T. 2010. A sustainable mountain paddy-fish farming of the Apatani tribes of Arunachal Pradesh, India. Aquaculture Asia. 15: 25-28.

Pandey BB, Durah DK, Sarkar N. 1999. Tribal Village Councils of Arunachal Pradesh. Directorate of Research, Government of Arunachal Pradesh, Itanagar.

Payyappallimana U. 2010. Role of traditional medicine in primary health care: an overview of perspectives and challenges. Yokohama J Social Scie. 14: 57-77.

Perrings C, Mooney H, Williamson M. 2010. The problem of biological invasions. In: Bioinvasions and Globalization: Ecology, Economics, Management and Policy, (Perrings, C., Mooney, H. and Williamson M., eds.) Oxford University Press, New York. pp. 1-18.

Plotkin MJ. 1991. Traditional knowledge of medicinal plants: the search for new jungle medicines. In: The Conservation of Medicinal Plants, (Olayiwola, A., Vermon, H. and Hugh, S., eds.) Cambridge University Press, Cambridge. pp. 53-63.

Polunin O, Stainton A. 1984. Flowers of the Himalaya. Oxford University Press, New Delhi.

Rai SC. 2005. Apatani paddy-cum-fish cultivation: an indigenous hill farming system of north east India. Indian J Traditional Knowledge. 4: 65-71.

Ramirez CR. 2007. Ethnobotany and the loss of traditional knowledge in the 21st century. Ethnobotany Res Applications. 5: 245-247.

Rawat MS, Choudhury S. 1998. Ethnomedicobotany of Arunachal Pradesh: Nishi and Apatani tribes. Bishen Singh Mahendra Pal Singh, Dehradun.

Saikia SK, Das DN. 2008. Rice-fish culture and its potential in rural development: A lesson from Apatani farmers, Arunachal Pradesh, India. J Agri Rural Dev. 6: 125-131.

Singh V. 2001. Indian Folk Medicines and Other Plant Based Products. Scientific Publishers, Jodhpur.

Srivastava RC, Singh RK, Mukherjee TK. 2010. Indigenous biodiversity of Apatani plateau: learning on biocultural knowledge of Apatani tribe of Arunachal Pradesh for sustainable livelihoods. Indian J Traditional Knowledge. 9: 432-442.

Stainton A. 1998. Flowers of the Himalaya: A Supplement. Oxford University Press, New Delhi.

Yakang B, Gajurel PR, Potsangbam S, Bhuyan LR. 2013. Account of common and traditional non-timber forest products used by Apatani tribe of Arunachal Pradesh, India. Pleione. 7: 514-529.