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Research Article

Botany for Better Health and Nutrition

Diversity and multipurpose utility of wild edible plant in Chopta – Mandal forest, Uttarakhand

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Abstract: Wild edible plants (WEP) play a very important role in providing stable and supplemented food and also the source of income to local communities providing food security during lean periods. The present study was conducted in 11 villages covering the Chamoli and Rudraprag district of Uttarakhand. The information was collected through structured questionnaires along with field visit, group discussions and key informant interviews. The methods employed in the study is designed with the purpose of providing baseline information on the ethnobotanical use of plant species in local communities. The study recorded 64 species of WEP belonging to 47 genera and 36 families. Most of the species are used as fruits (30 species) followed by leafy vegetables (20), about 31 wild edibles plant species are used as medicinal and almost half of the species (51%) were also used for purposes other than food and 28% species with market value. A few wild edible species are used for making pickles, chutney, jam, jelly and squash through value addition to ensure high returns in comparison to selling of raw materials. Dependency of local people on the wild edible plants for economic potential is still alive and is a traditional culinary practice that demonstrates rich traditional knowledge of local people. Wild edible plants provide all the essential nutrient and minerals to the local inhabitants to stay healthy but unfortunately the traditional knowledge on the use of WEP is diminishing. WEP are not only important for livelihood but have a great potential for crop improvement. These wild species should be promoted for income generation activities through sustainable collection and trade as they are important throughout the year because their consumption serves multiple purposes.

Keywords: Wild Edible, Traditional knowledge, Economic potential, Ethno botanical, livelihood

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1. INTRODUCTION

Wild edible plants (WEP) are an important source of food for mankind before the dawn of civilization and the domestication of the present day fruits[1,2]. These wild fruits have played a very vital role in supplementing the diet of the people, which are often collected from nearby forests as their collection does not require any skills and capital investment [3,4]. People living in the rural areas of the Himalayas utilize a variety of biological resources for livelihoods. Animal husbandry and marginal agriculture are the major source of their economy[5]. The Garhwal Himalayas region is the land of many beautiful holy places, valleys and hills, as the Himalayas are very rich in natural resources. The forest resources play an important role in the livelihood of the local communities [6,7]. The rich diversity of the area is utilized by the local inhabitants in various forms such as medicine, food, fodder, fuel, timber, agricultural implements etc[8]. Among these, wild edible plants play an important role in food supplementation during scarcity for local inhabitants. Because of small land holdings and subsistence agriculture, the local people collect many wild plants for food[9]. Many works have emphasized on the diversity and traditional uses of wild plants from Garhwal Himalayas[10-12]. Vegetational analysis[13] and systematic studies on the vascular plants of Mandal-Chopta forest has also been done[14]. An extensive floristic survey has been conducted in Kedarnath Wildlife Sanctuary, during the survey a total of 433 plant species belonging to 234 genera under 71 families were recorded along the subalpine and alpine region[15]. Many studies on ecological status and traditional knowledge of medicinal plants in Kedarnath Wildlife Sanctuary of Garhwal Himalaya have also been conducted[16]. An extensive floristic survey has been conducted on wild edible plants[17] and ethnobotanical uses of medicinal plants in Chopta-Mandal forest of Garhwal Himalayas in Uttarakhand[18]. Humans have relied mostly on wild plants for nutritional and medicinal needs for example aromatic leaves of *Murraya koenigii* are highly valued, in different parts of Asia, for their utility as condiment and spice[19] and for medicinal properties such as antidiabetic, antidysenteric, antioxidant, anti-inflammatory, anticarcinogenic, and hepatoprotective [20,21].

2. MATERIALS AND METHODS

2.1 Study Area

Kedarnath Wildlife Sanctuary (KWLS; 30^0 25'-30^0 45' N latitude, 78^0 55'-79^0 22' E longitude) is the one of the floristically rich and largest Protected Areas (PAs) in Uttarakhand covering an area of 975 km^2. An intensive study area of around 400 km^2 (figure1) was selected along the Southern fringe of Kedarnath WLS. Nearly 70% of the intensive study area lies in Mandal valley within Alaknanda catchment. Upper part of the study area is marked by the famous Hindu shrine temple Tungnath (3550m) [17].

2.2 Methodology

The Present Survey was conducted in 11 villages falling under the boundaries of Chopta-Mandal forest covering the Chamoli and Rudraprayag district of Uttarakhand. Structured and pretested questionnaires were used to interview approximately 10% of the total households in each village. The informers included responsible old persons, attempts were made to include females in interviews and middle aged people who were fully aware about their forest wealth[17]. A total of about 315 households have been taken from the study area. Sample households and interviewed individuals were selected randomly from the entire population on the basis of their possessiveness of traditional knowledge and studied through pre-reconnaissance surveys. The data collected for the study included general information about each household, such as literacy level, family size, landholding, number of animals per family, sources of income, occupation, sources of energy, extraction of wild edible plants and their multipurpose utility[17,22].

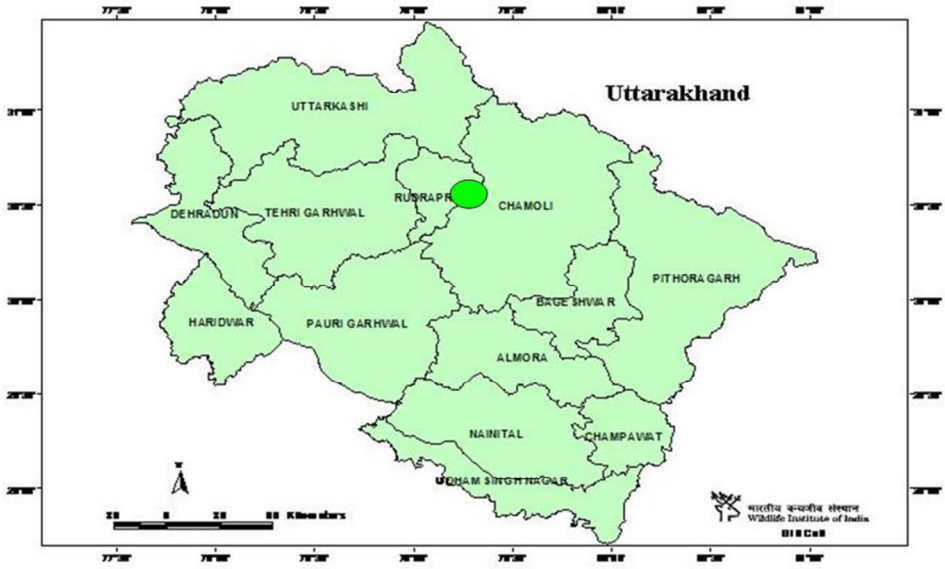


Fig 1. Location map of Study Area

3. RESULTS

The study came to document nearly 64 species of plants used as wild edible. Analysis of a taxonomic group of plants revealed that a total of 64 wild edible species belonging to 47 genera and 36 families are documented. Only one plant belongs to Pteridophyta and all others to Magnoliophyta.

Analysis of habits of plants doc0075mented shows that shrubs share the largest proportion with 24 species (37%), followed by herbs with 20 species (31%). Most importantly, fruits are found to frequently use part accounting for 45%, followed by leaves with 27%, flowers and seed with 7% respectively[17].

3.1 Nutritional

Wild edible plants are important and cheap sources of protein, carbohydrates, fats, vitamins and minerals (Table 1); moreover, their dietary contribution is increased because they are available during most seasons, including the periods in the year when the conventional staple and vegetables are scarce.

Table 1. Nutritive value of some wild edibles of study area (source: Kapur and Sarin, 1990[23]; Anonymous 1970-1988[24]; USDA (National nutrient database).

Name of plants	*Extracted* (%)	*Moisture* (%)	*Protein* (%)	*Fat* (%)	*Carbohydrate*	*Fibre*	*Minerals*	*Vitamins*
Asparagus curillus Buch. –Ham. ex Roxb	Lv	-	2.2	0.1	3.9	2.1		A,B,C
Berberis lycium Royle	F	83.29	1.81	0.63	-	0.81	-	A,B,C
Chenopodium album L.	WP	82.77	4.63	-	8.32	-	-	-
Cinnamomum tamala (Buch.-Ham.) Nees & Eberm.	Lv	-	0.4	0.12	8.06	5.31	-	-
Diplazium esculentum(Retz.)Sw.	Fr	86.00	8	2	4	-	-	A,B,C
Fagopyrum dibotrys (D.Don) Hara,	S	11.30	10.30	2.40	65.00	8.60	Ca,P,Fe	-
Ficus palmata Forsk.	F	-	13.27	-	-	-	Ca	-
Juglans regia L.	F	-	27	21.7	11	18	-	A,B,C, E,K
Rhododendron arboreum Smith	Fl	-	16.3	7.6	68.5	-	-	C
Oxalis corniculata L.	Lv	82.42	12.2	1.21	3.4	-	-	A,B,C
Rubus ellipticus Sm.	F	64.4	3.68	0.96	27.12	2.35	Ca, Mg, K	C, K
Rubus niveus Thunb.	S	84.56	1.23	-	5.24	-	-	-
Rumex hastatus D.Don	Fl	20.50	9.50	3.54	39.24	18.65	-	-
Rumex nepalensis Spreng	Lv	3.50	13.95	17.54	41.52	17.54	-	-
Solanum nigrum L.	F	-	17.50	21.50	20.00	-	-	A, C
Taraxacum officinale Weber	Lv, F	88.80	3.60	1.60	3.70	0.04	Ca, P, Fe	A
Urtica dioca L.	WP	-	30.40	3.40	10.30	10.30	Ca, P	-

S = Seed, F = Fruit, WP = Whole Plant, Lv = Leaves, R = Root, Fl = Flowers

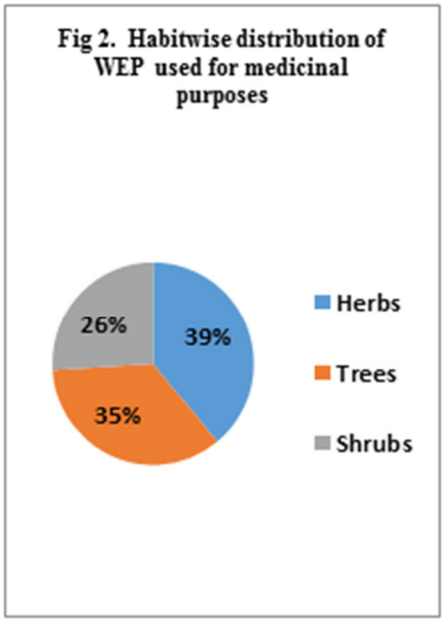
Notable among these in the study area are *Asparagus curillus* L., *Fagopyrum dibotrys* (D.Don) Hara, *Myrica esculenta* Ham. *Prunus cornuta* (wall. Ex Royle) Steud., *Rubus* spp., *Berberis* spp., are ripe when cultivated fruits are not available, while some of the wild edible has been stored for lean period when the cultivated vegetables are scarce, according to survey conducted only 38% approx household stored wild edible plants (table 2).

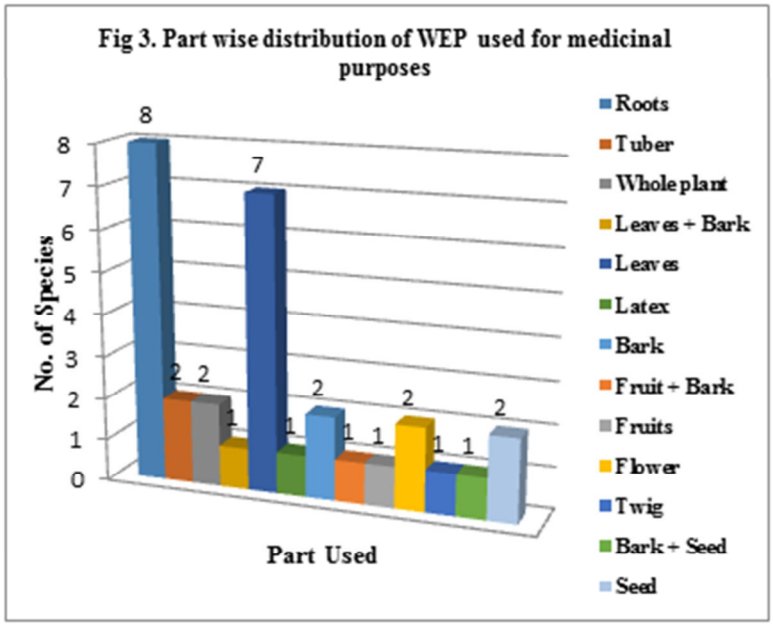
Table 2. % of household stored wild edible in study area

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	83	38.6	38.6	38.6
	No	132	61.4	61.4	100.0
	Total	215	100.0	100.0	

3.2 Medicinal

Total 31 wild edibles plant species are used as medicinal and was recorded to be used frequently to treat gastro-intestinal problems such as dysentery, diarrhea, gastric, abdominal pain and other disorder, indigestion and constipation etc., dermatological problems such as boils, scabies, burns, mumps, swelling, skin diseases and respiratory infections such as asthma, bronchitis cough/cold, sore throat etc[18]. Analysis of a taxonomic group of plants revealed that a total of 31 wild edible species used for medicinal purposes belongs to 27 genera and 23 families. On the other hand, the study showed that the species belonged to a diverse genera. In this regard, the genus *Berberis* is found to have 3 species followed by *Rhododendron* with 2 species. With respect to families, Rosaceae shared the largest proportion, i.e. consisted of 5 species, followed by Berberidaceae and Ericaceae with 3 and 2 species each. Analysis of habits of the 31 plants documented for medicinal use shows that herbs share the largest proportion with 12 species (39%), followed by trees with 11 species (35%) and shrubs with 8 species (26%) (figure 2). Among part used, most importantly roots are found to be frequently used, part accounting for 26%, followed by leaves with 23%, flowers, tuber, whole plant, bark and seed with 6% respectively (figure 3)[18].





3.3 *Oil Seeds*

In order to meet the acute shortage of oils and fats in the country, the potential of oil seeds of forest origin can be augmented. In the present study 7 species of wild edibles bear oil seeds (table 3). Oil produced from *Prinsepia utilis* Royle is used as a cooking medium as well as for burning.

Table 3. Oil seed bearing wild edibles of study area

Name of plants	Oil yield (%) [25]
Juglans regia L.	60-67
Myrica esculenta Buch.-Ham. ex D. Don	20-25
Pinus roxburghii Sargent	41.32
Prinsepia utilis Royle	37.2
Taxus wallichiana Zucc.	63.5
Urtica dioca L.	32.6
Zanthoxylum armatum DC.	20

3.4 *Multipurpose Utility and Informants Consensus*

As it was stated above, a total of 64 wild edibles has been documented from the study area. These plants are also found to have multiple uses apart from their food valued in the community. Many wild edible are used by the local inhabitants for their day to day requirements of fodder, fuel, timber, agricultural tools and miscellaneous items. For example *Bauhinia vahlii* Wt. & Arn besides as vegetable can also be used as medicinal, fodder and fuel, the bark of *Prunus cerasoides* D. Don is used as medicine, leaves are used as fodder and fuel (table 4 and figure 4). Therefore based on the information gathered, six(6) use categories (table 5) were set in which a total of 315 use-reports (Ur) were recorded from 64 species of wild edible plants. Analysis of ICF showed that there exists a high consistency (uniformity) of plant consumption among local people in the study sites. As it can be depicted from the table below, all ICF values (and also the mean ICF which is 0.87) are close to 1 showing the presence of homogeneity in use of plants for multiple purposes. Accordingly, the Fuel and Timber use category takes the uppermost ICF value (0.96) followed by Fodder use-category with ICF value of 0.93.

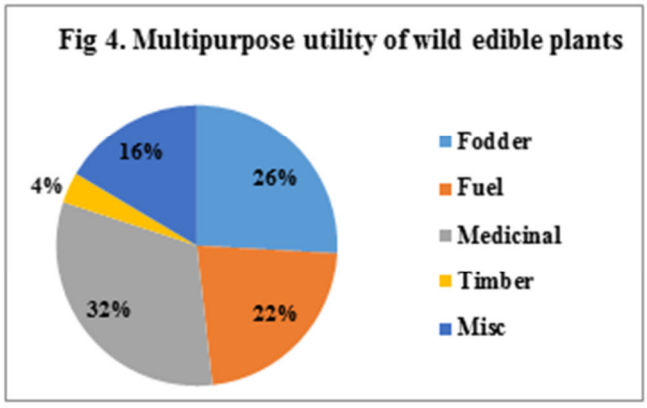


Table 4. Some multipurpose wild edibles occurring in study area

Name of plants	Local name	M	Fd	Fl	T	AT	Misc
Aesculus indica (Wall.exCamb.) Hook. F.	Pangar	+	+	+	-	-	-
Bauhania vahlii Wt. & Arn	Malu	+	+	+	-	-	-
Cannabis sativus L.	Bhang	+	+	+	-	-	+
Celtis australis L.	Kharik, Khadik	-	+	+	-	-	-
Crataegus Crenulata (D.Don)	Ghingaru	-	-	+	-	-	+
Debregeasia salicifolia (D.Don)	Syanru, Tusari	-	+	-	-	-	+
Juglans regia L.	Akhor	+	+	-	+	-	+
Grewia oppositifolia Roxb.	Bhimal	-	+	+	-	-	+
Myrica esculenta Buch.-Ham. Ex D. Don	Kaphal	+	+	+	-	-	-
Pinus roxburghii Sargent	Chir	+	-	+	+	-	+
Prunus cerasoides D.Don	Phaja, Parya	+	+	+	-	-	+
Prunus cornuta (Wall. Ex Royle) Steud.	Mehal	-	+	-	-	-	-
Pyrus pashia Ham.	Mole	+	+	+	-	-	+
Rhododendron rboretum Smith	Burans	+	+	+	-	-	-
Rhododendron barbatum Wall. Ex D.Don,	Burans	+	+	+	-	-	-
Zanthoxylum armatum DC.	Timur	+	+	-	-	-	+

M=Medicinal; Fd=Fodder; Fl=Fuel; T=Timber; AT=Agricultural tools; Misc=Miscellaneous; + = Used; - = Not used

Table 5. Informants' consensus factor (ICF) computed for wild edible species

Use category	Species (nt)	Percentage of species	Use-reports(Ur)	Percentage of use reports	ICF (nur-nt / nur-1)
Food	64	100	277	88	0.77
Fodder	14	22	189	60	0.93
Fuel	12	19	281	89	0.96
Medicinal	17	27	101	32	0.84
Timber	2	3	25	8	0.96
Misc	9	14	35	11	0.76
Mean ICF					**0.87**

3.5 Market Potential of Wild Edible Plants

Wild edible species are not only consumed for food by the local communities but are also a source of income generation. In the West Himalaya Garhwal Mandal Vikas Nigam and the District Drugs Cooperative Limited are the active exploiters and traders. Sixty four of the species used by the local people only twelve species (19%) had market value (table 6). The survey of trade centers showed that many species possess potentialities for livelihood enhancement and socio-economic development by making widely popular value added products that could be easily sold[26]. Out of the discussed species only Lingura (*Diplazium esculentum*) is sold in few nearby local markets in the study area. Still this species also does not have a huge market because of its less and seasonal productivity from the nearby forest areas to meet the demands of the consumers.

Table 6. Market value of wild edible plants

S.No	Name of species	Local name	Trade name	Rates (Rs/kg)
1	*Juglans regia* L.	Akhor	Akhrot	300-400
2	*Angelica glauca* Edgew	Choru	Chhipi	100-120
3	*Diplazium esculentum* (Retz.)Sw.	Lingura	Lingura	50-60
4	*Zanthoxylum armatum* DC.	Timur	Timur	50-60
5	*Rhododendron anthopogon* D.Don	Burans	Takkar	50-60
6	*Rhododendron arboreum* Smith	Burans	Burans	60-70
7	*Myrica esculenta* Buch.-Ham. ex D. Don	Kappahl	Kappahl	40-60
8	*Asparagus curillus* Buch. –Ham. ex Roxb.	Sharanoi	Satawar	30-40
9	*Bergenia ciliata* (Haw.) Sternb	Patharchur	Silphor	25-30
10	*Solanum nigrum* L.	Khalarkoi	Makoi	10-15
11	*Taxus baccata* L.	Thuner	Talis patra	30-35
12	*Cinnamomum tamala* (Buch.-Ham.) Nees & Eberm.	Tej patta	Tej patta	60-70

3.6 Value addition and By-Products

A few wild edible species were used for making pickles, chutney, jam, jelly and squash through value addition to ensure high returns in comparison to selling of raw materials. A few local residents in the study area use *Rhododendron arboreum* for squash preparation. Squash is prepared from rhododendron flowers. The local inhabitants of the study

area respond that rhododendron juice business apparently flourished during the blooming season only. However, local people admitted that preservation technology is lacking among them. The post-harvest/ preservation technique is effective practice with benefits of additional income generation to the local people. The juice extraction from rhododendron flowers needed to attract national and international collaboration to raise the socio-economic status of the local communities[27]. Table 7 reveals data on the cost-benefit analysis of squash preparation form *Rhododendron arboreum*. The squash making increased the cost of flower of *Rhododendron arboreum* from Rs. 40/litre to Rs. 70/litre with net profit of Rs. 30/litre. The profit was relatively higher but it is limited to few people in the study area.

Table 7. Income from Juice of *Rhododendron arboretum*

Particulars	Price (Rs.)	Quantity	Total (Rs.)
Cost of fuel wood	12/10 kg	4kg	4.8
Cost of sugar (with preservatives)	38/kg	0.8kg	30.4
Cost of flowers	5/kg	0.5kg	2.5
Cost of bottles	Rs. 2 each	1	2
		Cost of 1 bottle	40 approx
Source: Field survey 2014		**Total cost for 500 bottle**	**20,000**

Price of per bottle in market = Rs. 70/litre, Price of 500 bottle = Rs. 35,000
Net income = Total income – Total cost = Rs. 15,000

It was found that during the blooming season local people fetch an average price of Rs. 15,000/ litre. It can be concluded that value addition to wild edible plants in any form of by-product is profitable option, which yields high returns to the rural people and increases the keeping quality of different species.

4. DISCUSSION

The benefits of wild resources to inaccessible rural villages in Himalaya cannot be ignored. The positive relationship between the resources i.e., crops, non-timber forest products and livestock indicate their concurrent relevance to livelihoods[28-29]. However, chemical analyses were beyond the scope of this study and therefore, the information on the nutrient contents is entirely based on literature. Whilst the herbs are eaten as leafy vegetablesthe majority does play an opportunistic or overlapping role as medicinal and hence adding extra value, and thereby making them very attractive and important to the users[30]. In study area *Myrica esculenta*, *Berberis asiatica* and *Rubus ellipticus* were the most preferred fruit species while *Diplazium esculentum* and *Urtica dioca* are frequently consumed leafy vegetables. Households with limited access to cultivated vegetables such as the present study area had to store dried wild edible for use during the lean periods. Declining population of wild edible plants in the wild due to habitat loss has raised concern among various scientist, ecologists and conservationists of the Himalayan region[31-32]. Their distribution is dimishing day by day due to excessive collection, grazing, fodder and fuelwood collection, forest fire, indiscriminate felling of trees, illegal collection of wild plants and rapid increases of notorious weeds viz., *Eupatorium adenophorum* and *Parthenium hysterophorus* (Gajar Ghas) in several places[33.] However, when residents were asked to compare the current availability with the past decade, the majority was in agreement that the amount of wild herbs has decreased[34].

5. CONCLUSION

The study aims to investigate WEP diversity and their multipurpose utility in a study area, communities habitat near to the reserve forest depend significantly on WEP especially during their lean periods. The present study reveals that WEP are not only sources of food and nutrients to the native people but could also be means of income generation, if managed sustainably. Several WEP can benefit local people not only as food, but also for their medicinal properties. These essential natural resources are threatened by several anthropogenic and natural causes such as land-use change, habitat destruction, over-harvesting, over-grazing, and invasive species. Therefore it is utmost important to conserve these resources for our future generations. Mass scale propagation of wild edibles in the nurseries, arboreta and botanical gardens through asexual and sexual methods need to be popularized among the hill communities for their conservation and management.

6. AUTHORS CONTRIBUTION STATEMENT

Dr. Veena Chandra conceived the idea and guided in conducting this research study. Dr. Reenu Agarwal collected the data, wrote the manuscript and analysed the data. All authors discussed the results and contributed to the final manuscript.

7. CONFLICT OF INTEREST

Conflict of interest declared none.

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