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DIVERSITY AND SPECIES COMPOSITION OF INSECTS AT MONTANE FOREST ECOSYSTEM OF MEGHAMALAI WILDLIFE SANCTUARY, THENI DISTRICT

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Abstract: Meghamalai, popularly called High Wavy Mountains, is a cool and misty mountain range situated in the Western Ghats of Theni district, Tamilnadu, South India upholds biodiversity. It is a place of natural beauty dotted with cardamom plantations and tea estates up to an elevation of 1,500 m above sea level. The Sanctuary is also an excellent buffer sustaining the Periyar Tiger Reserve and Grizzled Squirrel Wildlife Sanctuary of the southern Western Ghats. The places, Upper Manalaru, Maharaja mettu and Iravangalaru are fringed by forests with rich flora and fauna. This study presents the first comprehensive inventory of species composition and diversity of insects of the Sanctuary.

Intensive studies were carried on the plant - insect interaction with the 108 focal tree species during the flowering phenology. Observations on pollination were made from a spot, about 10 – 20m away from the focal plant using a pair of binoculars. The hierarchies in insect order in percentage are Lepidopteran (50%), Coleopteran (23%), Hymenopteran (17%), Hemipteran (7%) and Dipteran (3%). A variety of Lepidopteran species as observed have half the percentage of the total number of insect visits. Their interactions are higher than the other insect orders. Among the insect visitors, the order Hymenopteran dominates the others in number and population.

Index Terms **- Meghamalai, Insects, Diversity, species composition, pollination.**

1. Introduction

Insects are the most diverse (species rich) group of animals in the world (Martin, *et al.*,1999). Insects are a part of the complex forest ecosystem. Like all parts of the ecosystem, they have a role to play and they interact with many other components. This group of organisms is incredibly diverse and their ecosystem functions are equally diverse (Kremen and Chaplin-Kramer, 2005, Vaughan, *et al.*, 2007). They provide an essential ecosystem service that result in the out-crossing and sexual reproduction of many plants.

Insects play various important roles in the forest ecosystem, such as pollination, nutrient cycling and food sources. They are often referred with the pollination, an important role played effectively by bees, wasps, ants, butterflies, beetles and other insect groups like flies and bugs that fly from plant to plant in search of food (Crane, *et al*., 1995, Bernhardt, 2000, Thien, *et al*., 2000, Grimaldi and Engel, 2005, Smit and Andrew, 2006). These humble creatures play an irreplaceable role in the production of fruits. Insects such as ants, termites and wood boring beetles bore into the wood of dead trees, speeding up the invasion of wood decaying microbes. Other insects can act as predators and parasites of herbivorous insect pests. Insects also act as food sources for many insectivorous birds, amphibians and small mammals like bats. These multiple roles indicate the complexity of insect functions in the forest ecosystem. Insects are involved in the ecological processes of the forest, including in forest stability, succession and productivity.

2.Study area

Meghamalai sanctuary acts as an excellent buffer to the Periyar Tiger Reserve and Grizzled Squirrel Wildlife Sanctuary and thus immensely strengthens conservation in the ranges of southern hills in the Palghat gap of Western Ghats (Anon, 2005). Meghamalai forest division lies between 9°302 N to 9°502 N and 77°102 E to 78°302 E. The elevation ranges from 300 to 2016 m above sea level. Meghamalai was declared as wildlife sanctuary in the year 2010 and the hill complex enclaved the Erasanayakkanur side of Suruli falls and Mel Gudalur on the Kumuli hills.

The forest types include shola forests and grasslands at high altitude, evergreen and semi-evergreen forests at slopes. Montane forest covering 108.44 sq. km and moist deciduous forests covering 103.38 sq. km predominated the sanctuary. Deciduous forests about 228.73 sq. km lies at the edge of eastern side. Plantations and commercial cropland consist of tea, coffee and cardamom covers 49.78 sq. km. The commercial crops grown are coffee, tea, cardamom, clove, cashew and silk cotton (Ramesh, *et al.*,1997). The remarkable amazing places of the sanctuary are Upper Manalar, Maharaja mettu and Iravangalar, Highwavys fringed forests with rich flora and fauna

(National Wildlife Data Centre, 2006). The Suruli river originates in the slopes of Meghamalai hills. The special feature of the Suruli waterfalls is that at falls down from 190 feet height, full of water round the year. Meghamalai forest area hosts a variety of butterflies, reptiles, birds including great Indian hornbill, mammals including the resident and migratory elephants and other important faunal members similar to other wildlife sanctuaries located in Western Ghats (Angus and Patrick, 2008).

3.Methodology

Studies were carried out in Meghamalai Wildlife Sanctuary.An intensive studies were carried on the plant - insect interaction with the 108 focal tree species during the flowering phenology. The tree species were tagged during flowering season and the insect visits to their inflorescence were numbered. Observations on pollination were made from a spot, about 10 – 20m away from the focal plant using a pair of binoculars. Extended watches (a minimum of 2hrs) were made near the focal tree species. During the extended watches, the following details were observed, such as time - log of the day, number of species visiting the plant, number of flowers visited and foraging maneuver employed by different species.

4.Result

Table 1 denotes the insect interaction preferences to the focal tree species during the extended watch. Figure 1 shows the comparison of order-wise insect visit to the focal tree species. Figure 2 shows the percentage of insect pollinators' visit to the focal tree species based on insect species diversity. Figure 3a-e shows the family-wise Lepidopteran, Coleopteran, Hymenopteran, Dipteran and Hemipteran visitors to the focal tree species.

Table 1: Insect Interaction Preferences to the Focal Tree Species during the Extended Watch

S.No	Botanical name	Family name	Le	Co	Hy	Di	He
1	*Anacardium occidental*	Anacardiaceae		√	√		
2	*Buchanania lanzan*	Anacardiaceae		√	√		
3	*Mangifera indica*	Anacardiaceae	√	√	√	√	√
4	*Miliusa eriocarpa*	Annonaceae			√	√	√
5	*Thevetia peruviana*	Apocynaceae	√		√	√	
6	*Wrightia tinctoria*	Apocynaceae	√		√		
7	*Schefflera racemosa*	Araliaceae	√	√	√		
8	*Caryota urens*	Arecaceae		√	√		
9	*Alnus nepalensis D.Don*	Betulaceae			√		√
10	*Spathodea campanulata*	Bignoniaceae	√	√	√		
11	*Jacaranda mimosifolia*	Bignoniaceae	√		√	√	
12	*Cullenia exarillata*	Bombaceae			√		
13	*Ehretia ovalifolia*	Boraginaceae	√	√	√		
14	*Canarium strictum*	Burseraceae	√	√	√		
15	*Cassia alata*	Caesalpinaceae	√		√		
16	*Saraca asoca*	Caesalpinaceae			√		
17	*Casuarina junghuhniana*	Casuarinaceae		√	√		
18	*Bhesa indica (Bedd.)*	Celastraceae			√		
19	*Calophyllum polyanthum*	Clusiaceae			√		√
20	*Poeciloneuron indicum*	Clusiaceae			√		
21	*Mesua ferrea*	Clusiaceae			√		
22	*Vernonia travancorica*	Compositae			√		
23	*Tetrameles nudiflora*	Datiscaceae			√		
24	*Dichapetalum gelonioides*	Dichapetalaceae			√		
25	*Vateria indica L.*	Dipterocarpaceae		√	√	√	
26	*Diospyros barberi*	Ebenaceae	√		√		√
27	*Diospyros foliosa*	Ebenaceae	√		√		√
28	*Diospyros paniculata*	Ebenaceae	√		√		√
29	*Elaeocarpus munronii*	Eleaocarpaceae			√		
30	*Elaeocarpus serratus L.*	Eleaocarpaceae		√	√	√	
31	*Elaeocarpus tuberculatus*	Eleaocarpaceae	√	√	√		
32	*Aleurites moluccana willd*	Euphorbiaceae			√	√	
33	*Bischofia javanica*	Euphorbiaceae	√	√	√	√	
34	*Drypetes roxburghii*	Euphorbiaceae			√		
35	*Emblica officinalis*	Euphorbiaceae		√	√		
36	*Givotia rottleriformis*	Euphorbiaceae			√		
37	*Macaranga peltata*	Euphorbiaceae			√		√
38	*Mallotus tetracoccus*	Eubhorbiaceae			√		
39	*Mallotus aureo-punctatus*	Euphorbiaceae			√		
40	*Mallotus philippensis*	Euphorbiaceae	√	√	√	√	√
41	*Putranjiva roxburghii*	Euphorbiaceae		√	√		

42	*Scolopia crenata clos*	Flacourtiaceae	√		√		
43	*Nothapodytes nimmoniana*	Icacinaceae			√		√
44	*Actinodaphne bourdillonii*	Lauraceae			√		
45	*Alseodaphne somecarpifolia*	Lauraceae	√	√	√		
46	*Cinnamomum macrocarpum*	Lauraceae	√		√		
47	*Litsea floribunda Gamble*	Lauraceae			√		
48	*Neolitsea scrobiculata*	Lauraceae			√		
49	*Cinnamomum tamala*	Lauraceae			√		
50	*Fagraea ceilanica Thunb.*	Loganiaceae			√	√	
51	*Magnolia grandiflora*	Magnoliaceae		√	√	√	
52	*Michelia champaca*	Magnoliaceae		√	√	√	
53	*Michelia nilagrica Zenk.*	Magnoliaceae			√	√	
54	*Memecylon malabaricum*	Melastomataceae			√	√	
55	*Memecylon heyneanum*	Melastomataceae			√		
56	*Dysoxylum malabaricum*	Meliaceae			√	√	
57	*Melia azadirachta*	Meliaceae		√	√	√	
58	*Trichilia connaroides*	Meliaceae	√	√	√		
59	*Walsura trifolia*	Meliaceae	√		√		
60	*Acacia caesia*	Mimosaceae	√		√		
61	*Acacia dealbata*	Mimosaceae	√		√		
62	*Acacia melanoxylon R .Br*	Mimosaceae	√		√		
63	*Ficus asperrima*	Moraceae			√		
64	*Ficus beddomei King*	Moraceae			√		
65	*Ficus dalhousiae*	Moraceae			√		
66	*Ficus microcarpa*	Moraceae			√		
67	*Ficus racemosa*	Moraceae			√		
68	*Ficus retusa*	Moraceae			√		
69	*Ficus tsjahela*	Moraceae			√		
70	*Maesa indica*	Myrsinaceae		√	√	√	√
71	*Callistemon lanceolatus*	Myrtaceae			√		
72	*Eucalyptus globosa*	Myrtaceae	√	√	√	√	
73	*Eugenia rottleriana*	Myrtaceae	√	√	√	√	
74	*Psiduium gujava*	Myrtaceae	√	√	√	√	
75	*Syzygium calophyllifolium*	Myrtaceae	√	√	√	√	
76	*Syzygium cumini*	Myrtaceae	√	√	√	√	
77	*Syzygium rubicundum*	Myrtaceae	√	√	√	√	
78	*Syzygium tamilnadensis*	Myrtaceae	√	√	√	√	
79	*Ligustrum walkeri*	Oleaceae	√	√	√		
80	*Ligustrum perrottetii*	Oleaceae	√	√	√		
81	*Ximenia americana*	Oleaceae			√		
82	*Erythrina indica*	Papilionaceae		√	√		
83	*Erythrina varigata*	Papilionaceae		√	√		
84	*Gouania microcarpa*	Rhamnaceae			√		
85	*Zizyphus rugosa Lam.*	Rhamnaceae	√		√		√
86	*Pygeum wightianum*	Rosaceae			√		√
87	*Achronychia pedunculata*	Rubiaceae			√		
88	*Benkara malabarica*	Rubiaceae	√	√	√	√	
89	*Cinchona officinalis*	Rubiaceae		√	√	√	
90	*Coffea arabica*	Rubiaceae			√	√	
91	*Pavetta indica*	Rubiaceae	√	√	√		
92	*Wendlandia thyrsoidea*	Rubiaceae			√	√	
93	*Atalantia monophylla*	Rutaceae			√		
94	*Citrus sps.*	Rutaceae		√	√		
95	*Salix sps.*	Salicaceae			√		
96	*Santalum album*	Santalaceae			√	√	
97	*Lepisanthes erecta*	Sapindaceae			√		
98	*Sapindus emarginatus*	Sapindaceae			√		
99	*Palaquium ellipticum*	Sapotaceae	√		√		

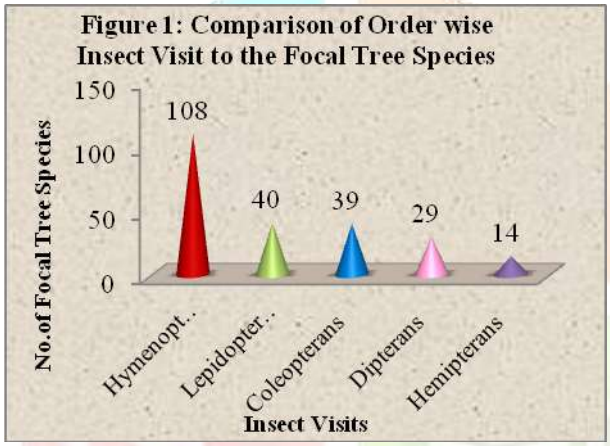
100	*Turpinia malabarica*	Staphylaceae	√		√		
101	*Turpinia nepalensis*	Staphylaceae			√		
102	*Antidesma acidum*	Stilaginaceae		√	√		
103	*Symplocos cochinsinensis*	Symplocaceae	√	√	√		
104	*Symplocos obtusa* Wall.	Symplocaceae	√	√	√		
105	*Gordonia obtusa*	Theaceae	√		√	√	
106	*Holoptelea integrefolia*	Ulmaceae			√		√
107	*Premna tomentosa*	Verbenacae	√		√		
108	*Calicarpa tomentosa*	Verbenaceae			√		

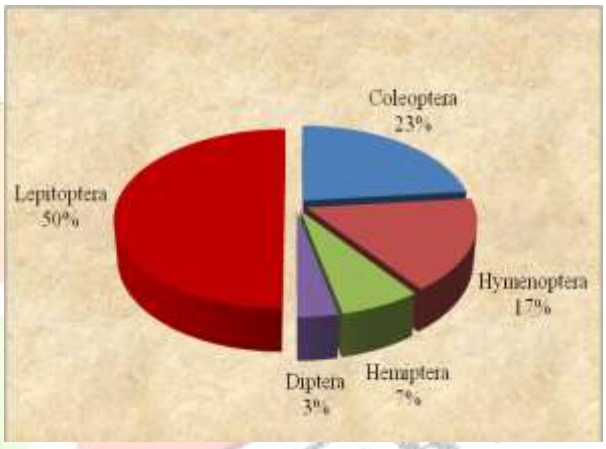
Le – Lepidopterans Co- Coleopterans Hy – Hymenopterans He – Hemipterans Di – Dipterans
Note: Insect Visit observation Based on Insect Order

5.Discussion

Ecosystem services provided by Insects

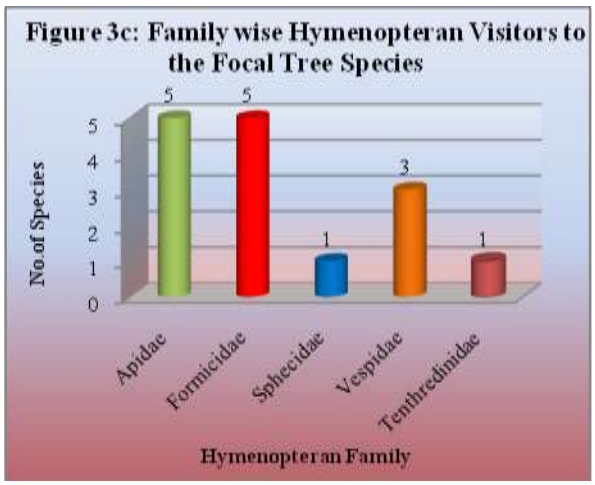
Pollination is an essential ecological survival function. Here is the place where the role of insects, in the maintenance of essential life support systems of natural habitats is well recognized (Wells, *et al*., 1983, Mathew and Rahamathulla, 1995, Adiroubane and Kuppammal, 2010). Most of the flowering plants could not produce seed without insect pollinators. The present study has identified the insect visitors to the focal plants on the basis of number of species represented in terms of percentages. The hierarchies in insect order in percentage are Lepidopteran (50%), Coleopteran (23%), Hymenopteran (17%), Hemipteran (7%) and Dipteran (3%). A variety of Lepidopteran species as observed have half the percentage of the total number of insect visits. Their interactions are higher than the other insect orders. Among the insect visitors, the order Hymenopteran dominates the others in number and population.

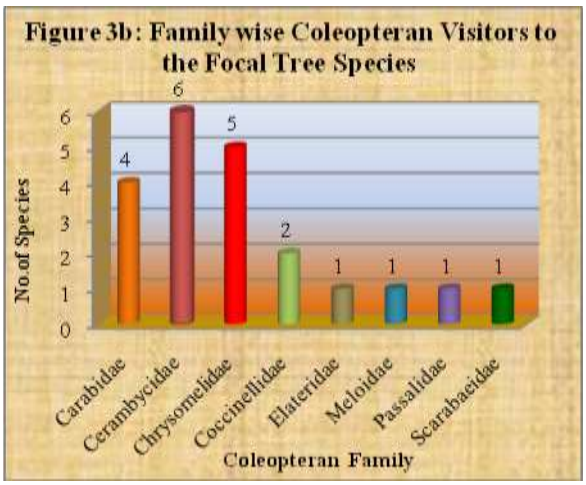


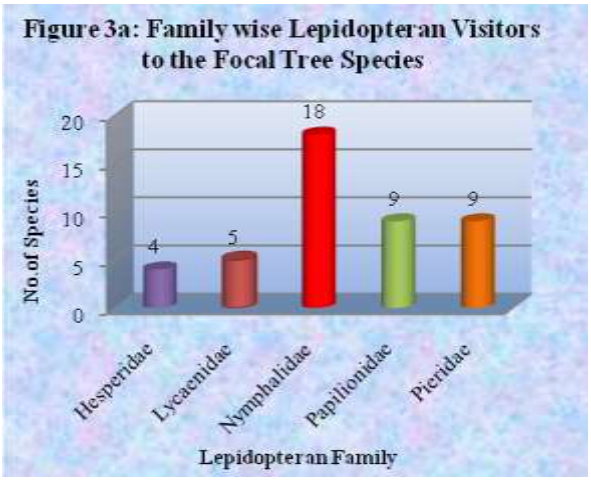


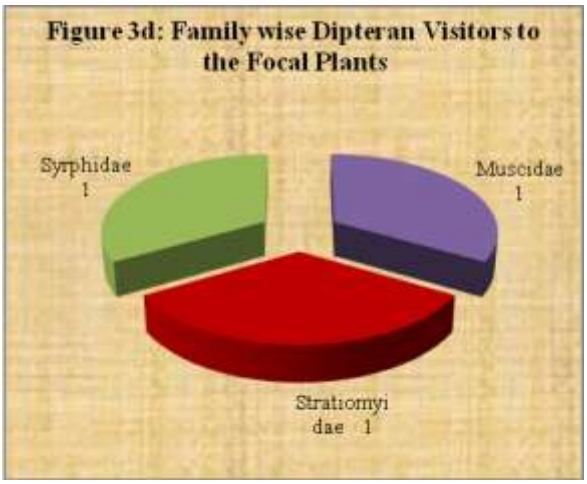
Impact of Lepidopteran Insects

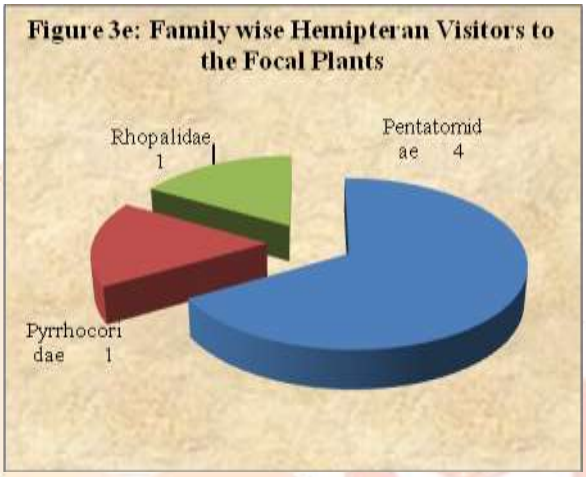
Lepidopteran insects are of diversified nature and as crop pests at the larval stage and as adult they are adult pollinators. At present about 80 % of the world's known animals are insects, and lepidopterans accounts for 1,12,000 species, which include both butterflies and moths (Gunathilagaraj, *et al*., 1998, Nair, 2001, 2002). The present study has a digital documentation, at reveals 45 butterfly species which are encountered during the extended watch near the focal plants. They are classified under 5 families, Nymphalidae (18 species), Papilionidae (9 species), Pieridae (9 species), Lycaenidae (5 species) and Hesperidae (4 species). The visits of Nymphalidae species were more when compared to other families, it include many common species which can be seen almost everywhere. Among the butterfly species *Arnetta vindhiana* (family Hesperiidae), is commonly found in Meghamalai Wildlife Sanctuary. In the mid-elevation rainforest like the other parts of Western Ghats, Meghamalai forest also enjoys the benefits of butterflies visits. About 40 tree species covered under the study considers that the butterflies are major pollinators.











Impact of Coleopteran Insects

Beetles are one of the largest orders of insects, with 3,50,000–4,00,000 species (Gilliott and Cedric, 1995, Vincent and Carde, 2009). In the present study, 23% of the focal plant visitors are Coleopteran species. Among the Coleopterans, 22 species of beetles from 8 families such as Carabidae (4species), Cerambycidae (6species), Chrysomelidae (5species), Coccinellidae (2species), Elateridae (1species), Meloidae (1species), Passalidae (1species) and Scarabaeidae (1species) were observed during the extended watch.

Impact of Hymenopteran insects

The Hymenoptera members such as bees, ants and wasps are the largest and most diverse orders of insects. The present study has documented about 26% of the insect visitors species are hymenopterans. They are all mutually depending on the focal plant species for survival. All of them live a social and colonial life, when compare to other insect orders, even though less in species number they were represented in large populations. The major Hymenopteran pollinate visitors in the present study has classified as 5 families, such as Apidae (5 species), Formicidae (5 species), Sphecidae (1 species), Vespidae (3 species) and Tenthredinidae (1 species). *Apis mellifera* is the most abundant ecologically important pollinator in the wild.

Ants are important components of ecosystems not only they constitute a great part of the animal biomass but also they act as ecosystem engineers. The present study has identified the family Formicidae were represented by five species of ants such as *camponotus compressus*, *Monomorium minimum*, *Lasius niger*, *Myrmica rubra* and *Solenopsis germinata.* Ant-mediated seed dispersal (myrmecochory) has been recorded in over 3000 plant species and more than 80 plant families in tropical region (Giladi, 2006). Among the focal tree species in the present study ants were observed only as pollinator and pest managers than seed dispersers.

Wasps play a crucial role in the lives of an important family of tropical rainforest plants, the figs (Fenster, *et al.*, 2004). Many plants especially the members of Moraceae cannot reproduce without the help of specific wasp species.

Impact of Dipteran Insects

Among the insect visitors, only 3% of the visits were made by a diverse group of flies. Diptera represented from three families Muscidae (*Musca autumnalis*), Stratiomyidae (*Sargus bipunctatus*), Syrphidae (*Episyrphus balteatus*) were observed during the extended watch. The Dipterans are the most likely pollinators of the ancestral angiosperms. More than 550 species of flowering plants are regularly visited by Diptera in America (Larson, *et al*., 2001, Evenhuis, *et al.,* 2008) which proves they are the potential pollinators.

Impact of Hemipteran Insects

Hemipterans represented from three families, such as Pentatomidae (4species), Pyrrhocoridae (1species) and Rhopalidae (1species). Only a few studies have reported hemipterans or flower bugs as pollinators (Yasunaga 1997). Fahn and Shimony (2001) reported that hemipteran insects are main flower visitors in forest ecosystem. In the present study, also 7% of the focal plant visitors are hemipterans. *Macaranga spp*, is pollinated by flower bugs breeding on the inflorescences (Chikako, *et al.,* 2008).

6.Conclusion

Insect pollination is an important concern in the life of plants. The cross-pollination through insect enhances the biodiversity of the forests due to the resultant inter and intra specific hybrids. They play a significant role in the evolution and maintenance of the tropical forest ecosystem of the southern Western Ghats as well as in Meghamalai forests. The insects are the good pollinators and seed dispersers in focal trees and other floral diversity of the Meghamalai forest ecosystem.

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