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Influence of environmental factors on insect pollination activity of *Mangifera indica* Linn

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ABSTRACT

Mango is known as 'king of fruits' because its delicious taste, high nutritive value and excellent flavour. Globally, the performance of pollinators is increasing the fruit production. Insects are the important role in pollinating all flowering plants in terrestrial and aquatic ecosystems. Six insect visitors were observed in mango flowers during the study period in relation to temperature and relative humidity. The abundance of ants, Camponotus compressus 33.78% was high followed by flesh fly, Chrysomya megacephala 32.94% and house fly, Musca domestica 25.44%. The abundance of Ropalidia marginata 0.62% was lower than rock bee, Apis dorsata 3.70% and little bee, Apis florea 3.42%, respectively. Chrysomya megacephala was spending more time in flowers followed by Musca domestica. Apis dorsata and Apis florea are equally spend time in blossoms. Low time spending insects are frequently visits the flowers and effective pollinators. Diurnal activity of insect visitors showed high during temperature and low during high relative humidity. The activities of these insects are found to be high from 0800 hr to 1100 hr, when the temperature ranged from 23-31ºC and relative humidity 75-81%. Chrysomya megacephala and Musca domestica showed insignificantly negative correlation and fairly positive correlation with temperature and significantly positive correlation with relative humidity. C. compressus showed that significantly positive correlation with temperature and insignificantly negative correlation with relative humidity. A. dorsata showed that fairly negative correlation with temperature and positive correlation with relative humidity and R. marginata showed that equally positive and negative correlation with temperature and relative humidity.

Key words: Insect pollination, *Mangifera indica*, relative abundance, relative humidity and temperature.

INTRODUCTION

Mangifera indica belongs to the family Anacardiaceae widely planted in tropical and subtropical countries [Sambamurthy and Subrahmanyan, 1989]. Anacardiaceae contains 60 genera of which 15 genera were reported in Malaysia [Abidin and Malik, 1996]. Insect pollination is not only a critical ecosystem function but also an essential input in production of a host of agricultural crops grown worldwide [Richards, 1993]. The majority of pollinators choose nectar of mango flowers as their food resource [Anderson *et al.*, 1982]. The biology of pollinators of mangos has been studied in India and their results demonstrated that insects of diptera and hymenoptera play major roles in pollinating of this fruits [Bhatia *et al.*, 1995; Dag and Gazit, 2000]. Interrelationship between insect and flowering plants probably existed back in cretaceous period and this has been done proceeding perhaps for 225 million years [Elinga, 1987]. Pollination effectiveness of bees depends on their foraging population in the field and behaviour of crops [Abrol, 1996]. One-third of the total human diet in tropical countries is derived from insect pollinated plants [Crane and Walker, 1983] and its global economic value adds up to € 153 billion [Gallai *et al.*, 2009]. The value of honey bee and bumble bees as pollinators of major selected UK crops for which market statistics are available has been estimated to £ 172 million for outdoor

crops and € 30 million for glasshouse crops [Carrack and Williams, 1998]. Declining pollinator populations has been observed and also physical and environmental factors that influence flower visitors are light, temperature, humidity, cloudiness, wind and rain [Sihag and Abrol, 1986]. Recently, researchers started collecting limited data on the importance of insect pollinators in commercial crops in tropics. There is an urgent need to undertake such studies in every plant family [Schimtt, 1980]. Such a need is much more intense in India, where there is a dearth of even a basic data [Reddi and Reddi, 1983]. In the respect, the present study aims to find the insect visitors of mango flowers *Mangifera indica* L. and their activities related to different weather conditions.

MATERIALS AND METHODS

Present investigation was carried out in and around Ayya Nadar Janaki Ammal College, Sivakasi, India situated at the 9.28 North altitude and 77.48 east longitude. The city is located 157 MSL. The town comprises of 6.89 Sq.Km in extent and population of 65,593. The study area is experienced with dry and pretty hot weather throughout the year. The town gets scanty rainfall during monsoon. It contains 5.88% of industrial areas, even as industrial down vast amount of agricultural crops (62.10 %) for the food source of industrial town. The maximum mean temperature during summer was 39 °C and during winter it is 23°C. The mean humidity was 76.2%. The annual rainfall is very low for about average of 812 mm. The sufficient of the rain and ground water almost helpful to farmers to cultivate the mango trees in front of well and their pump shed and some of them are used drip irrigation, which do not require much water.

Plant description

Mango has been cultivated in India for at least 4,000 years, originated in the Indo–Burma region. Mango is distributed throughout hilly regions above 90 m from sea level. The leading mango growing states are India, Uttar Pradesh, Andhra Pradesh, Bihar and West Bengal. Mango is used for Jams, Juice and mango nectar preparation and coffee preparation and raw mango is used as a pickle preparation. Preparation of mango chutney and other products such as candy, jelly, preserve squash etc., [Sambamurthy and Subrahmayan, 1989]. The kernel inside the stone is highly nutritious and contains 8% of protein, Vitamin A, and C along with minerals [Panday and Chandha, 1993].

Composition and relative abundance of flower visitors of mango, *Mangifera indica* L.

Mango field was visited during December, 2008 to March, 2009 to study the following parameters. Composition and relative abundance of flower visitors was determined following the method of [Jyothi *et al*., 1990]. The insects that visited flowers during the study period was collected and identified. Relative abundance of each insect visitor was calculated by watching number of visits of each insect visitor for 10 minutes/hrs from 0600 hr to 1800 hr. Mango flowers, the insect visitors to the flowers available in one inflorescence of mango tree. From this data the total number of visits per day was calculated based on temperature and relative humidity.

Time spent at flowers

This was calculated by each insect visitor using stopwatch following the methods of Reddi and Reddi, [1983]. When the insect approaches the flowers the stop watch switched on and insect leave the flowers it was switched off.

Diurnal activity

Diurnal activity of insect visitors was observed from 0600 hr to 1800 hr. This study was following the method of Abrol, [1987]. Forager's counts along with measurements of environmental factors such as temperature and relative humidity observed using Fischer Polyam Engs. Pvt. Ltd, Germany.

Data analysis

Insect visitors are correlated with temperature and relative humidity using Past Statistical tool.

RESULTS AND DISCUSSION

Composition and relative abundance of flower visitors of *Mangifera indica* L.

The inflorescence of mango was found to visit by 6 insect visitors, shown in Table 1 viz; flesh fly, *Chrysomya megacephala*; house fly, *Musca domestica*; ants, *Camponotus compressus*; little bee, *Apis florea*; rock bee, *Apis dorsata* and *Ropalidia marginata*. The result showed that *C. compressus* (33.78%); *C. megacephala*, (32.94%); and *M. domestica* (25.43%) are the dominant visitors. The *R. marginata* (0.62%) was less dominant visitor, followed by *A. florea* (3.42%) and *A. dorsata* (3.70%). Thus the study revealed that hymenopterans were dominant visitors. Similar kind of result was observed by Sung *et al*, [2006] one hundred and twenty-six individual insects belonging to 39 species, 23 families and five orders were recorded on mango flowers. Total of 95 bee species were recorded in mixed orchard containing 32 fruit species, contributing 79.5 % of the observations [Castro, 2002]. Six

species of pollinators were observed from *Cucurbita maxima* in relation to temperature and relative humidity [Kumar *et al.*, 2012] and hymenoptera is having a most important order of anthophilous insects. Kevan and Baker, [1983] reported that Formicidae are frequent flower visitors of many flowers. Ants are contributing 34% in *Jatropha curcus* L. [Solomon Raju and Ezradanam, 2002]. Flesh fly and housefly, *M. domestica* was visited both mango flowers. The Diptera, with their sectorial or lapping mouth parts, are also considered as primitive pollinators and the Muscidae is a large family with many well known anthophiles [Kevan and Baker, 1983]. Dipterans fly constituting 14.77% in cauliflower [Selvakumar *et al.*, 2002]. Housefly, *M. domestica* and flesh fly, *Sarcophaga* Spp. could be managed easily for achieving maximum pollination [Rama Devi *et al.*, 1989].

Fig.1.Time spent by insect visitors of Mango *Mangifera indica* L.

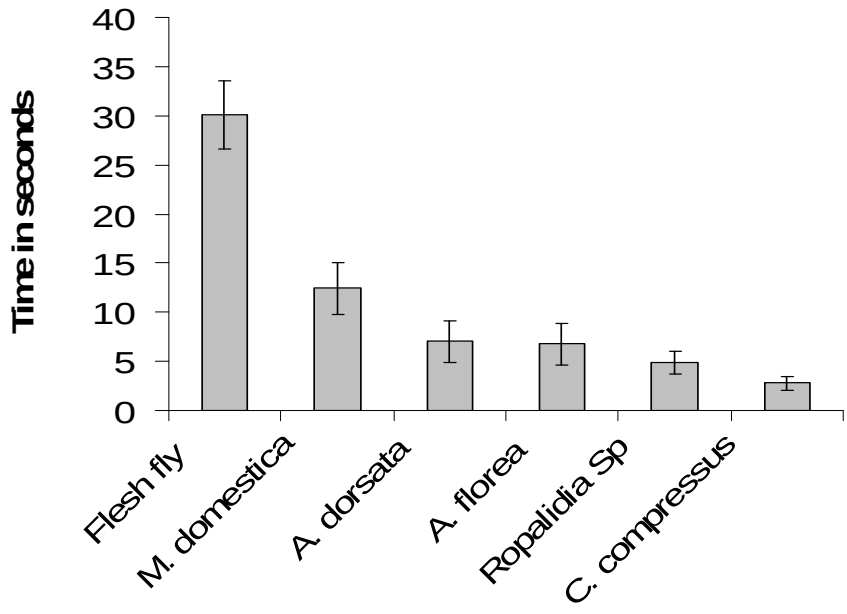

Table.1.Composition and relative abundance of flower visitors of mango, *Manifera indica* L. in relation to temperature and relative humidity

Pollinators	Number of visits per day															Total	Relative abundance (%)
	Feb 2009								March 2009								
Diptera Flesh fly Calliphoridae	25	31	36	17	29	39	41	34	60	82	41	66	35	31	20	587*	32.38
Hymenoptera Ants, *Camponotus compressus*	35	41	45	6	40	57	34	46	34	53	37	41	32	21	34	556	30.67
House fly *Musca domestica*	32	28	27	12	25	41	32	57	34	25	20	27	24	34	27	445	24.54
Ropalida sp.	6	7	10	9	6	6	4	4	8	6	5	6	9	5	6	79	5.35
Rock bee *Apis dorsata*	3	3	6	2	3	3	3	3	6	6	4	8	7	4	5	66	3.64
Little bee *Apis florea*	5	4	5	2	3	4	5	-	-	5	8	6	5	10	-	62	3.42
Total																**1813**	**100 %**

**Value indicates total insect visitors*

Time spent at flowers

Among the insect visitors flesh fly, *C. megacephala*, was found to spend more time in flowers (33.10sec/flower/visit); followed by housefly, *M. domestica* (12.41sec/flower/visit). The ants, *C. compressus* are found to spend lesser time (2.77sec/flower/visit). The rock bee, *A. dorsata* spent approximately 7.04 sec/flower/visit, followed by little bee, *A. florea* (6.80 sec/ flower/ visits). Little bee, rock bee and *ropalidia* sp less amount of visitor was observed in Mango flowers followed by housefly are showed spend more time and honey bees and ants (hymenoptera) was spending lesser time because of house fly has rasping type of mouth parts and pre digestion is important, the same result are followed by *Apis cerana indica* spent 4.0 seconds and the results corroborate with Kumar and Lenin, [2002] showed *Apis mellifera*, *Apis dorsata* and *Apis florea* spent 8.9, 8.6 and 12.2 seconds per flower, respectively on sesame flowers *Sesamum indicum L.* (Fig.1).

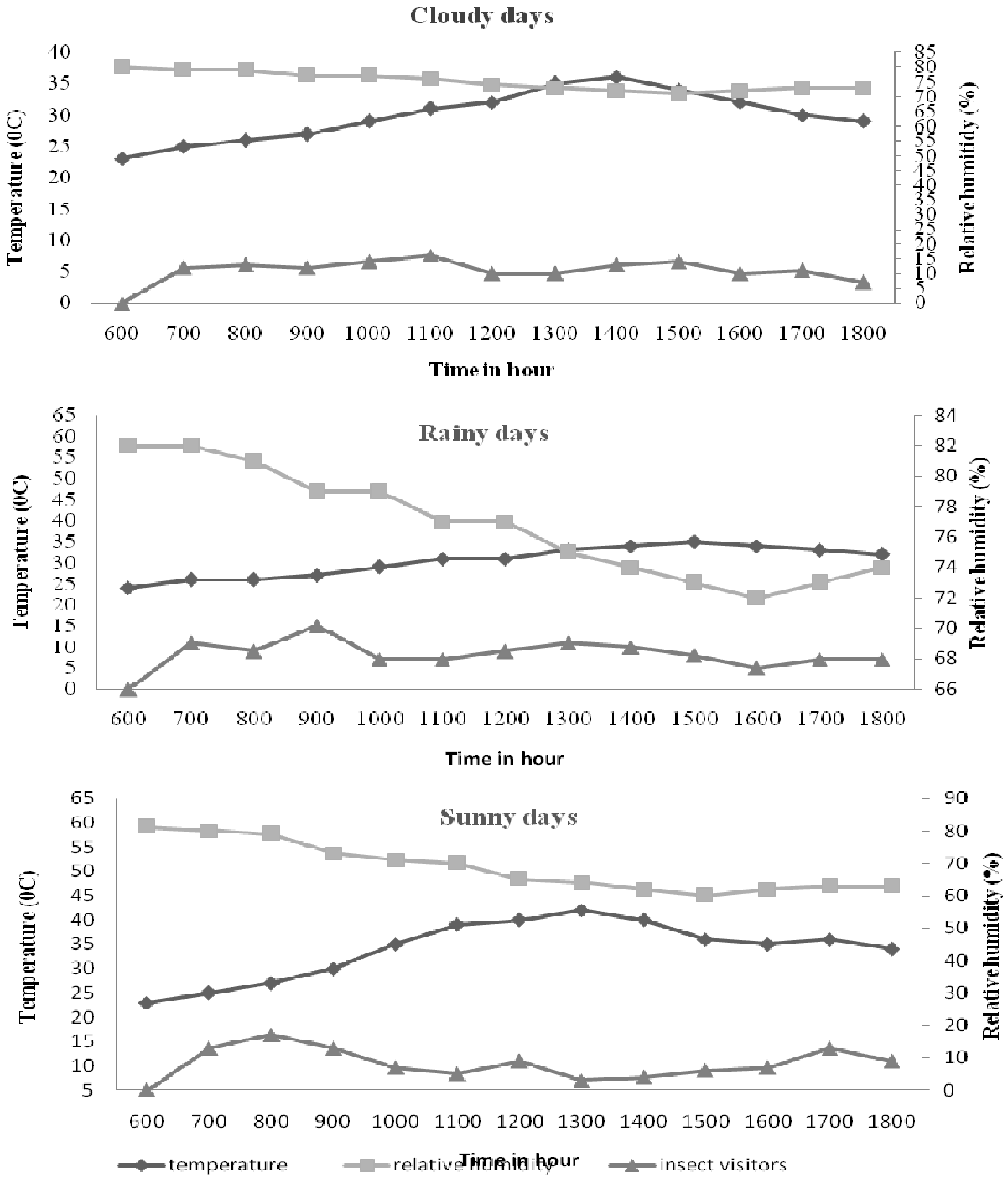

Fig.2.Diurnal activity of various pollinators of *Mangifera indica* L. in relation to temperature and relative humidity in cloudy days, sunny days and rainy days.

Diurnal activity of insect visitors of cloudy days, rainy days and sunny days

The diurnal activity of flesh fly, *C. Megacephala;* ants, *C. compressus*; housefly, *M. domestica*; littlebee, *A. florea*; rockbee, *A. dorsata* and *Ropalidia* Sp. was observed to begin around 0700 hr and cease around 1800 hr on cloudy days. The activity of these insect was found to be high from 0800 hr to 1100 hr, when the temperature ranged from 23-31ºC and relative humidity 75-81% (Fig.2).

The diurnal activity of flesh fly, *C. megacephala*; ants, *C. compressus*; housefly, *M. domestica*; little bee, *A. florea*; rock bee, *A. dorsata* and *R. marginata* was observed to begin around 0700 hr and cease around 1800 hr on rainy days. The activity of these insects was found to be high from 0900 hr to1100 hr, when the temperature

ranged from 23-33 °C and relative humidity 77-82%. The activity of these insects was found to decrease after 1700 hr, shown in Table 2.

Table. 2. Diurnal activity of insect visitors of *Mangifera indica* L. in relation to temperature and relative humidity

Time in hours	04.02.2009 (Sunny day)								05.02.2009 (Rainy day)							
	A	B	C	D	E	F	T (°C)	RH (%)	A	B	C	D	E	F	T (°C)	RH (%)
0600	-	-	-	-	-	-	25	80	-	-	-	-	-	-	25	79
0700	5*	3	1	-	2	-	27	80	1	2	6	-	-	1	27	79
0800	4	3	1	-	1	1	28	80	2	1	6	1	-	-	30	77
0900	7	4	5	1	-	2	31	78	1	-	5	-	-	1	33	76
1000	3	3	5	1	-	1	34	78	3	1	6	-	-	1	35	76
1100	4	2	4	1	1	3	37	76	1	1	7	-	-	1	37	76
1200	1	2	5	1	-	-	39	74	1	2	6	1	-	1	39	76
1300	2	1	5	-	-	1	40	74	1	-	5	-	2	1	40	74
1400	1	3	4	-	-	-	41	72	-	2	5	-	-	-	40	73
1500	1	2	5	-	1	2	38	70	2	2	6	-	-	-	39	72
1600	3	1	3	-	-	-	36	70	2	-	5	-	-	1	35	74
1700	2	1	3	-	1	-	34	72	2	1	5	-	-	1	33	74
1800	3	2	4	1	-	-	35	72	1	-	4	-	-	-	32	74

******* *The numbers indicates number of insect visits; - Absence of insect visitors*

***A**-Flesh fly; **B**- M. domestica; **C**- C. compressus; **D**- A. florea; **E**- A. dorsata & **F**- Ropalidia Sp; T(°C) -Temperature; RH (%) - relative Humidity*

Diurnal activity of flesh fly, *C. megacephala*; ants, *C. compressus*; housefly, *M. domestica*; little bee, *A. florea*; rock bee, *A. dorsata* and *R. marginata* was observed to begin around 0700 hr and cease around 1800 hr on sunny days. The activity of these insects was found to high from 0700hr to 1100 hr, when the temperature ranged from 27-39°C and relative humidity 76-76%. The activity of these insects was found to decrease after 1500 hr, when the temperature ranged from 29-42°C and relative humidity 68-77%. Rao and Solomon Raju, [2002] the brisk activity of honey bees was seen during 0600hr in *Bauhinia racemosa* and followed by Abrol [1996] in the evenings activity almost ceased at 600 hr in all the insects except bumble bees and honey bees which continued up to 1730 hr and 1745 hr, respectively. Weather characteristics play an important role in determining the frequency of insect visits, as high visitation rate was associated with warm condition and high light level [Mc call and Primack, 1992]. Kevan and Baker [1983] reported that lower temperature at which flight activity commenced in honey bees is about 10°C , but in spring flight usually begins at 12-14°C, in May at 14-16°C. Maximum foraging population of *Megachile lanata* L. was observed between 1200-1400hr when the air temperature ranged between 29.5-38°C and relative humidity between 45.0-67% [Abrol 1996].

Flesh fly, *C. megacephala* and housefly, *M .domestica* was showed negative correlation with temperature and positive correlation with relative humidity on cloudy days and sunny days. On rainy days, the activity showed positive correlation with temperature and negative correlation with relative humidity. The activity of ants, *C. compressus* showed positive correlation with temperature and negative correlation with relative humidity on cloudy days and sunny days. The activity of rainy days showed negative correlation with temperature and positive correlation with relative humidity. The activity of little bee, *A. florea* was negative correlation with temperature and positive correlation with relative humidity on cloudy days. On rainy days, activity showed positive correlation with temperature and negative correlation with relative humidity. The activity of rock bee, *A. dorsata* showed negative correlation with temperature and positive correlation with relative humidity on cloudy days. The activity showed both positive and negative correlation with temperature and relative humidity. The activity of flower visitors like *R. marginata* showed negative correlation with temperature and relative humidity on sunny days, shown in Table 3. Foraging population showed positive correlation with temperature, but negatively correlated with relative humidity for most of insect visitors, therefore temperature that influences the insect visitors of mango flowers. Same results are followed by Abrol [1996] showed positive correlation with air temperature, light intensity, solar radiation and nectar sugar concentration fluctuation, but was negatively correlated with relative humidity, soil temperature and wind velocity. Sihag and Abrol, [1986] reported that bee activity was positively correlated with air temperature, light intensity and negatively correlated with relative humidity. Indian bee *Apis cerana indica* showed insignificant positive correlation on sunny and cloudy day [Baskaran *et al.*, 1997].

Table.3.Analysis of correlation co-efficient based on the temperature and relative humidity

☼ - *Temperature*, ® - *Relative Humidity*

Pollinators	Physical parameter	Cloudy days			Rainy days			Sunny days								
		09.02.09	11.02.09	02.03.09	02.02.09	05.02.09	23.03.09	01.02.09	04.02.09	07.02.09	22.02.09	06.03.09	07.03.09	14.03.09	15.03.09	22.03.09
DIPTERA Flesh fly Calliphoridae	**'r' value T^{O}C & RH (%)**	- 0.3568☼ - 0.5403®	-0.016 0.1355	0.0108 0.0675	-0.4491 0.4378	0.0650 -0.2526	0.2721 -0.253	-0.1204 0.4731	-0.749 0.6881	-0.8383 0.8635	-0.693 0.773	0.0108 -	-0.861 0.874	-0.072 0.200	-0.535 0.373	0.277 -0.341
House fly ***Musca domestica***		-0.3941 -0.0573	-0.4217 0.5079	-0.4651 0.4599	-0.1093 0.1264	0.2849 0.2948	0.1078 -0.2023	0.0211 0.3326	-0.4821 0.6705	-0.8708 0.8384	0.7945 -0.7818	-0.4651 0.7302	-0.2642 0.1734	0.7757 -0.1796	-0.8739 0.7824	-0.0216 -0.0788
HYMENOPTERAAnts, ***C. compressus***		0.8732 -0.3349	-0.439 0.6017	0.6531 -0.5693	0.6118 -0.6786	-0.0325 0.4524	-0.5187 0.4913	0.3578 -0.0484	0.5904 -0.2030	0.1397 -0.2801	0.4059 -0.4177	0.5631 -0.5693	0.3169 -0.3157	0.3982 -0.5049	0.0049 0.0069	0.4414 -0.4908
Little bee ***A. florea***		- -	-0.9271 0.6622	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	0.4677 0.7009	- -	-0.2936 0.0674
Rock bee ***A. dorsata***		- -	- -	-0.2790 0.5773	- -	- -	-0.1259 0.1740	1 -1	-0.6395 0.5393	- -	- -	-0.2792 0.5773	- -	0.6347 -0.7009	0.4909 0.4444	- -
***Ropalidia* Sp**		0.3840 0.4642	- -	0.2936 0.5345	-0.8660 0.6546	- -	0.0124 -0.0318	-0.1721 -0.6784	-0.2334 -0.2273	-0.9156 0.9566	- -	0.2936 -0.5345	- -	- -	-0.3015 0.2563	0.0443 -0.0925

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