EKOLOGIA POLSKA (Ekol. pol.)	24	4	549–563	1976

Andrzej LEŚNIAK

Section of Ecology and Environmental Protection, Institute of Forest Research, Warsaw

FOREST STAND AND SITE CONDITIONS OF A PINE MOTH (*DENDROLIMUS PINI* L.) OUTBREAKS

ABSTRACT: The paper presents results of studies on the degree of a threat of stands at various age-classes and site indices by the pine moth. The paper concerns also the distinctness of the course of an outbreak in geographically differentiated stand conditions. Results of the studies may be utilized in designing forecasting operations and deciding about the necessity of rescue operations.

Contents

1. INTRODUCTION AND PURPOSE OF STUDIES

Knowledge of the duration of an outbreak and of numbers of the next generation of the pest harmful for a forest stand is rather important in decision making about the necessity of the application of chemical protective treatments. To determine how long the outbreak will last on a given area and what numbers will the pest attain (when no protective treatments are undertaken) is not possible today, except of cases of epizooties or mass parasitic infestation.

The cause of difficulties in forecasting of the development of so important phenomena lies in the complicated and variable nature of the pattern of factors deciding about the course of the outbreak. In practice, apart from situations decidedly requiring or not demanding the use of pest control, there are numerous cases in which it is very difficult to make a right decision concerning the control. This concerns intermediate situations, most frequently occurring in vicinity of strongly endangered areas. In such situations, when numbers of pest do not threat with a total feeding during the year of control, but only with a transient weakening of the assimilation apparatus of trees, to carry out rescue treatment is not justified from biological, and frequently also from an economic viewpoint. There are also cases, when giving up of control may turn to be wrong in effects, when during the next year it is necessary to organize again the action of chemical control in areas adjoining those treated during the previous year. This is why it seems purposeful to undertake studies aiming at a possibly detailed determination of the course of outbreaks of individual pests under various conditions.

On the area of forests of Poland outbreaks of most important primary pests, as *Acantholyda nemoralis* Thoms., *Diprioninae*, *Panolis flammea* Schiff., *Bupalus piniarius* L., *Ocneria monacha* L., *Dendrolimus pini* L. occur in general in pure pine stands. Pine stands occupy the majority of forested area in Poland (73.1% according to Dreszer and Zabielski 1962) and are differentiated mainly in respect to age and site indices.

Pure pine stands in Poland belong, in principle[1], to three forest site types: dry coniferous forest, fresh coniferous forest, and bog coniferous forest. Long-term observations indicate that pine moth outbreaks never occur in bog coniferous forests and rather rarely occur in typical dry coniferous forests. The fresh coniferous forest, corresponding with us with the association *Vaccinio myrtilli-Pinetum* Kobendza 1930 in the plant sociological classification, is most often infested by a mass breeding of the moth. This association characterizes itself by a high variation and occurs all over the Poland where forests grow on sandy soils. Despite the fact that it occupies so extensive area, it is not definitely divided[2] into adequately numerous, for purposes of the applied insect ecology, plant sociological units of a lower rank. This results probably from severe deformations caused by economic disturbance by man. The more detailed understanding of conditions of pine moth outbreaks depends upon the acceptance of another type of criteria for the analysis of the mentioned differentiation of pine stands, namely their differentiation in respect to age and site index.

The present paper contains thus results of studies aimed at the understanding of the course of pine moth outbreak in stands of various age-classes and with various site indices. The recent literature contains no papers pertaining to the problem of a possible correlation between the density of caterpillar population during an outbreak on the one hand and the age of stand and its site on the other.

What concerns the age of forest stands, in which occur primary centers of the pine moth outbreaks, the data contained in literature are contradictory to some extent. According to Nunberg (1948), Schwerdtfeger (1957), Koehler (1961), and Śliwa (1966) they are located mostly in stands of older age-classes, from which they afterwards spread to younger stands. In the opinion of above cited authors pine moth outbreaks occur mostly on poor sites. On the other hand Ryvkin (1954), Rudnev (1962), Grimalskij (1964), and Iževskij (1967) state that the pine moth attacks in masses mostly younger stands, according to Ryvkin (1954) – even young plantations of pine 8–14-years old. Grimal'skij (1964) cites also numerous examples of pine moth outbreaks in pine stands with the best Ia and I site indices. One may assume that contradiction in these opinions results from specific structures of age-classes of stands on areas with the pattern of

[1] There are also pure pine stands planted on unsuitable sites: mixed coniferous forests and even mixed deciduous forest and fresh deciduous forest, but pine moth does not occur in them. Also in seaside coniferous forests, *Empetro nigri-Pinetum* Libert et Siss 1939, pine moth was not recorded yet as a dangerous pest.

[2] Matuszkiewicz (1962) divided this association into two subassociations: *Leucobryo-Pinetum* for the south-western Poland and *Peucedano Pinetum* for the remaining lowland Poland, but this division is still not adequate for purposes of the applied insect ecology.

other ecological factors at best suiting the optimal development of the pest discussed. There occurred, perhaps an evolutionary adaptation of pest populations to definite local conditions. Such an adaptation, according to F o r d (1967) is possible even during rather short period of time, when the given species occurs in very high numbers, what happens in the case of the pine moth. A precise determination of the intensity and course of the outbreak of the insect discussed under definite forest stand conditions is important for a right planning of forecast operations, e.g. for the substantiation of adequate density of checking samples. The understanding of the relationship between outbreak phenomena and stand conditions will render possible also a more precise allotment of stands to rescue treatments.

2. SCOPE AND PROCEDURE OF WORK

The data presented and analyzed in the paper were collected during the action of a chemical control of pine moth during years of 1966–1971. During these years pine moth outbreaks

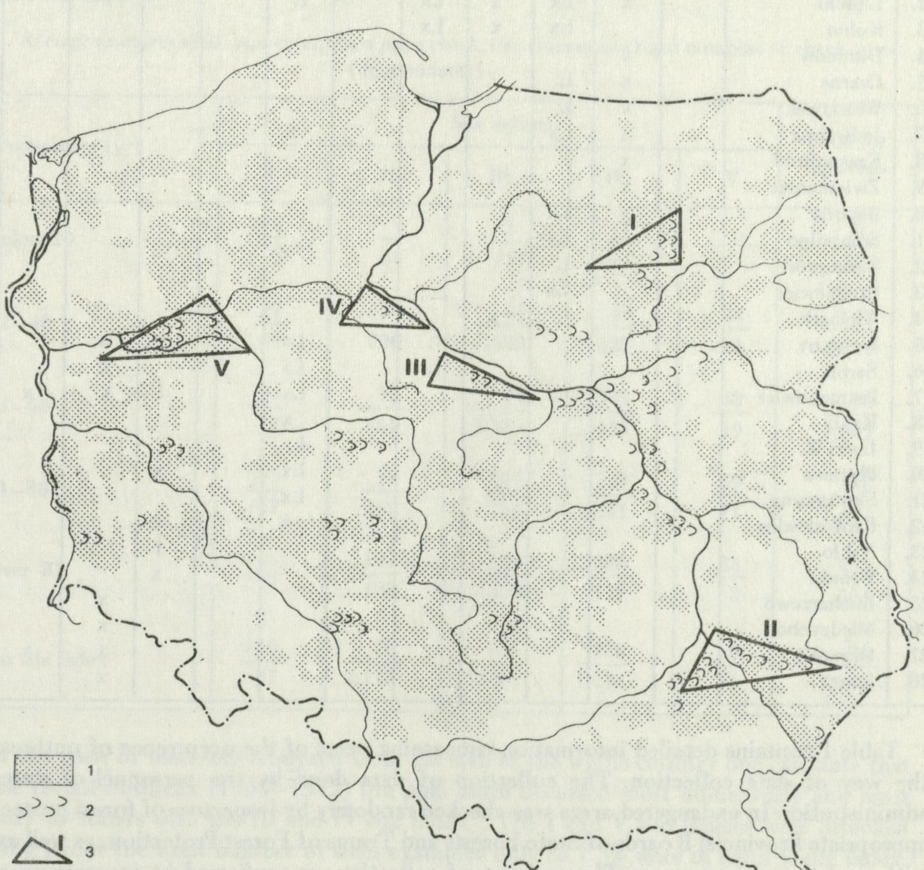

Fig. 1. Soil and geomorphological conditions of *Dendrolimus pini* L. outbreaks and the distribution of outbreak centers

1 – areas with the predominance of podzol soils formed on loose and coarse sandy soils, *2* – formations of fluviatile and pre-glacial accumulation, *3* – individual centers of *D. pini* outbreaks: *I* – the Kurpiowski Forest (forest districts no. 1, 2, 3, 14), *II* – the Solski Forest (forest districts no. 8, 9, 10, 12), *III* – coniferous forests of the vicinity of Włocławek (forest districts no. 4, 5, 6, 7), *IV* – coniferous forests of the vicinity of Bydgoszcz (forest district no. 23), *V* – the Nadnotecki Forest (forest districts no. 15–28, except of 23) characterized themselves with the intensity requiring protective treatments on rather vast areas. Map (Fig. 1) illustrates the situation of forest districts, from which data have been obtained. The map presents also soil and geomorphological conditions of outbreaks analyzed in the further part of the paper.

Table I. Dates and places of the occurrence of *Dendrolimus pini* L. outbreaks and the way of data collection
L – data from check glued trees, x – data from check trees cut on a canvas, sp. – spring, aut. – autumn

No.	Forest district	Dates											
		1966		1967		1968		1969		1970		1971	
		sp.	aut.	sp.	aut.	sp.	aut.	sp.	aut.	sp.	aut.	sp.	aut.
1.	Nowogród	x	x	Lx	x	Lx		L					
2.	Lipniki		x	Lx	x	Lx		L					
3.	Kolno			Lx	x	Lx							
4.	Duninów		x										
5.	Czarne		x	L									
6.	Włocławek		x	L									
7.	Jedwabna		x	Lx									
8.	Krasnobród		x										
9.	Zwierzyniec		x										
10.	Biłgoraj		x	Lx									
11.	Sompolno			Lx									
12.	Tarnogród			L									
13.	Brudzewice			Lx									
14.	Wielbark			L	x								
15.	Wyszyny					L		Lx			x		
16.	Sarbia					L		Lx			x		
17.	Potrzebowice							Lx		L	x	x	x
18.	Rąpin							x					x
19.	Lipki W.							Lx					x
20.	Płytnica							Lx		x			
21.	Skwierzyna							Lx					
22.	Krobielewko							x		L			x
23.	Nakło									L			
24.	Wronki									x			
25.	Bucharzewo										x		x
26.	Międzychód										x		x
27.	Drawsko										x	x	x
28.	Krucz										x		x

Table I contains detailed information concerning years of the occurrence of outbreaks and the way of data collection. The collection of data done by the personnel of state forest administration in endangered areas was checked randomly by inspectors of forest protection in appropriate Provincial Boards of State Forests and Teams of Forest Protection, as well as by the author of the present paper. The accuracy of collection, as confirmed by inspections, rose no reservations, due to very simple manner of performance and great responsibility put on persons carrying it. Materials analyzed were compiled in 28 tables, inserted in the documentation of the Institute of Forest Research (Leśniak 1974, unpubl.). These tables include: numbers of check trees examined, minimum, maximum, and average numbers of *Dendrolimus pini* caterpillars per one tree, per cent of trees checked, on which the number of caterpillars exceeded critical values (threatened with total feeding). Whole this information was given along with the age of forest stand, site index and geographic distribution of stands. On the basis of these tables comparisons and summary diagrams inserted in the present paper were developed.

Altogether very extensive material obtained from circa 8.000 check trees (glued or cut on canvas) was compiled and subjected to analysis.

3. RESULTS

The analysis of the material permit to draw following conclusions:

1. The pine moth during 1966–1971 occurred in Poland in mass breeding in forest stands from IInd to Vth age-class and with all site indices. Table II illustrates average numbers of pine moth caterpillars per one check tree and numbers of trees examined in individual age-classes of stands and site indices.

Table II. Average numbers of *D. pini* caterpillars per a check tree (numerator) and numbers of check trees (denominator)

Age-classes (yr)	Site indices					Total for age-class
	I	II	III	IV	V	
I – below 20	5/3	4/63	3/147	7/19	–/–	3/231
II – 21–40	17/60	66/720	57/1.552	49/527	44/13	57/2,872
III – 41–60	83/17	78/860	94/1,316	135/475	48/19	96/2,687
IV – 61–80	503/17	71/352	151/712	109/341	59/11	118/1,433
V – over 81	–/–	131/180	226/264	298/112	53/8	207/564
Total for site index	114/97	76/2,175	85/3,991	136/1,474	50/51	96/7,788

2. On the basis of materials analyzed from the area of the whole country one can state that during the recent outbreak (1965–1972) the pine moth occurred most numerously and most dangerously in stands with the III and IV site index[3]. The I and V site indices were attacked sporadically (from the total number of trees examined only ca 1.5% were in I and V site index, while more than half of all trees examined was in the IIIrd site index (Fig. 2).

3. Stands in the II and III age-classes were most severely threatened by the pine moth. The first age-class of stands was not seriously threatened by the moth on the area of Poland during

[3]R. Gadzikowski (Ph. D. thesis in the Agricultural University in Warsaw in 1972) obtained similar results in relation to *Diprion pini* L.

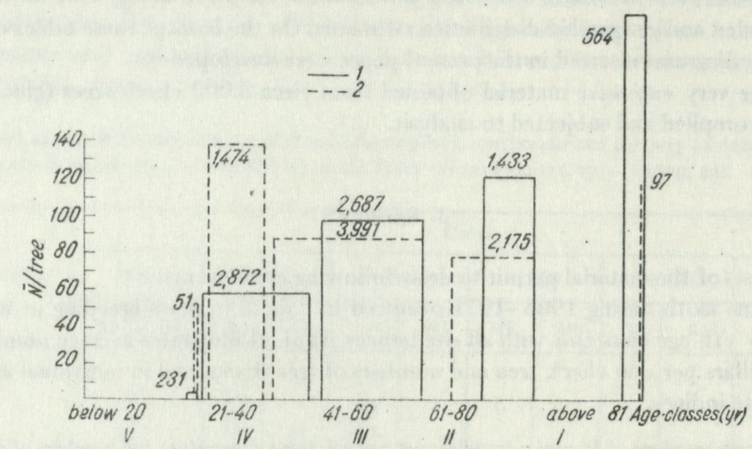

Fig. 2. Average numbers ($\bar{N}$) of *D. pini* caterpillars per 1 check tree and numbers of check trees in various age-classes of stand (*1*) and ones (*2*) with various site indices (*I–V*)
Width of a column shows numbers of check trees: 0.5 cm means 1,000 check trees

the period studied. Stands in the IV and V age-classes were threatened by the pine moth to a lesser degree than younger stands (Fig. 2).

4. The analysis of soil (based on data from forest surveys in forest districts endangered; unpubl.) and geomorphological data indicated that outbreak centers of *D. pini* occur exclusively in areas, where podzol soil formed on loose and coarse sandy soils predominate (Fig. 1). It is self-understanding that pure pine stands grow on such soils. On the other hand interesting is the statement that all outbreak centers of *D. pini* are situated on formations of fluviatile or glacial accumulation on extensive outwash plains (Fig. 1).

5. Materials collected indicate a distinctly different nature of pine moth outbreaks in areas of eastern and western Poland. Statistically very significant differences were marked in average numbers of caterpillars and emergency of forest stands (expressed by the percentage of trees, on which caterpillar numbers exceeded critical values) in the same age-classes and site indices (Figs. 3–6, Table III) among individual centers of mass appearances studied.

6. Determination of distinctness in population dynamics processes under various stand conditions, was rendered difficult due to carrying out effective rescue treatments. On the other hand one can note certain regularities, since most data were obtained before treatments. As revealed by a detailed analysis: 28 sets contained in records of the Institute of Forest Research (Leśniak 1974 unpubl.) and "dusting" maps, the highest emergency of stands was in primary outbreak centers preceding by two years secondary centers. Besides, outbreaks in II and III age-classes and with III site index developed earlier and lasted for longer. The course of gradations was more markedly differentiated in stands with various site indices than in stands from various age-classes.

Interpretation of results presented is very difficult both due to the great number of factors acting (also those not analyzed) and due to the previously mentioned fact of deformations of regular outbreak processes by rescue operations. Despite this, the materials collected, due to their bulk, permit to carry out some considerations. An attempt of a detailed determination of

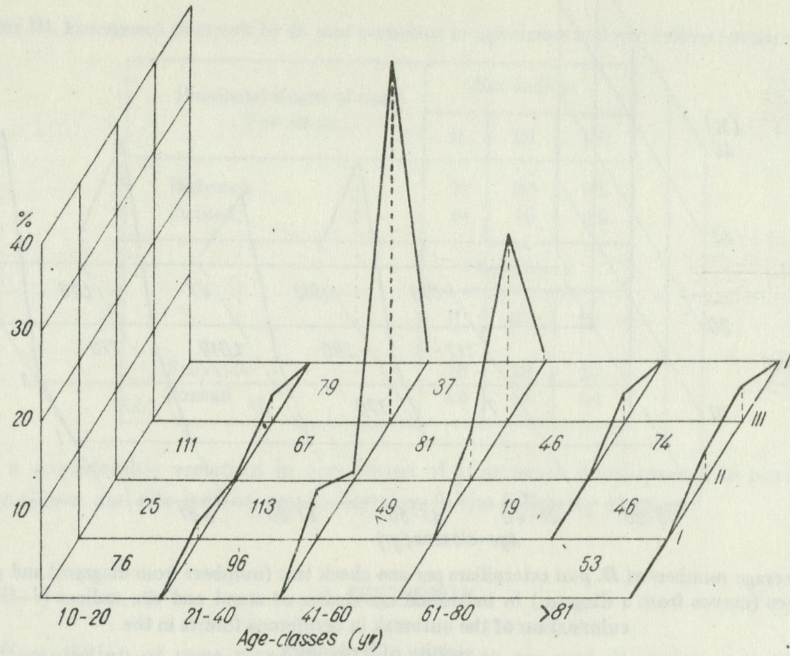

Fig. 3. Average numbers of *D. pini* caterpillars per one check tree (numbers from diagram) and percentage of check trees (curves from a diagram) in individual age-classes of stand and site indices (*I–IV*) during the culmination of the outbreak in the Solski Forest

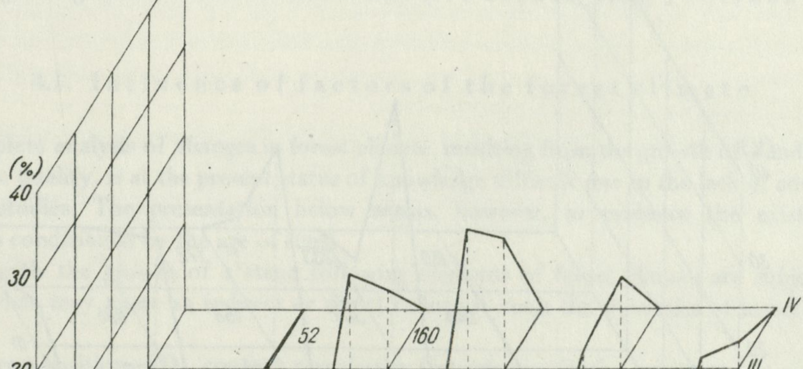

Fig. 4. Average numbers of *D. pini* caterpillars per one check tree (numbers from diagram) and percentage of check trees (curves from a diagram) in individual age-classes of stand and site indices (*I–IV*) during the culmination of the outbreak in the Kurpiowski Forest

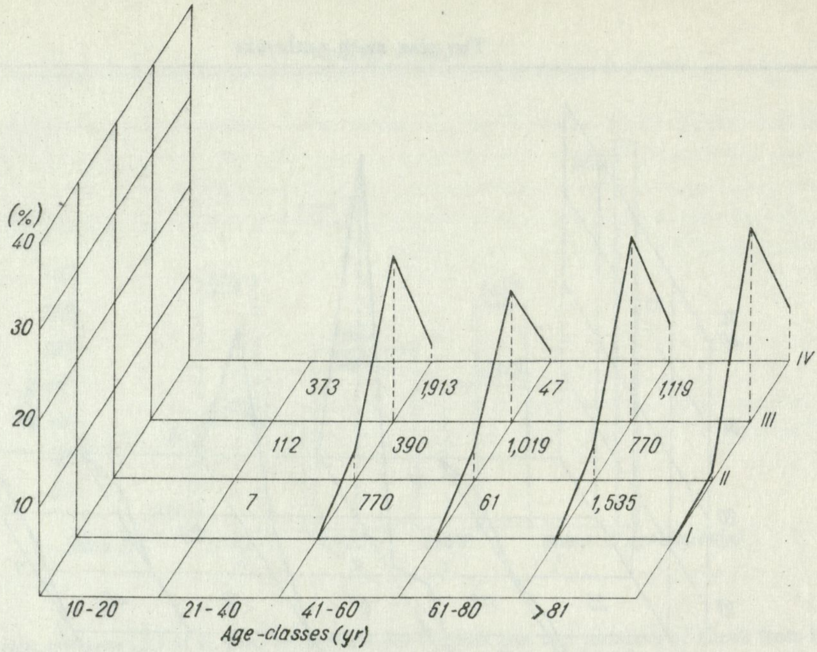

Fig. 5. Average numbers of *D. pini* caterpillars per one check tree (numbers from diagram) and percentage of check trees (curves from a diagram) in individual age-classes of stand and site indices (*I–IV*) during the culmination of the outbreak in coniferous forests in the vicinity of Bydgoszcz

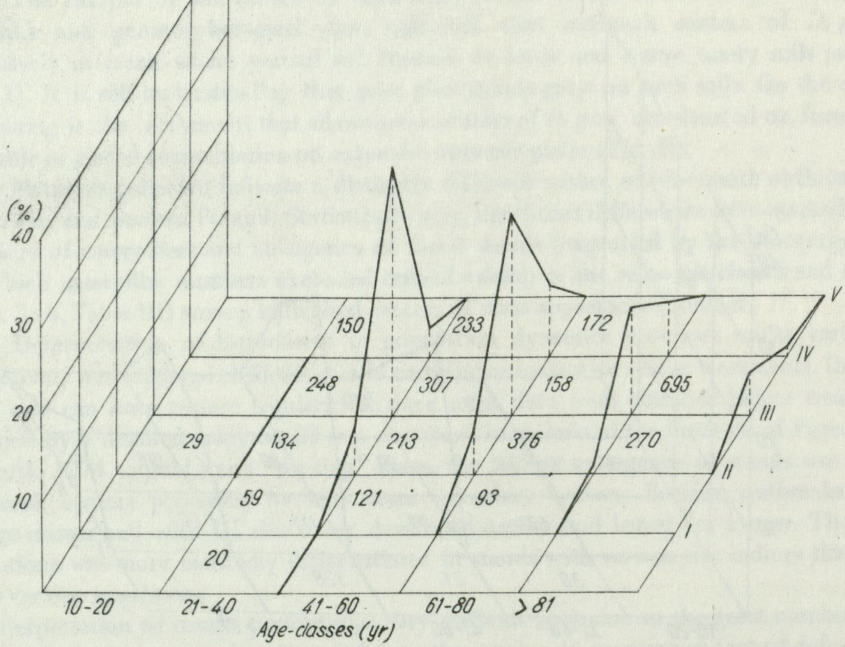

Fig. 6. Average numbers of *D. pini* caterpillars per one check tree (numbers from diagram) and percentage of check trees (curves from a diagram) in individual age-classes of stand and site indices (*I–IV*) during the culmination of the oubreak in the Nadnotecki Forest

Table III. Emergency of stands by *D. pini* according to age-classes and site indices (in per cent)

Provincial Board of State Forests in:	Site indices		
	II	III	IV
Białystok	29	20	28
Poznań	46	48	44
	Age-classes		
	II	III	IV
Białystok	28	29	22
Poznań	40	46	54

causes of a considerable variation in conditions of pine moth development in pure stands in various age-classes and site indices, was undertaken in the following chapter.

4. DISCUSSION

The differentiation of pure pine stands in respect to age and site index may exert a very significant influence upon the development and course of outbreaks of noxious insects. In various age-classes and different site indices insects are under the influence of the action of different complexes of climatic, food, and biocoenotic factors. One cannot consider separately changes in stand's age and those in site quality, because the transformation of stand under the impact of growing age is different on various sites (I l w e s s a l o 1922, J e d l i ń s k i 1929).

4.1. Influence of factors of the forest climate

A complete analysis of changes in forest climate, resulting from the growth of stand or from various site quality, is at the present status of knowledge difficult due to the lack of adequately designed studies. The presentation below seems, however, to evidence the existence of differences conditioned by the age of stand.

Along with the growth of a stand following elements of forest climate are subjected to changes, what may exert an indirect or direct influence upon the dynamics of insect population.

1. Air composition. CO_2 content reveals the highest quantitative variation. So-called soil respiration is the main source of CO_2 in forest environment. The excretion of CO_2 is greater from biologically efficient soils on better sites. In dense thickets it is more abundant than in thinned stands of older age-classes (Ż e l a w s k i 1967).

2. Light conditions change obviously along with the growth of stand; along with the increase in the number of trees per area unit and loosening the density there increases the number of trees with side illumination, what obviously affects the chemical content of foliage. Also quantities of light with various wavelength penetrating down to forest floor vary (O b m i ń s k i and T y s z k i e w i c z 1963).

3. Thermal conditions in a stand, strictly connected with light climate, are also subjected to changes along with the growth of a stand. In older stands lower temperatures are possible than in younger ones (Włoczewski 1968).

4. The total of precipitation reaching forest floor is according to Kuźniar (1954) roughly similar in stands in various age-classes. Their distribution, however, is variable: in older stands there are spots with minimum precipitation reaching the forest floor, what is of significant importance for the development of insects being there.

5. Evaporation is stronger in older, one-storeyed stands (Włoczewski 1968).

6. Younger stands, according to Kuźniar (1954), characterize themselves by a lower soil moisture than older stands.

The above brief review of changes occurring in forest climate along with the growth of stands, indicates that the age of stands may to some extent differentiate its climate. On the other hand, while taking into account the range of changes, one can suppose that their impact upon the dynamics of *D. pini* population is of significant importance only under extremal situations; i.e. in cases of thickets and mature stands, when the differentiation of forest climate may exceed the optimum of development conditions for a definite insect.

4.2. Impact of food factors

The hypothesis put forward by Zwölfer (1953) and Rudnev (1962) about the influence of food, as well as later papers, particularly by the "Ukrainian school" attribute very serious impact of food factors upon the dynamics of insect pest populations. Rudnev (1962) considers even the quality and quantity of food as the main factor of the variation in pest numbers and the remaining factors, as "weather, soil, and other ecological conditions" have, according to him, mainly indirect effect via their influence on a host plant. In the opinion of this author the beginning of an outbreak may occur exclusively in the case of physiological impairment of plants providing insects with food.

The chemical content of needles, providing a food for noxious insects, is variable in relation to individual age-classes of forest stand and various properties of sites; it seems that just these distinctions may be of crucial importance for the formation and course of mass appearances of pests.

Remezov, Bykova and Smirnova (1955) cite table presenting absolute contents of nutrients in pine growing in the *Vaccinio myrtilli-Pinetum* forest type in relation to the age of trees. It results from the table that the content of Fe, Na, and Mn increases most slowly with the age of trees, that of Si, Al, P, and Mg somewhat faster, K and S still faster, and N and Ca – at fastest.

Jakušev (1965) reports that the percentual content of nutrients changes in relation to age of trees in the *Pinetum callunosum* forest type.

According to Remezov, Bykova, and Smirnova (1955) the content of nutrients in foliage and other organs alters slightly along with the age of trees (fluctuations are contained within limits of determination errors). Another opinion was expressed by Ovington and Madgwick (1959), who found that the concentration of numerous nutrients diminishes along with the growth of pine. The contradiction of opinions may result from individual variation in the content of individual nutrients, what was found by Themlitz and Behrens (1957). Ostalski (1967) claims that in pines from the I and IV age-class the content of sugars, b-carotene, vitamin C, volatile oils, and moisture in needles differs by almost twice (older pines have more components mentioned).

Żelawski (1967), basing on research by Keller and Werhrman (1963) and Margajlik (1962), claims that the chlorophyll content in needles differs obviously along with changes in site conditions, as well as those in the age of pine.

Kopcewicz (1967) states that the highest content of gibbereline-like compounds (growth substances) occurs in pine at the age of forty years.

As it results from studies by Maxwell and Painter (1962a, 1962b) there exists an obvious relationship between the resistance (tolerance) of host plants against feeding by insects and the content of growth substances. This relationship was expressed by a considerably higher content of free auxins in susceptible plants. Research by Maxwell and Painter concerned, after all, the feeding by aphids on corn, but it seems that the coincidence between the highest content of gibbereline-like compounds in pine at the age of 40 years and the highest numbers of pine moth in forest stands at this age is not casual. One can explain thus the highest numbers of moth caterpillars found in the present paper on trees belonging to the Ist class according to Kraft's (1884) biosocial classification (Ist class – dominating trees with strongly developed crowns projecting above the general level of stand's crowns).

Also Koehler (1966) and Burzyński (1966) found the phenomenon of stronger attacks on saplings growing above the level of young plantation or thicket by *Rhyacionia buoliana* Schiff. and *Exoteleia dodecella* L.

The cited paper by Burzyński discusses problems of the effect of fertilization of young plantations of pine upon the occurrence of noxious insects. These problems in relation to *D. pini* were dealt with by Luterek (1969), who found that the mineral fertilization of pine, while changing the chemical content of needles, may have positive or negative impact on the development of pine moth.

On the basis of previously cited data from literature one may state that the chemical content of needles, being of fundamental importance for the survival, particularly of the youngest larval instars of the pine moth, alters obviously in relation to the age-class of forest stand and the quality of site.

4.3. Impact of biocoenotic factors

Clearcut is the fundamental and almost sole harvest method used in areas of outbreaks of the most important insect pests of pine. As a result of clearcut way of management in pine stands developmental conditions for insect communities, among other things those of useful insects are entirely changed immediately after the felling of stand. Eurytopic organisms are maintained under altered conditions, while the regular composition of entomofauna regenerates only at the end of the IInd age-class of the new stand (Szujecki 1966). Considering, that also most other organisms (both animal and plant ones) are subjected to adverse impacts of clearcut management, the network of coenotic relations is weakened and thus conditions are created for an easier build-up of pest outbreaks (Koehler 1951). Due to this, younger stands, particularly those in the IInd age-class, may be more inclined to the mass breeding of noxious insects in them. Research (Leśniak 1963, Szujecki 1966) indicated that in these stands useful components of entomofauna are by far less numerous than in stands approaching maturity and mature ones.

4.4. Final remarks

Three groups of factors: climatic, trophic, and biocoenotic were discussed. They vary in individual age-classes of stands and with different site indices and are of different significance in processes regulating numbers of insect populations. One can assume that food subjected to most evident qualitative and quantitative changes along with the growth of stands and alterations in site quality, exerts a strongest effect upon insect defoliators.

As it results from studies carried out (Fig. 2) average numbers of caterpillars increase rather regularly along with the increase in the bulk of crowns resulting from an increase in the age of trees. On the other hand, with the change of the size of crowns conntected with the quality of site (on trees in the same age-classes) curves of caterpillar numbers and the bulk of crowns had a divergent course. One may expect thus that in reality the quality of food has for the development of the insects discussed, still more important role than it would result from numerical data obtained in the course of studies. An increase in the size of crown with similar quality results in an increase in numbers of the insect discussed. The size of crowns decreases with the impairment of site quality (Szymkiewicz 1968), but despite this an increase in the numbers of pine moth caterpillars is to be noted. This phenomenon may evidence not only the importance of food quality, but also a significant impact of underestimated until now (Viktorov 1971) some information processes, i.e. a strong impact of group effect. These problems were discussed in the paper dealing with intrapopulation and trophic conditions (Leśniak 1976b). An obvious differentiation in the nature of outbreaks in various, geographically distant outbreak centers was also found in the studies (Table III, Figs. 3–6). The explanation of these differences is contained in the paper dealing with climatic and meteorological distinctions of conditions of *Dendrolimus pini* outbreak (Leśniak 1976a).

5. SUMMARY

Making of economically right decisions on the use of rescue operations depends, among other things, upon the knowledge of the duration of an outbreak and numbers of subsequent generations of the insect controlled. It is assumed that the course and intensity of outbreak depends both on endogeneous and exogeneous factors, mainly on the resistance of forest stands. This resistance, conditioned by an action of a complex of factors: climatic, biocoenotic, and trophic, may be in the case of pure stands correlated with their age and site quality.

The purpose of work was to determine the intensity and course of an outbreak under individual stand conditions. Extensive data from the recent outbreak of the pine moth (*Dendrolimus pini* L.), which occurred during years of 1965–1972 on the area of 28 forest districts (Fig. 1) were subjected to analysis. Analysis included data from 8,000 check trees – glued ones or fell in canvas.

As a result of work the following relationships were found.

1. During the recent outbreak pine moth occurred most numerously and most dangerously in stands with the III and IV site index and in the II and III age-class (Fig. 2, Table II).

2. Pine moth outbreaks are of entirely different nature in western versus eastern Poland. The emergency in stands of the same age-classes and site indices is in the west almost twice as high (Table III, Figs. 3–6) than in the east.

3. Outbreaks of pine moth in primary centers of outbreaks attain their erruptive stage at least two years earlier than in secondary centers. In the II and III age-classes of stands and under III site index outbreaks developed earlier and lasted for longer.

4. An increase in crowns' bulk along with age involved a raise in average numbers of pine moth caterpillars (Fig. 2).

5. An increase in caterpillar numbers proceeded also with the decrease in crown bulk along with the deterioration of site quality. This evidences a strong impact of the quality of food (Fig. 2).

6. In respect to geomorphological and soil conditions, outbreak centers of the pine moth occur on

outwash plains and formations of fluviatile accumulations, on podsolic soils formed on loose and coarse sandy soils (Fig. 1).

Results of the work permit to improve the precision of the classification of stands for rescue operations and indicate the need for a differentiated approach to the practice of forecasting and protective treatments in the areas of eastern and western Poland.

6. POLISH SUMMARY (STRESZCZENIE)

Podejmowanie prawidłowych gospodarczo decyzji dotyczących stosowania ratowniczych zabiegów ochronnych uzależnione jest m.in. od znajomości czasu trwania gradacji i liczebności następnych pokoleń zwalczanego owada. Zakłada się, że przebieg i nasilenie gradacji uzależnione jest zarówno od czynników endogennych, jak i egzógennych, głównie od odporności drzewostanu. Odporność ta – uwarunkowana działaniem kompleksu czynników: klimatycznych, biocenotycznych i pokarmowych – w przypadku drzewostanów jednogatunkowych może być skorelowana z ich wiekiem i bonitacją siedliska.

Celem pracy było określenie nasilenia i przebiegu gradacji w poszczególnych warunkach drzewostanowych. Analizie poddano obszerny materiał danych z ostatniej gradacji barczatki sosnówki (*Dendrolimus pini* L.), ktora przebiegała w latach 1965–1972 na terenach 28 nadleśnictw (fig. 1). Analizowano dane z 8000 drzew kontrolnych – lepowanych bądź ścinanych na płachty.

Stwierdzono następujące zależności:

1. W czasie ostatniej gradacji barczatka sosnówka występowała najliczniej i najgroźniej w drzewostanach III i IV bonitacji siedliska oraz II i III klasy wieku (fig. 2, tab. II).

2. Gradacje barczatki sosnówki mają zupełnie odmienny charakter na terenach zachodniej i wschodniej Polski. Zagrożenie drzewostanów tych samych klas wieku i bonitacji siedlisk jest na zachodzie około dwukrotnie wyższe (tab. III, fig. 3–6).

3. Gradacje barczatki sosnówki w pierwotnych ogniskach gradacyjnych osiągają stadium erupcyjne o co najmniej dwa lata wcześniej niż w ogniskach wtórnych. Wcześniej rozwijały się i dłużej trwały gradacje w II i III klasie wieku drzewostanów oraz na III bonitacji siedliska.

4. Zwiększenie się masy koron wraz z wiekiem pociągało za sobą podwyższenie przeciętnych liczebności gąsienic barczatki (fig. 2).

5. Podwyższenie liczebności gąsienic barczatki następowało także przy zmniejszeniu się masy koron w miarę pogarszania się bonitacji siedliska. Świadczy to o silnym wpływie jakości pokarmu (fig. 2).

6. Pod względem geomorfologicznym i glebowym ogniska gradacyjne barczatki sosnówki występują na terenach sandrowych i utworach akumulacji rzecznej, na glebach bielicowych wytworzonych na piaskach luźnych i słabo gliniastych (fig. 1).

Wyniki pracy umożliwiają zwiększenie precyzji kwalifikowania drzewostanów do zabiegów ratowniczych i wskazują na potrzebę zróżnicowania podejścia do praktyki prac prognostycznych i zabiegów ochronnych na terenach wschodniej i zachodniej Polski.

7. REFERENCES

1. Burzyński J. 1966 – Spostrzeżenia na temat występowania owadów szkodliwych w nawożonych uprawach wydmowych – Sylwan, 110: 43–53.
2. Dreszer L., Zabielski B. 1962 – Urządzanie lasu – Warszawa, PWRiL, 457 pp.
3. Ford E. 1967 – Genetyka ekologiczna – Warszawa, PWRiL, 349 pp.
4. Grimalskij V. J. 1964 – Ustoičivost' sosnovych nasaždenij protiv chvoegrizuščich vreditelej – Lesnaja promyšlennost, Moskwa, 135 pp.
5. Ilwessalo Y. 1922 – Vegetationsstatistiche Untersuchungen über die Waldtypen – Acta for. fenn. 20: 1–41.
6. Iževskij S. S. 1967 – Osobennosti razvitija sosnowogo šelkopriada w raznych tipach lesa (In: Sb. Rab. mosk. lesotech. Inst. Ed. A. I. Voroncov) – 15: 48–55.
7. Jakušev B. 1965 – K voprosu o vlijanii živogo napočvjonnogo pokrova na mineral'noe pitanie kultur sosny (In: Ékologija drevesnych rastenij) – ANBSSR, Minsk, 38–47.
8. Jedliński W. 1929 – Kształtowanie się struktury drzewostanu pod wpływem wieku i siedliska – Las pol. 3–6: 1–64.

9. Keller T., Werhrman J. 1963 – CO_2 Assimilation. Wurzelstwung und Ertrag von Pichten – und Kiefernsämlingen bei unterschiedlicher Mineralstoffernährung – Mitt. schweiz. Anst. forstl. VersWes. 39: 65–73.

10. Koehler W. 1951 – Przyczyny powstawania i przebieg gradacji szkodliwych owadów – Inst. badaw. Leśn. 74: 1–42.

11. Koehler W. 1961 – Patologia i ochrona lasu – PWRiL, Warszawa, 415 pp.

12. Koehler W., przy współpracy Burzyński J., Schnaider Z., Sierpiński Z., Śliwa E. 1966 – Z badań nad zwójką sosnóweczką (*Rhyacionia buoliana* Schiff.) –Pr. Inst. badaw. Leśn. 337: 1–155.

13. Kopcewicz J. 1967 – Dynamika związków giberelinopodobnych w ontogenezie sosny zwyczajnej (*Pinus silvestris*) – Uniw. Mikołaja Kopernika, Toruń, 85 pp.

14. Kostrowicki J. 1957 – Środowisko geograficzne Polski – PWN, Warszawa, 542 pp.

15. Kraft G. 1884 – Beiträge zur Lehre von den Durchforstungen, Schlagstellungen und Lichtungshieben – Klindworth Verlag, Hannover, 147 pp.

16. Kuźniar K. 1954 – Kształtowanie się wilgotności gleby leśnej i uprawnej w zależności od niektórych czynników ekologicznych – Ekol. pol. 2: 289–322.

17. Leśniak A. 1963 – Przyczynek do badań nad określeniem zależności fauny *Carabidae* od wieku drzewostanu – Sylwan, 107: 51–68.

18. Leśniak A. 1976a – Climatic and meteorological conditions of the pine moth (*Dendrolimus pini* L.) outbreaks – Ekol. pol. 24: 515–547.

19. Leśniak A. 1976b – Certain trophic and intrapopulation conditions of the pine moth (*Dendrolimus pini* L.) outbreaks – Ekol. pol. 24: 565–576.

20. Luterek R. 1969 – Badania nad śmiertelnością larw *Dendrolimus pini* L. – Pr. poznańsk. Tow. Przyj. Nauk, 28: 231–279.

21. Margajlik G. J. 1962 – Dinamika nakoplenija chlorofila w chvoe sosny i eli v zavisimosti ot vozrasta derevev i uslovij ich proizrastanija – Lesn. Choz. 15: 6–9.

22. Matuszkiewicz W. 1962 – Dyskusja nad systemem zbiorowisk roślinnych Europy Zachodniej i Środkowej – Wiad. bot. 6: 15–28.

23. Maxwell F. G., Painter R. H. 1962a – Auxin content of extracts of certain tolerant and susceptible host plants of *Toxoptera graminum*, *Macrosiphum pisi*, and *Therioaphis maculata* and relation to host plant resistance – J. econ. Ent. 55: 1012–1035.

24. Maxwell F. G., Painter R. H. 1962b – Plant growth hormones in ether of the greenbug *Texoptera graminum* and the pea aphid, *Macrosiphum pisi* fod on selected tolerant and susceptible host plants – J. econ. Ent. 55: 1035–1046.

25. Nunberg M. 1948 – Barczatka sosnówka i jej zwalczanie – Poznań, Wydaw. Inst. badaw. Leśn. Ser. C, 20 pp.

26. Obmiński Z., Tyszkiewicz S. 1963 – Hodowla i uprawa lasu – PWRiL, Warszawa, 812 pp.

27. Ostalski R. 1967 – Badania nad możliwością wykorzystania igliwia sosnowego w procesie pozyskania drewna małowymiarowego – Pr. Inst. badaw. Leśn. 326: 121–134.

28. Ovington J. D., Madgwick H. A. 1959 – Distribution of organic matter and plant nutrients in a plantation of Scots pine – For. Sci. 5: 65–71.

29. Remezov J. P., Bykova L. J., Smirnova K. M. 1955 – Biologičeskij krugovorot azota i zolnych elementov v lesnych nasaždenijach – Trudy Inst. Lesa, Mosk. 24: 14–22.

30. Rudnev D. F. 1962 – Vlijanie fizjologičeskogo sostojanija rastenij na massovoe razmnoženie vreditelej lesa – Zool. Ž. 41: 1–15.

31. Ryvkin B. J. 1954 – Borba s glavnejšimi vrediteljami lesa – Gosudarstv. Izd. BSSR, Minsk, 79 pp.

32. Schwerdfeger F. 1957 – Die Waldkrankheiten – Paul Parey Verlag, Berlin, 543 pp.

33. Szujecki A. 1966 – Kształtowanie się stosunków ilościowych i jakościowych wśród ściółkowych kusakowatych (*Coleoptera*, *Staphylinidae*) borów sosnowych świeżych pod wpływem zrębów zupełnych – SGGW, Warszawa, 86 pp.

34. Szymkiewicz B. 1968 – Tablice zasobności drzewostanów sosnowych – Warszawa, PWRiL, 123 pp.

35. Śliwa E. 1966 – O występowaniu barczatki sosnówki (*Dendrolimus pini* L.) i jej zwalczaniu w lasach Polski – Sylwan, 110: 51–59.

36. Themlitz R., Behrens W. 1957 – Untersuchungen zu Düngungversuchen mit Rhenania-Phosphat in Forstamt Gartow und der Phosphossauresaufnahme aus radioaktiven Phosphat – Allg. Forstz. 12: 56–73.

37. W ł o c z e w s k i T. 1968 – Ogólna hodowla lasu – PWRiL, Warszawa, 497 pp.
38. V i k t o r o v G. A. 1971 – Trofičeskaja i sintetičeskaja teorii dinamiki čislennosti nasekomych – Zool. Ž. 50: 361–372.
39. Z w ö l f e r W. 1953 – Biologische und chemische Schädlingsbekämpfung vom Standpunkt des Forstschutzes geschen – 50: 14–28.
40. Ż e l a w s k i W. 1967 – Wymiana gazowa i bilans wodny igliwia (In: Zarys fizjologii sosny zwyczajnej. Eds. S. Białobok, W. Żelawski) – PWN, Warszawa, 328 pp.

Paper prepared by J. Stachowiak

AUTHOR'S ADDRESS:
Dr inż. Andrzej Leśniak
Zakład Ekologii i Ochrony Środowiska
Instytut Badawczy Leśnictwa
ul. Wery Kostrzewy 3
02–362 Warszawa
Poland.