

Reconstruction of a mixed-species forest in central New England

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Introduction

<研究テーマ>

マサチューセッツの落葉広葉樹が優占する老齡林における時空間的な林分発達の推測

The temporal and spatial development of an old, mixed species, deciduous forest in Massachusetts is investigated in the present study by a detailed reconstruction of a 0.36-ha plot.

Introduction

<推測方法>

林分発達のパターンは、3つの仮説の検証によって決定する

The pattern of development is determined through the investigation of three hypothesis

Allogeneic
succession



Patch dynamics

Dominant canopy is comprised of a broad range of ages

Introduction

Allogeneic succession

- 大規模攪乱直後に樹木が一斉更新
- Most trees initiated soon after large disturbances



Patch dynamics

- 一部の上層木の攪乱による林分のモザイク化
- A forest subjected to disturbances is a mosaic small stands.

dominant canopy is comprised of a broad range of ages

- 幅広い樹齢の個体による林冠層の形成
- Dominant canopy is comprised of a broad range of ages

Introduction

<仮説の検証>

林分発達パターン^①の仮説には、**齡級構成**、更新の水平分布、**林分の垂直発達**が関連している

These hypothesis are concerned with the stem age distribution, the horizontal pattern of new stem recruitment, and the vertical development of the forest canopies

Introduction

-age distribution of trees-

- 二次林の発達には2つのパターン

Two patterns of development have been described in forests during secondary succession

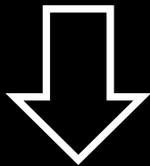
1. The recruitment new stems constantly
 - **autogenic succession** (Spurr & Barnes 1973)
 - relay floristics (Egler 1954)
2. New stems are recruited after disturbance
 - **allogeneic succession** (Spurr & Barnes 1973)
 - initial floristic composition (Egler 1954)

Introduction

-age distribution of trees-

Autogenic succession

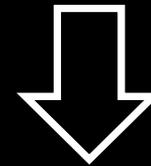
- 個体の成長に伴う更新スペースの拡大
- 樹齢の増加に伴う枯死木の増加
- Changing forest environment by the tree's growing promotes a steady recruitment
- Most of trees die as they get older



Reverse-J-shape

Allogeneic succession

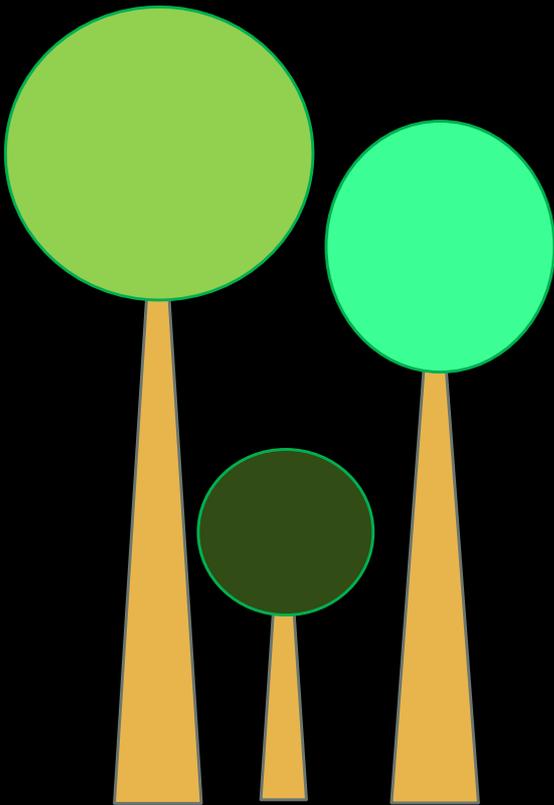
- 攪乱に依存した個体の一斉更新
- The times when most new trees become established in a forest is when a disturbance releases some of the previously occupied growing space



Irregular

Introduction

-vertical development of a forest-



上層木、中~下層木が存在

- 樹種によって棲み分けがなされている
- Tree heights vary considerably
- Often segregation by species occurs



- 同じタイミングで侵入しても垂直分化あり
- Vertical stratification by species can occur among individuals which initiate together soon after a single disturbance

procedures

<Study area>

Compartment VI of the Tom Swamp tract of the Harvard Forest in Petersham, Massachusetts

<Method>

Between 1950~1955 the author dissected a 0.36-ha sample of this stand

- Transect(25.6m × 140.2m)

procedures

<Method>

- 444 living trees were recorded by species, diameter, canopy position, ...
- 245 dead stems were similarly described in as much detail as possible
- All of the living and dead tree were felled, their heights measured, and aged at 0m
- Annual diameter growth at the root collar (0m) was recorded
- 322 living trees were also aged at 1.4 m, and every 1.2 m higher along the stem
- ...

Results

- 直径分布は逆J型
- The diameter distribution has the reverse-J-shape

—forest structure and disturbance patterns—

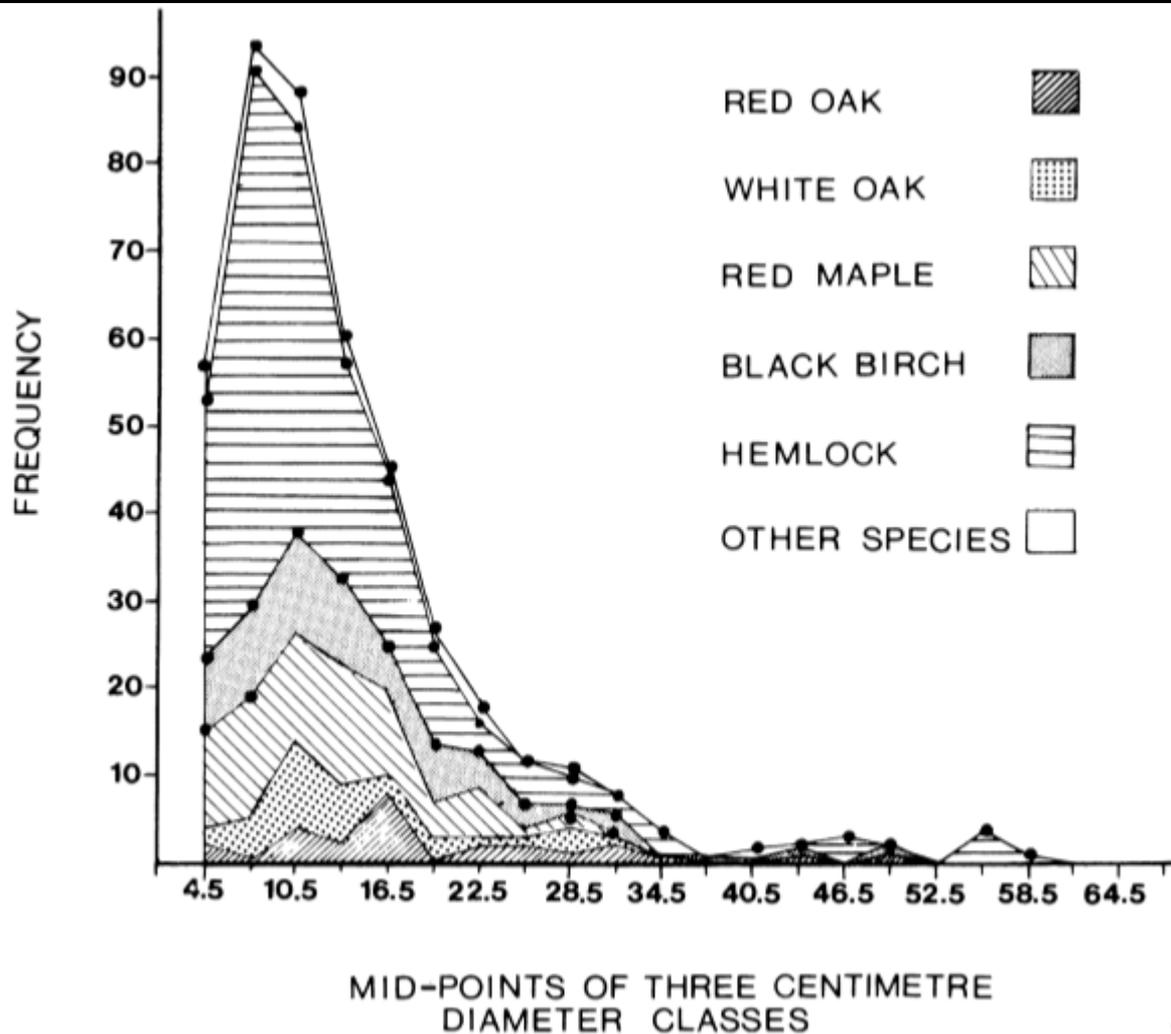


FIG. 1. Distribution of all trees on the Tom Swamp transect in 1952 by diameter and species.

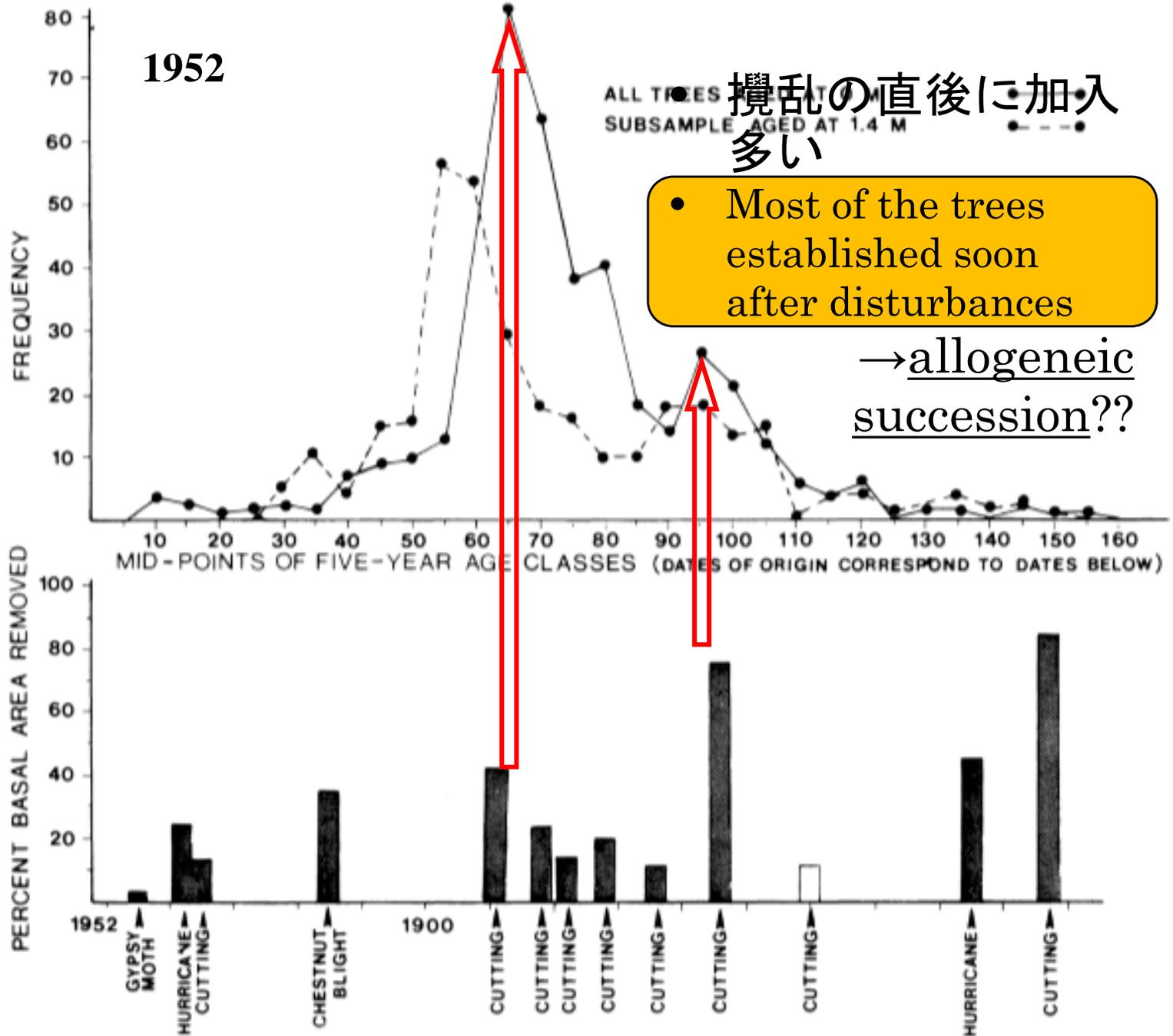
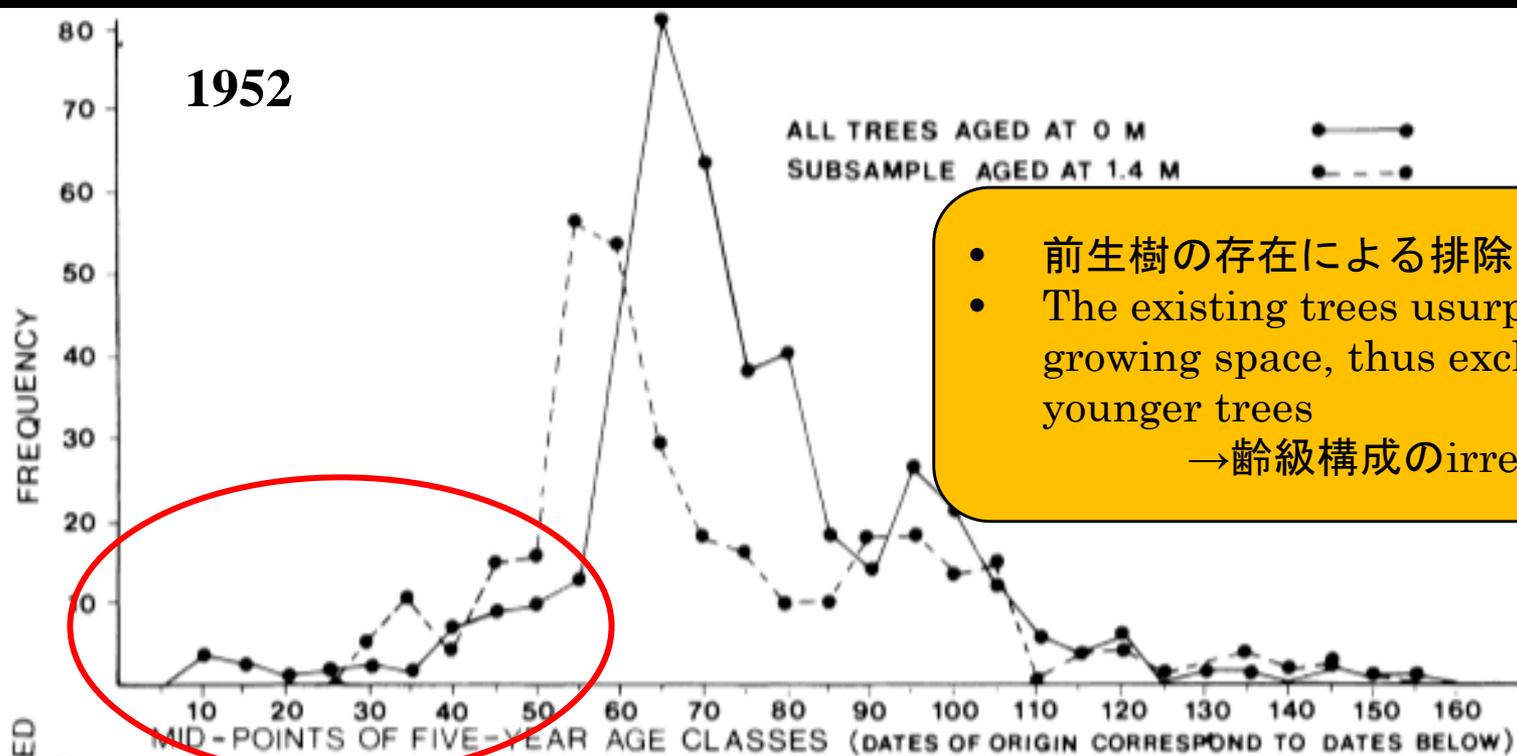


FIG. 3. Distribution of root collar age of all trees in transect and of subsample aged at 1.4 m (upper graph). Corresponding distribution and intensities of disturbances is shown in lower graph.



- 前生樹の存在による排除
- The existing trees usurped the growing space, thus excluding younger trees
→ 齡級構成のirregular化

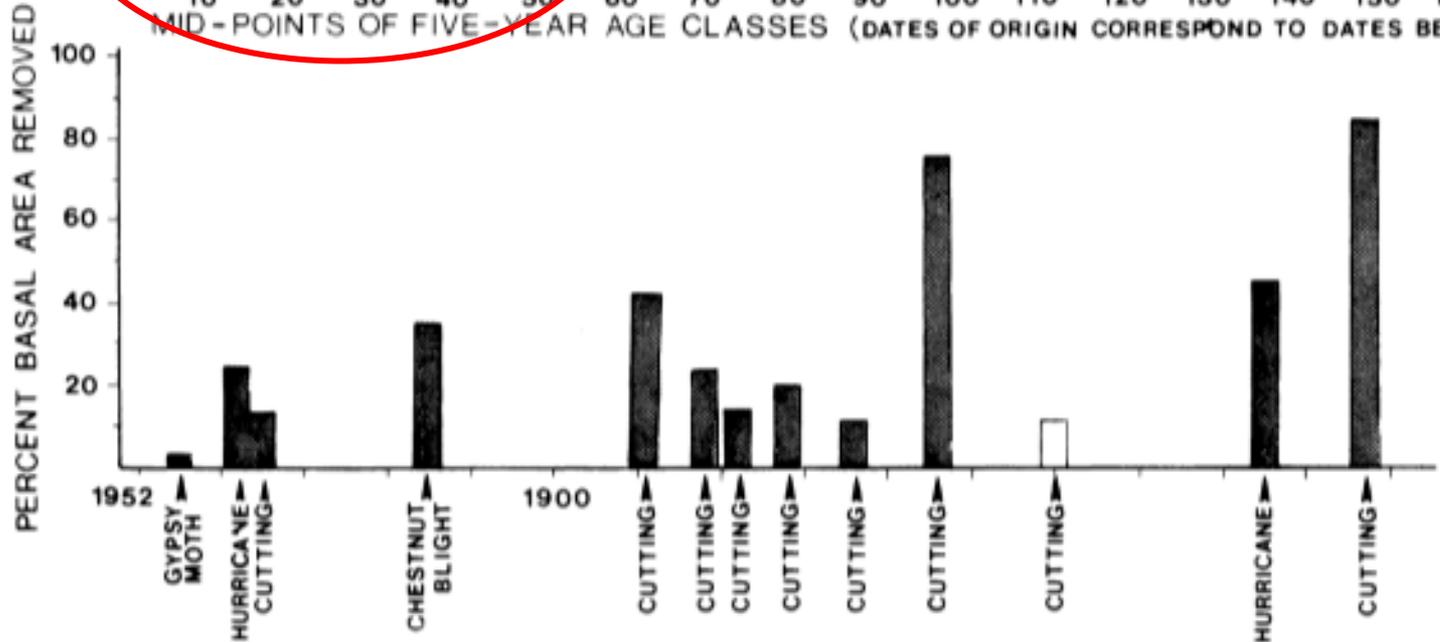


FIG. 3. Distribution of root collar age of all trees in transect and of subsample aged at 1.4 m (upper graph). Corresponding distribution and intensities of disturbances is shown in lower graph.

<Dominant,codominant>

red maple

black birch > red oak

hemlock

<Suppressed>

Ex. Red oakは下層にほぼない

Certain species, especially red oak, were rarely present in the lower crown classes

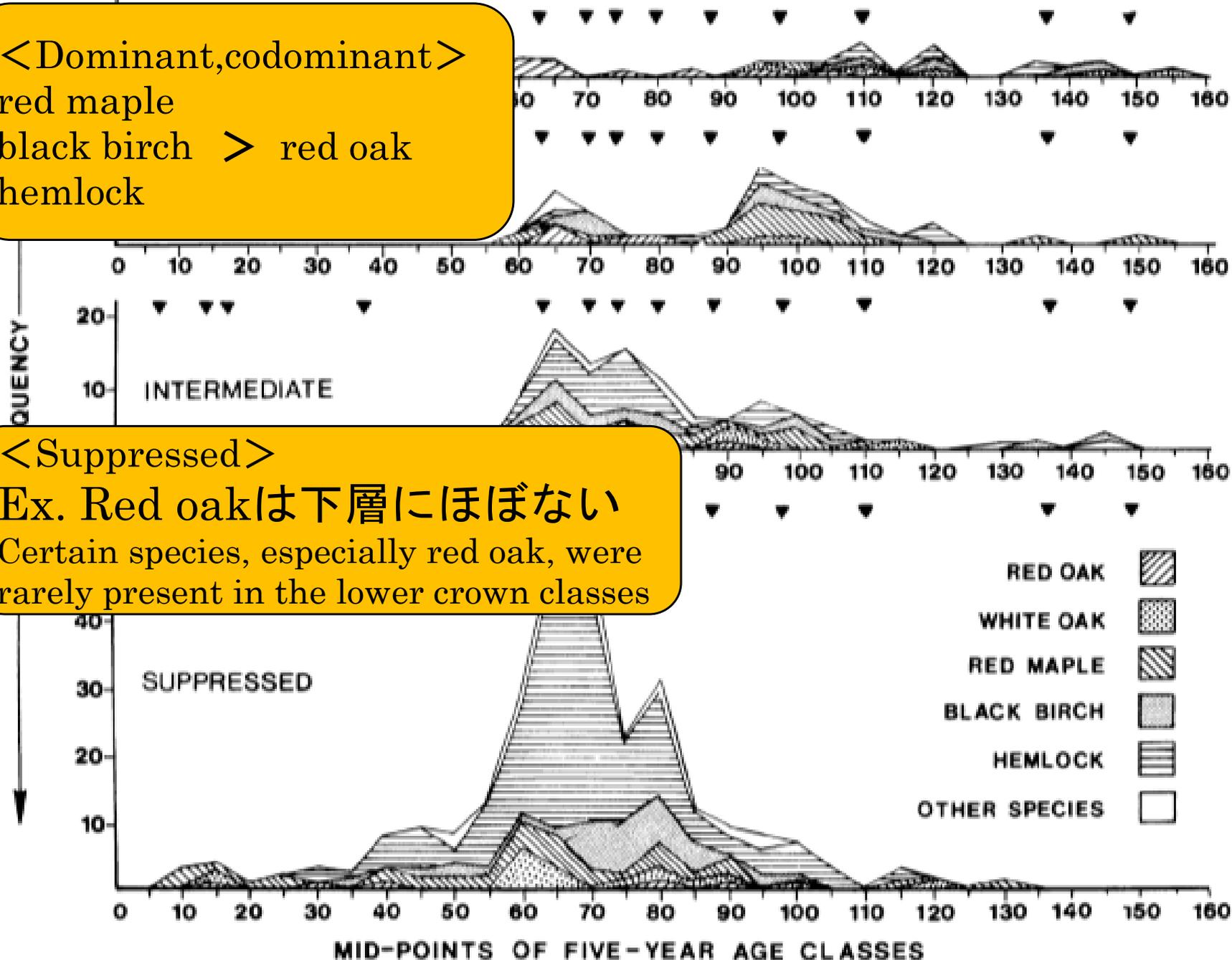


FIG. 4. Distribution of species by age and crown class. Triangles note times of disturbances.

林分発達を個体の成長から把握するために

直径成長は2パターン
(dominant & co-dominant, N=84)

Steady growth(N=38)

- Canopy position was not frequently and abruptly altered

Step-like growth(N=46)

- A series of crown suppressions and releases

species	Steady growth		Step-like growth
Red oak	2/3	>	1/3
Black birch	1/2	=	1/2
Red maple	1/3	<	2/3
Hemlock	1/5	<	4/5

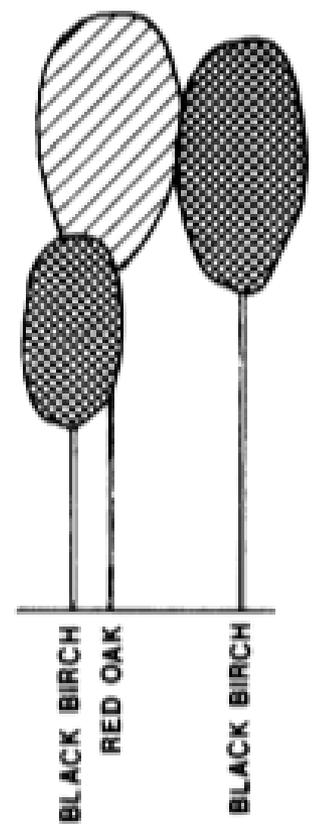
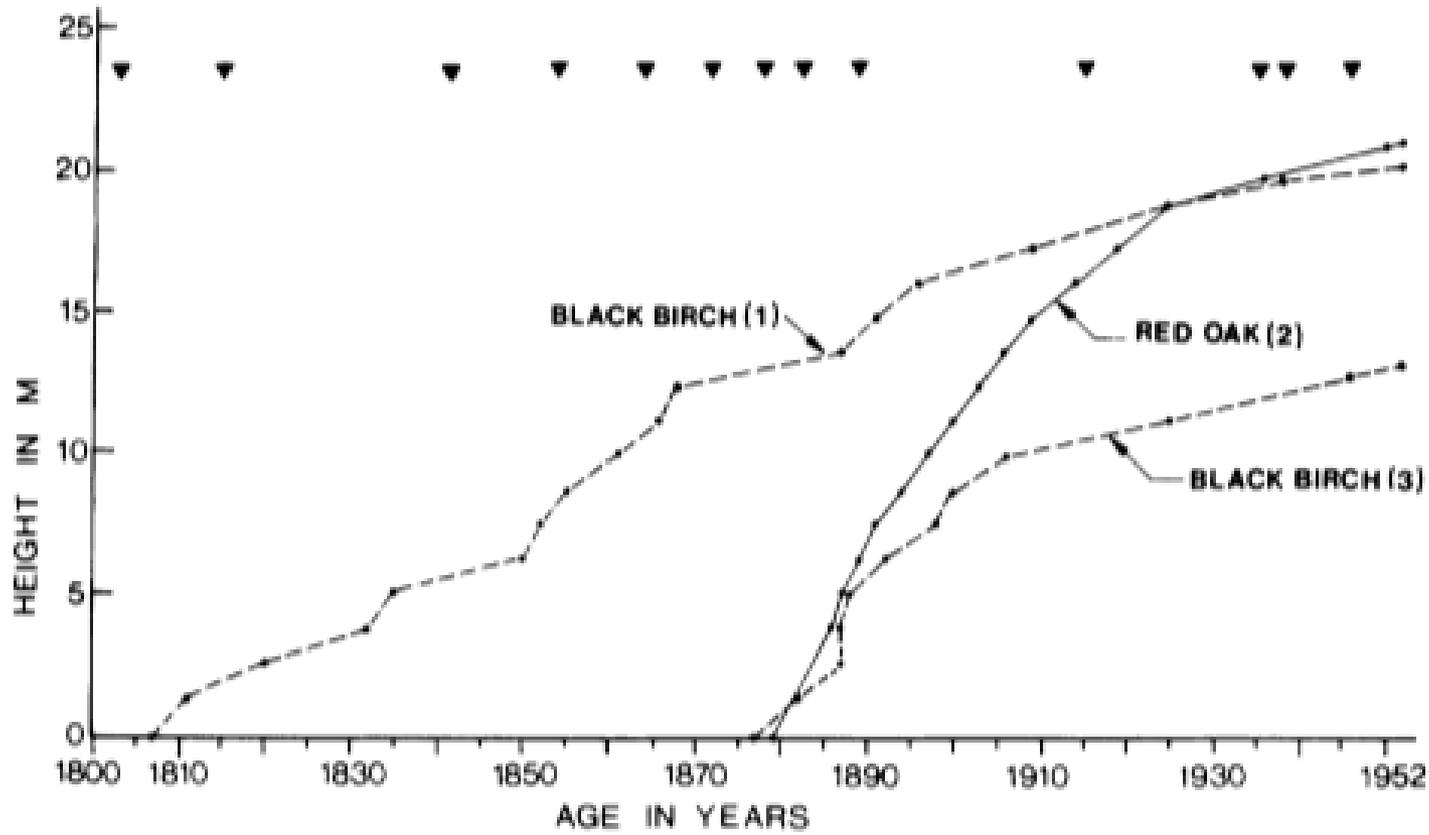
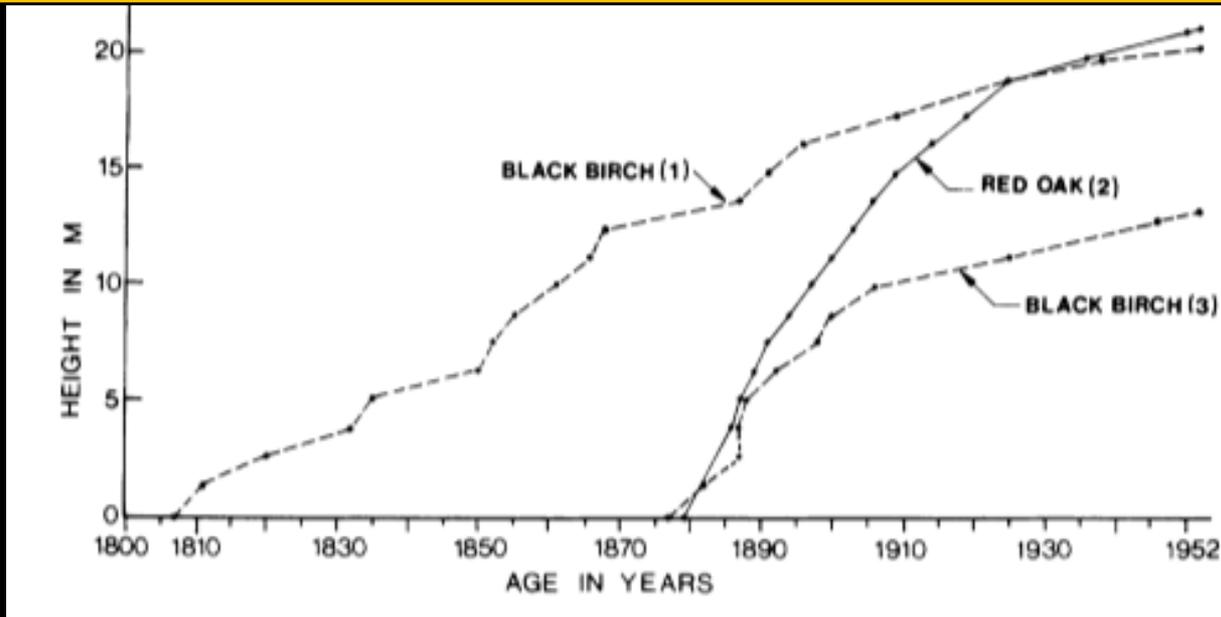


FIG. 5. Growth of selected trees with steady diameter and height growth (red oak #2) and step-like diameter and height growth (black birch #1). Note both trees reached the dominant canopy—the red oak by steady growth, and the black birch (31) by responding to a series of releases. Tree #3 is an example of a black birch which fell behind its contemporary red oak to form a lower strata. Triangles note times of disturbances.

- Black birch#1: step-like growth pattern
- Red oak#2: steady growth pattern
- Black birch#3: step-like growth pattern & lower stratum

The early growth of black birch#1 is similar to black birch#3



Two types of upper canopy

Black birchのパターン

- 上層木がある時は下層で待機
- 上層木が除去されたら成長を速め、林冠層に達する
- Stratified beneath other, probably contemporary, trees and later accelerated again upon removal of the overstory

Red oakのパターン

- 初期からコンスタントに成長し林冠層に達する
- Grew immediately to the overstory after a disturbance

Discussion

この地域では...

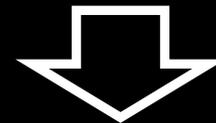
- 攪乱は「一斉更新」「下層木と上層木の入替」の役割を持つ
- Disturbances appear to have two effects which are not mutually exclusive: they can create a new age class; and they can alter the relative canopy position of species in the existing forest.

- 攪乱の直後に加入多い
- Most of the trees established soon after disturbances



Allogeneic
succession

- 上層の攪乱で下層が成長
- disturbances which allowed understory species to grow into the main canopy



林冠層の多様性
The variety of species in
the upper canopy

Discussion

- 攪乱により空いたスペースは「前生樹の成長」と「更新した個体」で埋められる
- When a disturbance releases light and soil growing space, it can be refilled both by previously existing trees and by new individuals

一斉更新

下層木と上層木の入替

攪乱規模
大

攪乱規模
小

+ 前生樹の成長能力

Discussion

大規模攪乱
Large disturbance

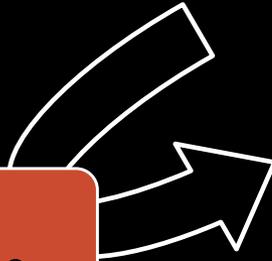
Disturbance type, species present...



Recruitment of new individuals

time

小規模攪乱
small disturbance



Remove dominant trees
Substrata species respond

(Trees excluding later arriving ones
→allogeneic succession)

大規模攪乱
Large disturbance

Conclusion

- Large and small scale disturbance of natural and man-created origin were basic to the structure of the central New England forest studied.
- The allogeneic pattern of succession predominated here rather than the autogenic pattern
- When a large disturbance removed a high proportion of the trees on an area it initiated new trees within the forest; when a smaller disturbance removed fewer trees it generally did not allow recruitment of new trees but rather allowed accelerated growth of the remaining trees.