

## Investigations of the initial infestation of new teak plantations by the trunk-inhabiting termite, *Neotermes tectonae* Damm., in Java\*)

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In common forest practice in Java, an infestation by *Neotermes* — the "rangas djati" — often remains unobserved until the plantation is some 15 or 20 years old, about the time a third thinning operation has to be carried out. By then a noticeable percentage of trees may show, in the upper part of the trunk, the rough-barked swellings — called "inger-inger" in Central Java —, which originate from the reactions of vigorous trees to the tunnelling of a *Neotermes*-colony beneath the bark.

Systematic investigations of the rate of infestation in teak plantations of various ages were started by the present writer near Tjepu (Rembang) and Telawa (Semarang) as early as 1924. It was found that visibly infested trees, comprising up to 1% of the stand, could occur in plantations only 8 or 9 years old (KALSHOVEN, 1927). However most attention was given at the time to the infestation of 20-year old and older stands, which required intensive thinning and yielded considerable amounts of workable timber, and the incipient stage of infestation was not studied in detail.

It had become evident that the first infection of new teak plantations with *Neotermes* was due to alates ("sulung" in Javanese) swarming from colonies inhabiting trees in the surrounding compartments of older age-classes or adjacent mature forests, since infestation was found to be rather common and wide-spread over the whole teak-area in the districts Rembang and Semarang. As soon as these first colonies, already thriving in the young plantations, reached maturity and produced alates, additional self-infection of the stands could begin.

It was thought worth-while to investigate at what precise time and to what extent the first infestation of a new teak plantation exactly took place. Later on an inquiry into the gradual spreading and building-up of a population of *Neotermes*-colonies might yield valuable indications about the possible measures of protecting the plantation from infection from abroad, as well as about the time control measures for an established infestation should be started.

**M e t h o d.** Investigations to clear such points were put on the 1935, 1936 and 1937 programme for field work to be carried out in the teak-area between Kedungdjati and Telawa (S. of the town of Semarang), where the field laboratory was situated amidst the forest ranges of Gedangan, Manggar, Padas and Telawa. Fairly large plantations, varying not too much in development in their different parts, had to be selected in order that any differences in infestation between the marginal and the central parts could be found. This selection was not an easy one as most of the plantations had very irregular border-lines or were

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long and narrow, while the quality of the stand sometimes differed considerably in the various parts.

Because the incipient colonies of *Neotermes tectonae* inhabit dead parts of the tree (KALSHOVEN, 1930), and have not yet penetrated into the living trunk, no outward signs of their presence is visible from the ground. To detect them one has to examine closely all dead limbs, snags, broken tops, etc. which require to be cut down from the trees. Fortunately the forest labourers in Java are very clever in climbing trees, and so the collecting of this material could be done on a large scale. Dead limbs infested were carefully opened to collect the *Neotermes* colony as complete as possible and sketches were made of the position and extent of the nest. The colonies were put in spirit for determining their size and composition. For every tree examined the number of dead branches investigated was listed.

Under this scheme 14 plantations ranging in age from 5—12 years were investigated. In each case the whole plantation was first searched for any trees showing distinct swellings of the trunk, the crown, or the top, which might indicate the presence of well-established *Neotermes*-colonies of some age and size. These trees were felled and the infested parts sawn and split to exhibit all galleries and cavities, and to collect the entire colony. In this way a first impression was gained of the age and extent of the initial infestation.

For the subsequent investigation of the crowns of other trees for dead parts which might harbour incipient *Neotermes*-colonies, at first all trees were climbed and inspected along trails laid out from the border of the plantation to the central part, but the number of trees covered in this way proved to be too small. Therefore the same plantations — viz. the compartments numbered (4), (7), and (12) — were re-investigated, using plots of 100 trees laid out in various parts of the compartments and including any different qualities of the stand. This method was then applied in all further instances. In compartment (12), however, after the examination of 11 plots of 100 trees, another larger plot, exactly covering one hectare and containing 837 trees, was investigated (see table).

Simple ground plans of the compartments and their immediate surroundings were drawn up where the positions of the trees showing swellings and the plots of 100 trees were indicated, together with the quality grades in the different parts, and the type and age of adjacent compartments.

All the field work was carried out by the mantri WARNODIHARDJO with a number of fellow workers and trained climbers, and under direct supervision of the forest-entomological assistant MAS SUDIRO KARTOHADIBROTO, who also prepared the fair copies of the lists. The work was inspected by me during regular visits to the field laboratory, when supplementary observations in the forest and of the collected material were made. Some initial calculations were carried out by Mr. ATJUNG at the Institute for Plant Diseases in Bogor. The final calculations have now been made by me, and the figures arranged in the table on the next (opposite) page.

A few general remarks. It will be clear from the data that the infestation by *Neotermes* of the plantations varies greatly in the different

Experimental compartment	Size in ha.	Date of investigation	Age of plantation	Visibly-infested trees p. ha.	Number of trees investigated	Neoletermes - infestation				Size of largest colony found	
						of plots	of trees in percentages		of dead branches		
							range	avert.			range
(1)	2.8	IV.1937	5 y., 5 m.	0	500	60	0—2	0.6	0—0.5	0.15	59
(2)	7.2	XI-XII.1936	6 y.	0.1	1200	75	0—7	0.2	0—1.0	0.4	200
(3)	9.1	XI-XII.1936	7 y.	0.1	1300	69	0—8	2.1	0—1.3	0.5	88
(4)	22.4	I.1936	7 y., 2 m.	0.2	762	69	0—6	0.9	0—1.2	0.06	211
(5)	6.9	III-V.1936	7 y., 5 m.	0.6	3600	75	0—2	1.6	0—0.3	0.2	510
(6)	7.7	I-II.1937 III-IV.1937	7 y., 2 m. 5 m.	0.6	1200 1700	65	0—4	1.2	0—0.8	0.2	1046
			± 7 y.		8562	69		1.5			
(7)	8.4	I.1936	8 y., 2 m.	0.5	225	79	0—6	0.9	0—1.0	0.08	694
(8)	7.9	III-IV.1936	8 y., 5 m.	1.4	1400	100	1—8	2.0	0—1.0	0.3	499
(9)	11.6	II-III.1937	8 y., 3 m.	0.5	1700	90	0—14	3.8	0—1.5	0.4	769
(10)	3.4	III-IV.1937	8 y., 4 m.	0.3	2000	83	0—3	2.9	0—0.5	0.2	54
(11)	5.6	IV.1937 V.1937	8 y., 5 m. 6 m.	0.4	600 1000	80	0—4	1.5 1.7	0—0.4	0.2	184
			± 8 y.		6925	88		2.6			
(12)	6.0	VIII-XI.1935	9 y., 10 m.	2.2	501	100	1—15	3.2	0—1.2	0.3	1075
"	"	V-VII.1936	10 y., 7 m.	1.0	1100	100		6.2	0.1—1.9	0.7	748
"	"	VIII.1936	10 y., 8 m.	2.4	837	100		4.1	0.3—1.0	0.5	407
(13)	4.1	VIII-X.1935	10 y., 10 m. ± 10 y.		366 2804	100		9.0 5.5	0.4—0.8	0.6	
"	"	V-VI.1936	11 y., 6 m.	6.1	900	100	2—16	10.7	0.2—2.2	1.0	1020
(14)	5.0	V-VI.1937	12 y., 6 m.		1000	100	18—50	29.9	0.6—2.0	1.3	1667

parts of the compartments, as well as in different stands of the same age.

It will also be apparent from the figures that in all cases the actual infestation is much larger than would have been concluded from a superficial observation, because so many colonies had not yet grown sufficiently or had not yet moved into the living parts of the trees for long enough to cause visible signs of their presence. Still most of them are potential factors for an increasing devaluation of large sections of the timber.

Both facts make the control of the infestation by means of the removal of affected trees during thinning operations — as has been proposed formerly — extremely difficult.

**First infestation and gradual increase.** In this respect the data grouped in the table lead to the following conclusions:

A 5-year old plantation may already be slightly infested by *Neotermes* though no outward signs are visible. The largest colony found in this case, comprising 59 individuals, may well have been 1 year and 5 months old (see the diagram in KALSHOVEN, 1930, p. 68), and therefore must have been started at a time the plantation was 4 years old.

The earliest externally visible infestation has been found in a single tree in a plantation of 6 years old. The colony in question, numbering 200 individuals, had probably been started 3 years previously (i.e., diagram on p. 70). Therefore the very first infestation can start in a new plantation at the early age of 3 years.

In plantations ca 7 years old, the infestation, still mostly in the visible stage, may have affected 1—2% of the trees here and there.

In plantations of 8—10 years the infestation gradually increases, finally reaching some 9% of the trees in the invisible stage, and 1—2.5% trees per hectare showing the outward signs of the presence of large colonies.

In the 12-year old compartment a much higher percentage was found for the total infestation, viz. 30%. It has to be checked still whether this leap is a constant feature or not. This may be found out when similar figures collected in plantations of 13—20 years old will have been worked out.

Attention may be drawn to the fact, that, while there is a steady increase in the number of infested trees with the increasing ages of the plantations, there is not the same trend in the percentage of dead branches and tops inhabited by the *Neotermes*-colonies. This percentage appears to fluctuate between rather narrow limits, and this may be due to the increase of the number of dead branches and snags during the period the trees have their largest growth in height, during which time the side-branches in the lower level of the crowns cease growing and die off.

The figures further show that the parts of the compartments which have remained free from any infestation are decreasing in extent with the growing age of the plantations. After they have reached the age of 10 years the infestation is apparently to be found in every corner.

It is still of greater interest that large, "mature" colonies — i.e. colonies which can produce sexuals (alates) that will swarm and found new colonies — may already be present in 7 year old plantations. At that early age self-infection may start and contribute to the increase of the population of *Neotermes*-colonies in a plantation.

Different grades of infestation and their causes. The various observations made, and the study of the ground plans of the experimental compartments, in which the data have been entered, all support the opinion that the early infection of new plantations is not confined to the borders and marginal parts, but is spread over the whole area from the beginning. This fact is in agreement with the observations about the dispersal and settling of *Neotermes* alates, made in 1933/1934 (KALSHOVEN, 1957).

However the spreading of the infestation over the plantations is rather irregular showing decidedly lower figures in some parts than in others and even remaining absent in some places for some years.

Four factors may be taken into consideration for the explanation of these irregularities, viz. (a) differences in type of the adjacent forest compartments as to age, degree of infestation, etc., (b) a greater chance for infestation along the border lines where the plantations are adjacent to glades and felling areas, and where *Neotermes* alates swarming from the near-by forest divisions may first alight, (c) differences in the development (quality grade) in subdivisions of the compartments due to variations of soil, topography, etc., and (d) any influence attributable to the westerly direction of the prevailing winds during the period of swarming of *Neotermes*.

Concerning factor (a) it may be observed that, because the infections penetrate deeply into a new plantation from the beginning, any influence from the type of the adjacent forest compartments is somewhat obscured. Still there are some indications that more infection originates from plantations surpassing the enclosed compartment in age, than from surrounding old, natural forests. This appears to be plausible as the absolute number of *Neotermes*-colonies present in mature forests with their comparatively small number of large trees with wide-spreading crowns is thought to be well below the number of colonies in densely stocked plantations of about 20—30 years of age.

The factor (b) appears to have played a role in compartments (3) and (9). However, the matter remains speculative as conditions concerning insect infestations in marginal parts of large uniform plantations are different in more than one respect.

Factor (c). Some indications of more ready settling and thriving of *Neotermes*-colonies in the best-developed parts of plantations were found. However, the quality grade of the stands shows so much local variation in the plantations investigated and is, moreover, connected with differences in elevation, due to the accidented terrain crossed by ravines and ridges, that the influence could not be substantiated by figures.

No influence of prevailing West winds (d) could be deduced from the figures found and this factor might well be discarded, for observations made already in 1927/1928 have shown that the *Neotermes* alates have a comparatively strong flight. They proved to be able to direct their flight against the wind — albeit a weak one at the time of the observations — and to cover distances of at least 200 m and probably more when flying over open spaces.

## References

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## Enige gevallen van Homoeose

door

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Foto V. A. SEKET

In de zomer van 1958 heb ik tamelijk veel aandacht besteed aan de dagvlinders. Op 14 september ontdekte ik tussen ongeveer 20 stuks op die datum te Amsterdam gevangen exemplaren van *Aglais urticae* L. een ♀, dat op de bovenzijde van de linker achtervleugel een merkwaardige vorm van homoeose vertoonde.

Ongeveer in het midden van de vleugel bevindt zich een baantje van ongeveer 1 mm breed, dat in het verloop van de aderen vanaf de wortel tot bijna tegen de zwarte omlijsting van de blauwe manen doorloopt. Het baantje is verdeeld in vakjes, die dezelfde kleuren vertonen als de vlekken aan de voorrand van de voorvleugel. Ook de volgorde is gelijk aan die van de voorrandsvlekken van de voorvleugel. Aan de onderzijde is de vleugel normaal.

Tevens vermeld ik een geval van homoeose, dat ik ontdekte bij een ♂ van *Coenonympha pamphilus* L., gevangen op 8.IX.1958 te Amsterdam. Op de onderzijde van de linkerachtervleugel bevindt zich in het midden en bij de achterrand een vlekje van ongeveer 1 mm<sup>2</sup>, dat de kleur heeft van de bovenzijde van de voorvleugels.

Beide exemplaren bevinden zich in mijn collectie.

### Summary

Two specimens with homoeose. A female of *Aglais urticae* L. showing on the