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STUDIES ON INSECT PESTS OF TIMBER YIELDING TREE SPECIES IN A TROPICAL MOIST DECIDUOUS FOREST (BETHUADAHARI : WEST BENGAL)

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INTRODUCTION

About 420 million years ago, during the Silurian Period, ancient plants and arthropods began to occupy the land. Fossil evidence of both terrestrial arthropods and vascular plants can be found from as far back as the Silurian (between 408 and 438 million years ago: Scott *et al.*, 1992). Though the direct evidence of insect-plant coevolution is rare, it can be assumed that, insect-plant relationship evolved early in the history of life on land. Recent work has shown that, the high likelihood of intimate and reciprocal interactions between insects and plants (*i.e.* coevolution) occur, as far back as the late carboniferous period (around 280-300 million years ago: Labandeira and Phillips, 1996).

According to the Food and Agricultural organization of the United Nations (FAO), land with tree crown cover (or stand density) of more than about 20% of total area is defined as 'forest' in 'developed regions', whereas in 'developing countries', ecosystem with a minimum of only 10% tree (and/or Bamboo) crown cover can be called 'forest' (FAO,1997). Today, Forests cover about 3,870 million ha, or 30 percent of the earth's land area (Sharma, 1992) and contain about 70% of carbon present in living things.

Insects play a vital role in tropical forest ecosystem, both from a beneficial or neutral point of view, but also as 'pests'. Insects interact at many complex levels with the trees and with the general abiotic and biotic conditions around them. A proper understanding of how such interactions bring about tree decline and death is a vital prerequisite for curing the problems. Role of various abiotic factors on insects were studied by Khan *et al.* (1988) and Verma *et al.* (1990).

Herbivorous insects feed on different parts i.e. leaves, woods, barks, inflorescences, roots *etc.* of trees and thus causing massive damage of tree health as well as timber quality. The wood and bark boring insects, mainly belonging to the orders Dictyoptera, Isoptera, Coleoptera, Lepidoptera, and Hymenoptera, bore into the wood in search of food or for shelter. Defoliators, skeletonizer and sap suckers of leaves are belong to the orders Coleoptera, hemiptera, thysanoptera, Lepidoptera. They feed on leaves. As a result, the surface area for photosynthesis and transpiration is greatly reduced and the growth rate of trees as well as timber quality is also reduced.

A large number of insects and diseases are known to damage both naturally regenerating forest and plantation forests in India. Nair has a great contribution on the understanding of forest insect pests (Nair *et al.*, 1986, Nair, 2000 & 2001), Varma *et al.*, (2007) studied the pest complex associated with intensively managed Teak plantations in the state of Tamilnadu and Andhra Pradesh, India. Insect pests of naturally regenerating forests and plantation forests in India and Indonesia were also reported by FAO (2007 a, b).

The present study was undertaken to inventorise the insect pests of the major timber yielding tree species *viz. Tectona grandis*, *Shorea robusta* and *Swietenia macrophyla.* Besides this, the incidence and seasonal variations in insect pest populations and their occurrence were studied in relation to some environmental factors like temperature and rainfall of the mentioned area and in relation to nitrogen and phenol contents of leaf, wood and bark of the host trees.

STUDY AREA

Considering the insect pest and plant relationship and its immense importance in management of forests, the protected Tropical Deciduous Forest, Bethuadahari Wild Life Sanctuary, Bethuadahari, Police Station Nakashipara, District Nadia, West Bengal, India was selected as the study area. Geographically the sanctuary is positioned at 23.30°N and 88.30°E and the Tropic of Cancer passes just about 20 km south.

VEGETATION

As per the Champion's and Seth's classification the study area is a forest of Tropical Moist Deciduous type. The upper canopy is mainly comprised of Teak (*Tectona grandis*), Arjun (*Terminalia arjuna*), Siris (*Albizia lebbeck*), Sissoo (*Delbergia sissoo*), Sal (*Shorea robusta*), Mahogany (*Swietenia macrophyla*) and Ficus (*Ficus* sp.). The middle and lower canopies are not well demarcated, they comprise Jamun (*Syzigium cumit*), Minjiri (*Cassia* sp.), Bael (*Aegle marmelos*), Atha (*Annona squamosa*), Hamjam (*Polyalthia suberosa*) etc.

In the partly opened up areas weeds such as *Cassia tora*, *Ageratum* sp. *etc.* are found to thrive as the major ground vegetations. In the water logged areas ground flora is dominated by *Polygonum sp.* and various species of *Colocasia.* Grasses like *Imperata* sp. (Ulloo ghash), *Paspalum* sp., *Panicum* sp., *Cynodon* sp., *Brachiaria* sp. etc. are also occuring sparsely.

MATERIALS AND METHODS

Three timber yielding tree species i.e. teak (*Tectona grandis*), sal (*Shorea robusta*), and mahogany (*Swietenia macrophyla*) were selected for the study. Among the above said tree species teak and sal are indigenous and the mahogany is an exotic species to India.

15 trees of each species were randomly selected for regular observations on the occurrence of insect pests. Insects were collected at weekly intervals from the months of April to September (Pre-monsoon and Monsoon), 2007. In addition to the recording of insect pest species, the nitrogen and phenol concentrations of leaf, wood and bark of selected timber yielding tree species were recorded at monthly interval. In addition, data on abiotic factors *i.e.* temperature and rainfall in the sanctuary was noted. Apart from this, during weekly visits to the study area, detailed observations on the incidence of various insect pests and their damage intensity were also recorded.

a. Collection of insects : Insects were collected by hand picking, bush beating, aspirating, and light trapping methods.

b. Determination of Nitrogen content in the leaf, wood and bark of Teak, Sal and Mahogany : Plants can contain many different nitrogenous compounds, from protein to amino acids, and presence, absence and balance of essential compounds may be more important to a particular insect species than the gross levels (Bernays and Chapman, 1994). Nitrogen content in leaf, wood and bark of teak, sal and mahogany were determined by MicroKjeldahl digestion and distillation method.

c. Determination of phenol content in the leaf, wood and bark of Teak, Sal and Mahogany : Phenols are the plant's secondary metabolites which rather than being beneficial to insects, may deter or even poison them. Total phenol estimation in plant tissue was carried out with the Folin–Ciocalteau reagent.

d. Statistical Analysis :

A diversity index is a mathematical measure of species diversity in a community and provide more information about community composition than simply species richness (i.e., the number of species present).

The Shannon diversity index (*H*) is an index that is commonly used to characterize species diversity in a community.

$$H = -\sum_{i=1}^{S} ni / N \ln ni / N.$$

Where, ni = The number of individuals in each species (Species abundance).

S = The number of species. (Species richness).

N = The total number of all individuals.

RESULTS

1. *Occurrence of insect pests in Teak, Sal and Mahogany* : The list of insect pests found to occur in three species of trees shown in table-1 indicates that leaf, wood and bark of *Tectona grandis*, *Shorea robusta*, and *Swietenia macrophyla* were fed by 15, 8 and 4 different insect species respectively during the study period.

Table-1. Showing the Insect species occurring on three tree species during the study.

Insect species	Order	Family	Teak	Sal	Mahogany
1. *Agrypnus* sp.	Coleoptera	Elateridae	+	-	-
2. *Aeloderma* sp.	Coleoptera	Elateridae	++	-	+
3. *Scleron* sp.	Coleoptera	Tenebrionidae	++	+++	+
4. *Alcidodes* sp.	Coleoptera	Curculionidae	+	-	-
5. *Dihammus* sp.	Coleoptera	Cerambycidae	+	-	-
6. *Neotermis* sp.	Isoptera	Kalotermitidae	++	+	-
7. *Odontotermes feae*	Isoptera	Termitidae	+++	-	-
8. *Odontotermes assmuthi*	Isoptera	Termitidae	++	+	+
9. *Hypsipyla* sp	Lepidoptera	Pyralidae	++	+	+++
10. *Hybalea* sp.	Lepidoptera	Hyblacidae	+	-	-
11. *Eutectona* sp.	Lepidoptera	Pyralidae	+	-	-
12. *Covia conifer*	Hemiptera	Cercopidae	+	-	-
13. *Lisarda annulosa*	Hemiptera	Reduviidae	+	-	-
14. *Leptocentrus leucaspis*	Hemiptera	Membracidae	++	+	-
15. *Tricentrus* sp.	Hemiptera	Membracidae	++	+	-
16. *Thrips longiceps*	Thysanoptera	Thripidae	-	+	-
17. *Haplothrips tenuepinnis*	Thysanoptera	Phaeleothrips	-	+	-

2. *Abiotic factors* : Drake (1994) stated that pests and beneficial insects and vectors of plant and animal diseases, are all influenced directly or indirectly by temperature and rainfall. From the secondary data of temperature and rainfall of the area in the year 2006 and 2007 (Table-2) we can assume that the temperature remain high from April to June and fall in July onwards, the rainfall is minimum in April, May and June and maximum in July, August and September. Excessive rainfall occurred in the month of June, of the year 2006 due to depression.

Table-2. Showing fluctuation of temperature and rainfall during the study period.

Month	2007			2006		
	Temperature (°C)		Rainfall (mm)	Temperature (°C)		Rainfall (mm)
	Maximum	Minimum		Maximum	Minimum	
April	36.47	24.43	1.80	36.43	23.46	1.21
May	36.69	25.25	2.76	36.82	24.42	3.33
June	34.63	24.86	15.44	34.16	26.15	2.90
July	32.28	26.09	12.85	33.07	24.47	13.22
August	32.86	25.18	8.04	31.52	26.53	8.15
September	31.67	24.43	10.12	32.34	25.34	14.06

Figure 1. Damage to sal leaf caused by insect pest.

Figure 2. Damage of teak leaves caused by insect pest.

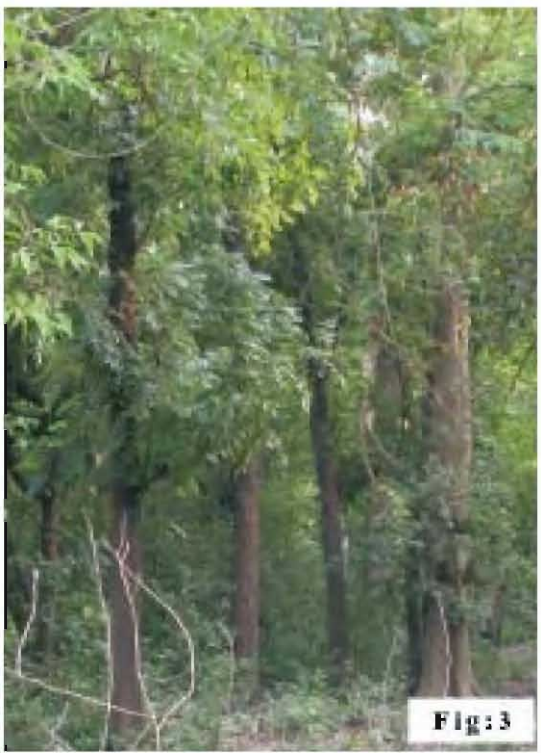

Figure 3. A view of mahogany trees at Bethuadahari forest.

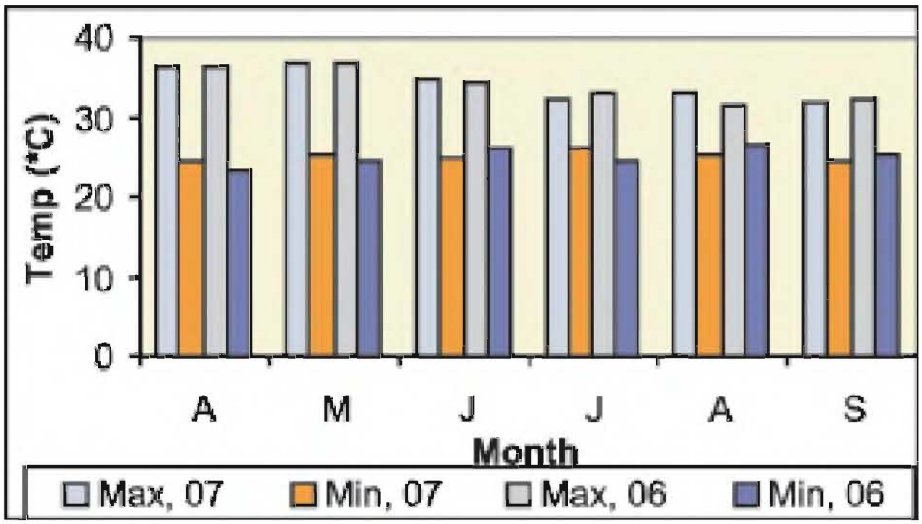

Fig. 4. Monthly variation of temperature of the study area.

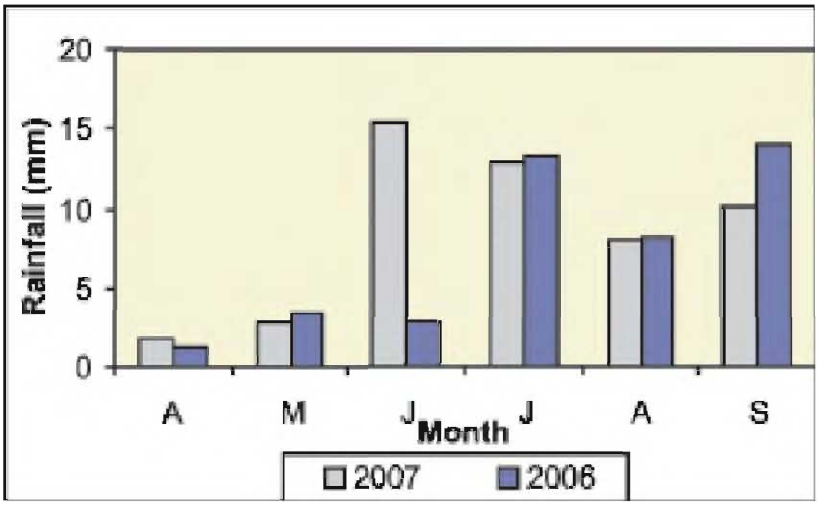

Fig. 5. Monthly variation of the rainfall (mm) of the study area

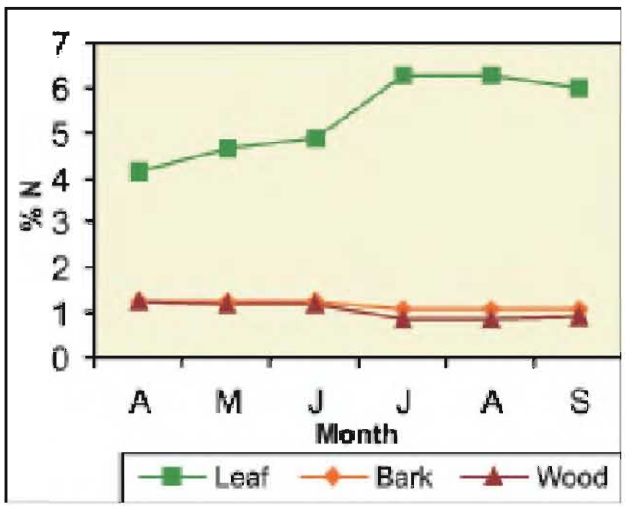

Fig. 6. % N content in leaf, wood and bark of Teak.

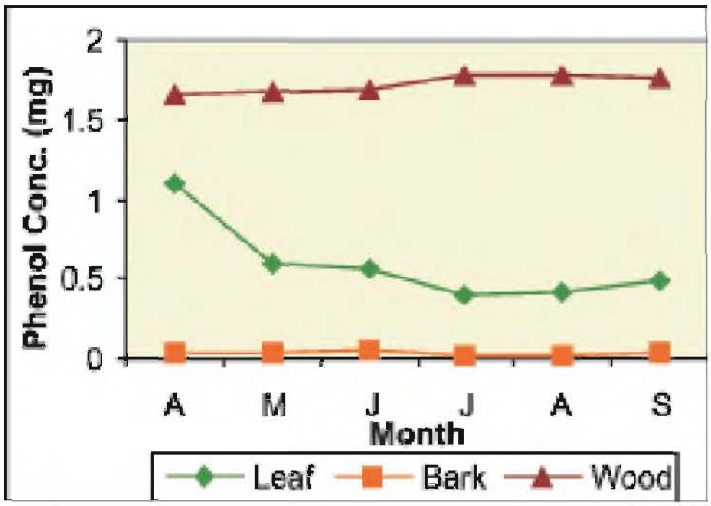

Fig. 7. Phenol concentration (mg) in leaf, bark and wood of Teak.

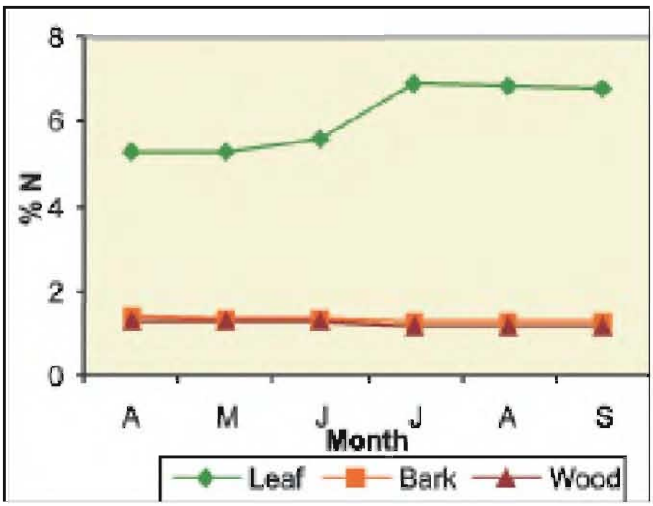

Fig. 8. % N content in leaf, bark and wood of Sal.

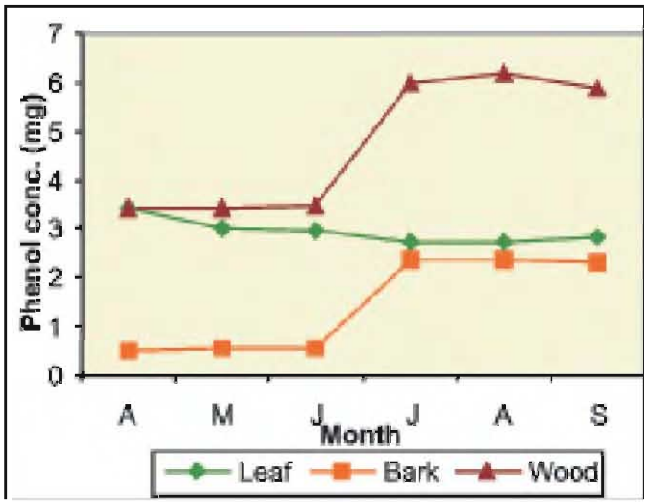

Fig. 9. Phenol concentration (mg) in leaf, bark and wood of Sal.

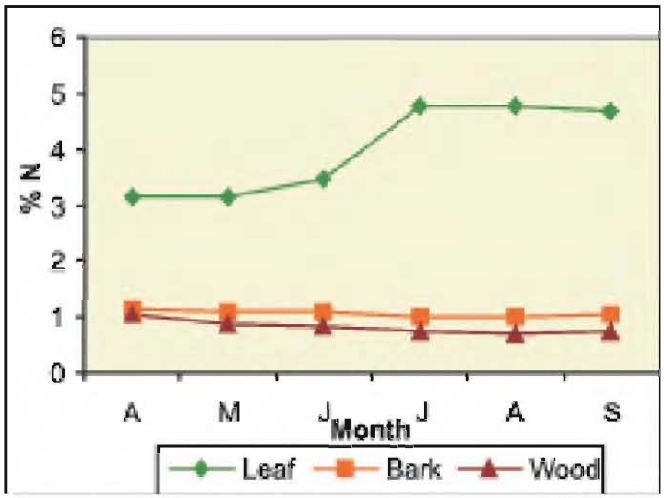

Fig. 10. % N content in leaf, bark and wood of Mahogany.

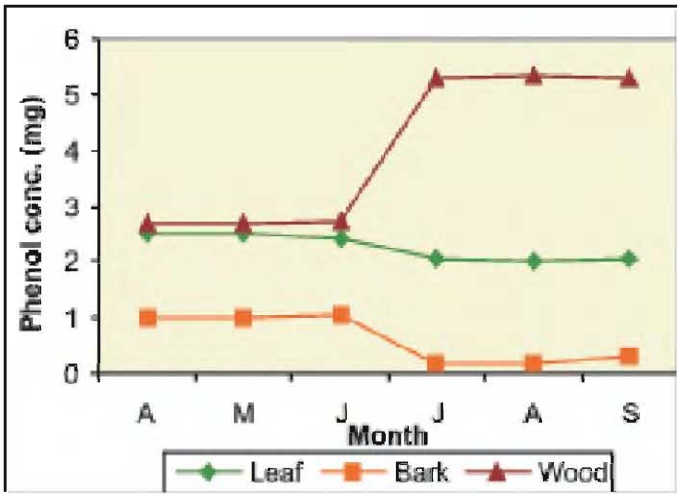

Fig. 11. Phenol concentration in leaf, bark and wood of Mahogany

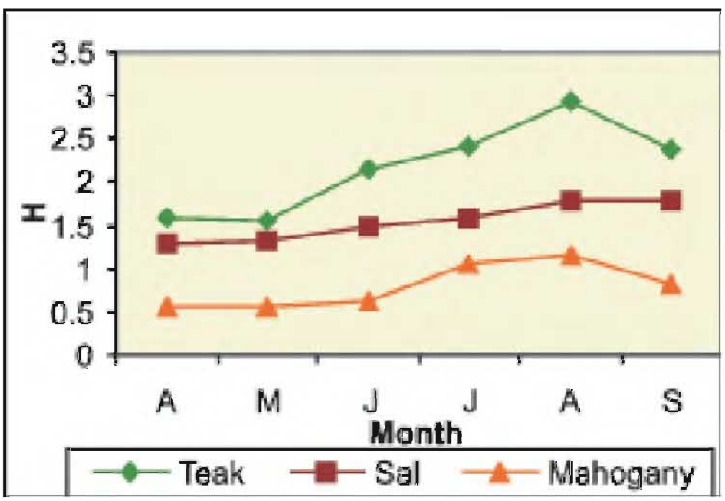

Fig. 12. Diversity indices (H) of insect pests of Teak, Sal and Mahogany.

3. *Standing Percent Nitrogen content (%N) & Standing Phenol concentration (mg/100 gm plant tissue) in Leaf, Wood and Bark of* ***Tectona grandis***, ***Shorea robusta*** *and* ***Swietenia macrophyla*** *at different months* : The organic nitrogen concentrations and the phenol concentrations in wood, leaf and bark of teak, sal and mahogany, were measured at different months, from April to September (Table-3). In teak, sal and mahogany percent nitrogen content in leaf is greater than bark, and the percent nitrogen content in bark is greater than wood, *i.e.* wood contain least amount of organic nitrogen.

On the other hand, phenol concentration in 100 gram of wood was higher and 100 gm of bark contained least amount of phenol.

Table-3. Showing Nitrogen and Phenol concentration in leaf, wood and bark of teak, sal and mahogany

Teak						
Months	$\%N_2$			Phenol (mg)		
	Leaf	Bark	Wood	Leaf	Bark	Wood
A	4.12	1.24	1.21	1.10	0.039	1.66
M	4.66	1.24	1.19	0.60	0.040	1.68
J	4.89	1.22	1.18	0.55	0.046	1.70
J	6.25	1.04	0.845	0.40	0.025	1.78
A	6.26	1.05	0.856	0.42	0.025	1.79
S	6.01	1.07	0.887	0.48	0.030	1.77
Sal						
Months	$\%N_2$			Phenol (mg)		
	Leaf	Bark	Wood	Leaf	Bark	Wood
A	5.27	1.38	1.29	3.4	0.5	3.42
M	5.29	1.32	1.28	3.0	0.56	3.42
J	5.57	1.32	1.24	2.95	0.56	3.49
J	6.89	1.27	1.15	2.7	2.36	6.0
A	6.87	1.26	1.14	2.7	2.37	6.2
S	6.79	1.26	1.16	2.8	2.31	5.89
Mahogany						
Months	$\%N_2$			Phenol (mg)		
	Leaf	Bark	Wood	Leaf	Bark	Wood
A	3.14	1.15	1.06	2.5	1.01	2.67
M	3.15	1.11	.868	2.5	1.02	2.68
J	3. 46	1.09	0.854	2.4	1.05	2.70
J	4.78	1.02	0.723	2.04	0.16	5.3
A	4.78	1.02	0.721	2.03	0.18	5.33
S	4.69	1.05	0.730	2.06	0.29	5.29

DISCUSSION

1. *Different insects are causing different types of damages to their host trees* : Almost every part of the tree can serve as food for insects. There are several types of host tree damages caused by different insects pests and depending on the mode of damage caused by the insects, they are named as, leaf defoliator, leaf skeletonizer, sap sucker from leaf, sap sucker from wood, bark and wood feeder, shoot borer etc.

Table 4a shows that barks and woods of teak are highly susceptible to pest attack. 10 insect species were identified to cause damage of wood bark, and shoot of teak. Among them 7 were bark and wood feeder, 1 was sap sucker and 2 were shoot borer. Among the bark and wood feeder 5 coleopteran beetles were found to cause damage throughout the study period. Termites were considered as the major pest of this study area, causing extensive damage of the host trees, throughout the study period. There were 1 species of leaf defoliator *Hyblea* sp. and 1 species of leaf skeletonizer *Eutectona* sp. which were found to cause severe damage from May, as the new leaves come in teak trees, to September. Nair *et al.* (1985, 1996) found that the *Hyblea puera* caused very significant loss of increment, 44% of the potential growth volume remaining unrealized because of its attack. One of the very important hemipteran pest of teak leaves, *Covia conifer*, causing severe damage during the monsoon season and other sap suckers of leaves, *Leptrocentrus leucaspis, Tricentrus sp., and Lisarda annulosa* were also causing significant damage during monsoon period. Sap feeding insects suck liquid or semi liquid materials from succulent parts of the host plants *i.e.* leaves, stems, roots, fruits, flowers, etc. (Elliott *et al.,* 1998). Mahogany shoot borer Hypsipyla sp was causing little damage at June and July.

From sal (table - 4b) 4 different species of sap suckers were collected among them Thysanopterans feed on leaves throughout the study period but the Hemipterans feeds only during the monsoon period. Mahogany shoot borer *Hysipyla* sp. was found to cause very little damage at June and July.1 coleopteran beetle *Scleron* sp. and 1 isopteran *Odontotermes assmuthi* fed on bark and woods of sal throughout the study period and another isopteran species *Neotermis* sp. causing little damage during the end of the study period.

In mahogany (table- 4c) severe damage was caused by mahogany shoot borer *Hypsipyla* sp. and significant damages were caused by 2 bark beetle *Aeloderma* sp. and *Scleron* sp. and by 1 termite species *Odontotermis assmuthi*.

Table-4a. Damage caused by insect pests of *Tectona grandis*

Damage Caused by insects	Name of Insects	Pre-monsoon			Monsoon		
		Apr.	May	June	July	Aug.	Spet.
1. Bark and wood feeding	1. *Agrypnus* sp.	+	+	+	+	+	+
	2. *Aeloderma* sp.	+	+	+	+	+	+
	3. *Scleron* sp.	–	–	–	+	+	+
	4. *Alcidodes* sp.	–	–	+–	+	+	+
	5. *Odontotermes feae*	+	+	+	++	++	+
	6. *Odontotermes assmuthi*	–	–	–	+	+	+
	7. *Neotermis* sp.	–	–	–	+	+	+
2. Leaf Defoliator	8. *Hyblea* sp.	–	+	++	++	++	+
3. Leaf skeletonizer	9. *Eutectona* sp.	–	+	+	+	+	+
4. Shoot borer	10. *Hypsipyla* sp.	–	+	+	+	–	–
	11. *Dihammus* sp.	–	–	+	+	+	+
5. Sap sucker (Wood)	12. *Lisarda annulosa*	–	–	+	+	+	+
6. Sap Sucker (Leaf)	13. *Leptrocentrus leucapsis*	–	–	–	+	+	+
	14. *Tricentrus* sp.	–	–	–	+	+	+
	15. *Covia conifer*	–	+	+	++	++	++

Table-4b. Damage caused by insect pests of *Shorea robusta*

Damage Caused by insects	Name of Insects	Pre-monsoon			Monsoon		
		Apr.	May	June	July	Aug.	Spet.
1. Bark and wood feeding	1. *Scleron* sp.	+	+	+	+	+	+
	2. *Odontotermes assmuthi*	+	+	+	++	++	++
	3. *Neotermis* sp.	–	–	–	–	+	+
2. Shoot borer	4. *Hypsipyla* sp	–	–	+	+	–	–
3. Sap sucker	5. *Haplothrips tenuipennis*	+	+	++	++	++	+
	6. *Thrips longiceps*	+	+	++	++	++	+
	7. *Leptocentrus leucaspis*	–	–	–	++	++	+
	8. *Tricentrus* sp.	–	–	–	++	++	+

Table-4c. Damage caused by insect pests of *Swietenia macrophyla*

Damage Caused by insects	Name of Insects	Pre-monsoon			Monsoon		
		Apr.	May	June	July	Aug.	Spet.
1. Bark and wood feeding	2. *Aeloderma* sp.	–	–	–	+	+	+
	3. *Scleron* sp.	–	–	–	+	+	–
	3. *Odontotermis assmuthi*	–	–	–	–	+	+
3. Shoot borer	3. *Hypsipyla* sp.	+	+	+	+	+	+

2. *The diversity of insect pest varies with season and with host tree species* : From the species diversity index (Shannon Weiner Index of Diversity) (Table-5) we can assume that the diversity of insect pests in *Teactona grandis, Shorea robusta* and *Swietenia macrophyla* was highest at monsoon. At monsoon the Insect diversity as well as the population size was increased, but sometimes insect's activities were retarded by heavy rainfall. May be the temperature ranging from 24°-32°C (from Table-2) is the definite range of temperature within which the insects can live better.

We can also assume that diversity of insect pests in *Tectona grandis* both in pre-monsoon and monsoon was highest than *Shorea robusta* and *Swietenia macrophyla.*

Species diversity index also showed that the diversity of insect pests in exotic tree species *Swietenia macrophyla* was very low than the indigenous tree species *Tectona grandis* and *Shorea robusta.*

Table-5. Showing the Species Diversity Index of *Tectona grandis, Shorea robusta* and *Swietenia macrophyla* at different months

Tree species	April	May	June	July	August	September
1. *Tectona grandis*	1.5773	1.5647	2.1515	2.4149	2.9371	2.3723
2. *Shorea robusta*	1.2995	1.319	1.4950	1.5776	1.7692	1.773
3. *Swietenia macrophyla*	0.5657	0.5656	0.617	1.0581	1.1652	0.8265

3. *There is a relationship between Percent Organic Nitrogen Content and Phenol Concentration in Leaf, Wood and Bark of host Tree species and Insect Diversity (Host tree insect relationship)* : There is a direct relationship between insect density and diversity and the nitrogen concentration in plant parts i.e. when the nitrogen concentrations in the plant parts increase, the insect density and diversity also increase.

Again, there is an inverse relationship between the phenol concentration in plant parts and the insect density and diversity, i.e. as the phenol concentration in plant parts increase, the density and diversity of insects is retarded. Phenols inhibit herbivore digestion by binding to consumed plant proteins and making them more difficult for insects to digest, and by interfering with protein absorption and digestive enzymes.

Table-6 showed that percent nitrogen content in leaves, woods and barks of teak and sal were more or less same but phenol content in 100 gm of leaves, woods and barks of sal was very high than teak. Large number of insects fed on different parts of teak but in sal phenol as a secondary metabolite retarded the insect feeding.

On the other hand percent nitrogen content in leaves, woods and barks of Mahogany were very low and phenol content in 100 gm of leaves, woods and barks were very high, so, few insects fed on this species.

Table-6. Shows Percent Organic Nitrogen Content and Phenol Concentration in Leaf, Wood and Bark of host Tree species and Insect Diversity

Month	Teak			Sal			Mahogany		
	Leaf								
	N2	Phe	DI	N2	Phe	DI	N2	Phe	DI
A	4.12	1.10	0.6921	5.27	3.4	0.6909	3.14	2.5	–
M	4.66	0.60	0.6926	5.29	3.0	0.6923	3.15	2.5	–
J	4.89	0.55	0.6911	5.57	2.95	0.3427	3. 46	2.4	–
J	4.89	0.55	0.9820	5.57	2.95	1.3835	4.78	2.04	–
A	6.26	0.42	1.2872	6.87	2.7	1.3854	4.78	2.03	–
S	6.01	0.48	1.2939	6.79	2.8	1.3861	4.69	2.06	–
	Bark								
	N2	Phe	DI	N2	Phe	DI	N2	Phe	DI
A	1.24	0.039	1.0465	1.38	0.5	0.7855	1.15	1.01	–
M	1.24	0.040	1.0233	1.32	0.56	0.5748	1.11	1.02	–
J	1.22	0.046	0.9261	1.32	0.56	0.7362	1.09	1.05	0
J	1.04	0.025	1.8191	1.27	2.36	0.6043	1.02	0.16	1.0529
A	1.05	0.025	2.6176	1.26	2.37	0.6262	1.02	0.18	1.0517
S	1.07	0.030	1.6752	1.26	2.31	0.6420	1.05	0.29	0.5983
	Wood								
	N2	Phe	DI	N2	Phe	DI	N2	Phe	DI
A	1.21	1.66	–	1.29	3.42	–	1.06	2.67	0
M	1.19	1.68	–	1.28	3.42	–	.868	2.68	0
J	1.18	1.70	0.9302	1.24	3.49	0	0.854	2.70	0.4340
J	0.845	1.78	0.9598	1.15	6.0	0	0.723	5.3	0.4194
A	0.856	1.79	0.6860	1.14	6.2	–	0.721	5.33	0.4649
S	0.887	1.77	0.6920	1.16	5.89	–	0.730	5.29	0.5029

4. *Exotics are less susceptible to pest attack than indigenous species* :

A total of 15 species were found to cause damage in teak, 8 species in sal, which are indigenous to India and 4 species in mahogany which is exotic to India.

According to, Zobel *et al.* (1987), ".....The argument that establishing a species outside its natural habitat (i.e. as an exotic) increase its susceptibility to pests has not been proven. .....Growing a species as an exotic may actually release that species from its natural pests and thus improve its health and performance."

Empirical results may be support the Zobel's argument. Mahogany as an exotic species in India as well as in Bethuadahari forest were less susceptible to insect pest attack, whereas the teak and sal both are indigenous species and were suffering from severe pest attack. It may be explained from the angle of nitrogen content and phenol concentrations in plant tissues.

The phenol content in different parts of mahogany was very high and nitrogen content was very low than different parts of indigenous species teak. So the insect pest diversity and abundance was very low in mahogany than teak. Thus, the study showed that severity of pests attack depend on percent nitrogen content and phenol concentration in plant tissues.

As the leaf, wood and bark of teak contained least amount of phenol than sal and mahogany, large number of insect species can fed on it.

CONCLUSION

This study showed that 15 different insect species fed on teak (*Tectona grandis*), 8 different species fed on sal (*Shorea robusta*) and 4 different species fed on mahogany (*Swietenia macrophyla*) in Bethuadahari forest, Nadia, West Bengal, India, which is a tropical moist deciduous forest.

This study also showed that the population density and diversity of insect pests in teak, sal and mahogany were high at monsoon season.

From this study it was concluded that the indigenous timber yielding tree species teak (*Tectona grandis*) is highly susceptible to insect herbivory, because leaf , wood and bark of this species possess low amount of phenol, which gave protection to the trees against insect herbivory. On the other hand, leaf, wood and bark of another indigenous species, sal (Shorea *robusta*), contained high amount of phenol, and thus it was less susceptible to insect pest attack.

Mahogany (*Swietenia macrophyla*) is an exotic species in India and it is least susceptible to insect herbivory than teak and sal. Empirical results showed that leaf, wood and bark of this tree species contain little amount of nitrogen and high amount of phenol.

SUMMARY

The paper consists results of a "Study on insect pests of timber yielding tree species in a tropical moist deciduous forest". The study was carried out at Bethuadahari Wild Life Sanctuary, Bethuadahari, Nadia, West Bengal, which is a tropical moist deciduous forest and the vegetation comprises indigenous timber yielding tree species teak, sal, sissoo, ficus, siris, arjun etc. and one exotic timber yielding tree species mahogany. For this study, teak, sal and mahogany trees were selected and the study period was April to September, 2007. At the study area 15 trees from each species were selected randomly for monthly observations of insect pest diversity.

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