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Incidence of Japanese Oak Wilt in Relation to Topography and Sunshine

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Abstract

In this study, we investigated the relationship between historical JOW incidence with topographical features, including slope, aspect and exposure to solar radiation. The study site was a mountainous region including Mt. Kariyasu and was nearly uniformly covered by forest stands dominated by *Quercus crispula*. Killed trees were identified by their red coloration in aerial photographs taken before natural fall color change in middle of October. The slope and aspect were calculated from a digital elevation model (DEM). Solar angle at the time when the beetles flied frequently were calculated and relative amounts of solar radiation at each position was also calculated using the DEM. All data were compiled using a geographic information system (GIS). The incidence of JOW was higher in east-facing slopes than that in west-facing slopes. *P. quercivorus* adults are positively phototactic. The east-facing slopes receive more solar radiation in the morning, when adult flights occur. Incidence of JOW tended to be greater in locations that received more solar radiation in the morning.

1. Introductions

Recently, Japanese oak wilt (JOW) has been prevalent in Japan. The dieback oak was bored into by ambrosia beetle, *Platypus quercivorus* (MURAYAMA). The beetle has a symbiotic relationship with *Raffaelea. quercivorus* and carries the fungus to a new host trees. This fungus causes necrosis in sapwood of oak trees, stop water conductance, and kills oak trees [1][2]. Since the late 1980, epidemics have lasted for more than ten years, and the area of dieback has been spreading to new localities where JOW has never been recorded in the past. Especially the area of dieback has expanded in the Japan Sea side of the main island of Japan [1]. There are researches of detail about JOW at stand scale level. However, there is almost no report that analyzed at large scale level. Although there is a report about the geographical feature where JOW occurred frequently, there is almost no examination about the season [3].

It is important to clear a topographical effect on the vector for the prevention of JOW relating to the vector behaviors. In this study, the topographical feature where JOW occurred was analyzed and the effect of the feature on JOW is cleared. Additionally the place in that JOW is occurring frequently is discussed in connection with the vector behaviors.

2. Material and method

2.1 Study area and data source

In this study the research area is around Mt. Kariyasu, Ishikawa prefecture. In this area, JOW was first discovered in 1997 and it is guess that JOW occurred before 1997.

Around the study site, an attack of *P. quercivorus* starts at late in June. A part of attacked trees change leaf color to read from late in July and an outbreak of newly died trees is finished at August. The trees killed by *R. quercivora* wilt suddenly and can't make abscission layer. The leaves changing color keep on the tree. Then, in the aerial photographs taken until the middle of October, when the leaves hasn't started putting on autumn colors yet, the dead trees can be identified. Then dead tree crown was identified using aerial photograph taken in 1998, 1999, 2000 and 2002 and the distribution map of kill trees at each year was produced. The size of the area covered by aerial photograph used in this study is 5,240m by 1,760m. The 10m mesh DEM (product of Hokkaido-chizu co., ltd.) was used as source of elevation data. The vegetation map predicted by ministry of the environment was used to know the vegetation distribution of research area.

2.1 Analysis

All information of dead trees was inputted to GIS (TNTmips) and managed. The area where the oak tree is not in existence in vegetation map was excluded from analysis area. Then the positions of JOW were extracted inputted to the GIS and the map of JOW distribution was made from aerial photographs with visual inspection.

The elevation resolution of 10 m mesh DEM is 1m. DEM was inputted to GIS and direction of slope is calculated from DEM. 0 degree indicates east direction and direction rotated clockwise. Then 10 mesh data of direction of slope is converted to 1 m mesh data with the cubic convolution interpolation. To exclude bias of distribution of slope direction, the rate of dead tree crown area at each direction is calculated. Then the rate of dead tree crown area was tested with Rayleigh's test.

Flying beetle has positive phototactic and it is expected that light condition influence on the distribution of dead trees. The light intensity of sunshine on each 1 m mesh slope in the morning, when many beetle flied frequently [4], was calculated from DEM. The sunshine condition was indicated as relative light intensity. The largest light intensity was shown by 1 and the smallest light intensity was shown by 0. Then the relationship between sunshine and dead tree rate was checked.

3. Results

Figure 1 shows the result of calculation of rate of dead tree crown area at each slope. Average of direction of dead tree crown area in 1998 is 21.8 degree and that in 1999 is 32.0 degree and that in 2000 is –9.8 degree and that in 2002 is –12.4 degree. Average at four years is –2.4 degree. These directions indicate from north-east to east-south-east and it was shown that the rate of dead tree crown area is higher at eastern slope (Rayleigh's test, $P<0.001$). Figure 2 shows the result of relationship between sunshine in the morning and

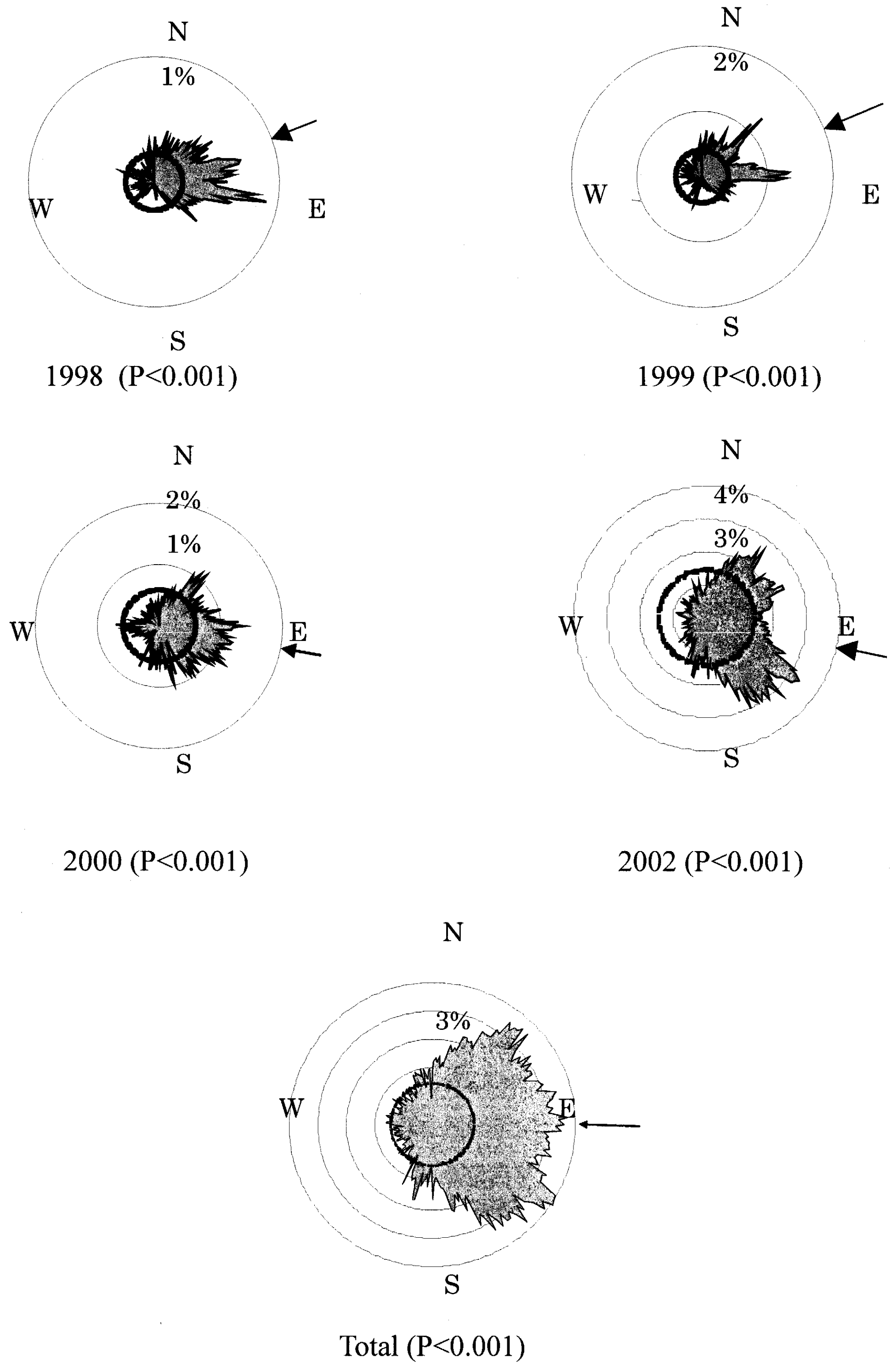

Fig. 1 Result of calculation of rate of dead tree crown area at each slope (1998, 1999, 2000, 2002, Total. Broken line shows the average of rate of dead tree crown area. Arrow is average of slope direction. Rayleigh's test)

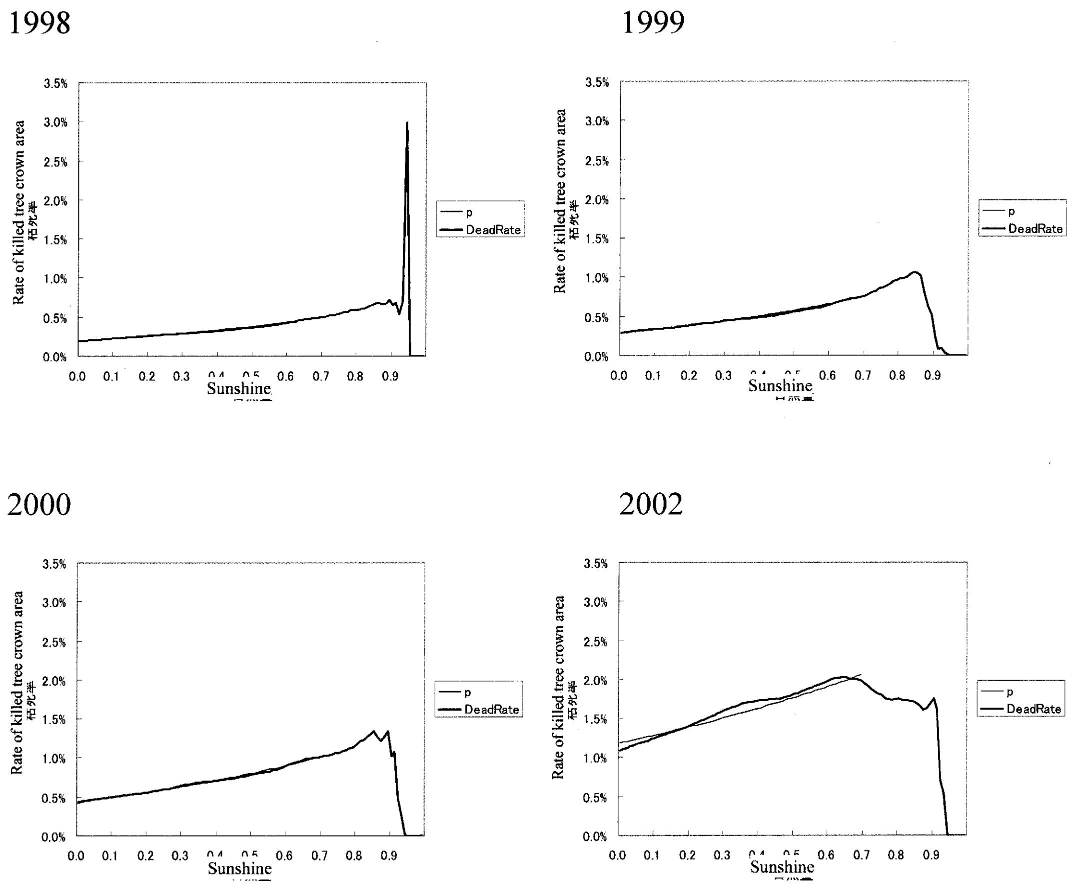

Fig. 2 Result of relationship between sunshine and dead tree crown area rate and logistic curve.(Sunshine and dead tree crown area rate in 1st Aug.)

dead tree crown area rate. The larger light intensity of sunshine is the higher the rate of dead tree crown area where the light intensity is between 0 and 0.87 in 1998, 1999 and 2000 and is between 0 and 0.6 in 2002. These results are almost same with logistic curve.

Discussions

In the result of calculation of rate of dead tree crown area at each slope, the rate is higher in the eastern slope. There is a report in that it was shown that the rate is higher in the north-east slope [4] but there is no explanation about the reason. It is known that adult beetle has positive phototactic and fly frequently in the morning [4]. The eastern slope has lager sunshine at the morning. It is guessed that the beetle crowd at the eastern slope that has strong sunshine in the morning and the number of dead tree become high in that slope. Actually, the stronger the sunshine between sunrise and 8 AM calculated from DEM is, the higher the rate of dead tree crown area is. In the figure 2, in the area in that the sunshine is between 0.87 and 1 the trend is unstable. The season why the trend is unstable is that the area in that sunshine is strong is too small to analyze. In the area in that the sunshine is between 0.6 and 0.87, the trend of the rate of dead tree crown area in 2002 is decrease as sunshine become strong. In the tree attacked in the past year, the beetles can't breed. It is guessed that in 2002 almost all trees in strong sunshine area had already been attacked in the past year and the number of dead tree at that area become small. '

From above results, it is clarified that the frequency of dead tree is higher in the area in that sunshine is strong at the morning because of positive phototactic of *P. quercivorus*.

References

[1] S. Ito, T. Yamada, "Distribution and spread of the mass mortality of oak trees," J. Jpn. For. Soc., 80(3): pp. 229-232, 1998.

[2] T. Kubono, S. Ito S, "*Raffaelea quercivora sp.* nov. associated with mass mortality of Japanese oak, and the ambrosia beetle (*Platypus quercivorus*)," Mycoscience, 43, pp. 255-260, 2002.

[3] A. Sato, T. Nohori, M. Saito, "Geographical feature on Japanese oak wilt in Yamagata prefecture," Proceedings of 12th BioGIS seminar, 2002.

[4] U. Akira,, M. Kobayashi, "Relationship between flight of *Platypus quercivorus* (Coleoptera: Platypodidae), temperature and sunshine," Ap. Fore. Sci., 9-2, pp. 93-97, 2000.