釧路湿原における野火跡地の植生変化

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Satoshi TSUDA* & Takao KIKUCHI** : **Vegetation Change After a Fire at Kushiro Marsh, Hokkaido, Japan, with Special Reference to Seedling Emergence**

津田　智*・菊池多賀夫**：釧路湿原における野火跡地の植生変化

Abstract

An accidental fire occurred at Kushiro marsh in Hokkaido, Japan, on April 30, 1985. We examined vegetation recovery at the *Phragmites australis* marsh following the fire. The predominant species such as *P. australis, Calamagrostis langsdorffii, Equisetum limosum,* and so on were mostly regenerated by vegetative sprouts. On the other hand, *Rubia jesoensis, Cicuta virosa, Artemisia montana,* and others were regenerated by seed germination. In spite of a little change of species composition, the physiognomy of the marsh hardly changed after the fire. This minor change induced by seedling emergence is transitory at the initial stage of burned marsh and introduce a long-term vegetation change of the *P. australis* marsh.

Key words: fire, marsh, seedlings emergence, vegetation recovery

There are two ways of plant establishment at burned area, vegetative regeneration and seed germination, as their basic categories (GILL, 1981 ; NAKAGOSHI *et al*., 1982 ; ROWE, 1983). Some of plant communities recovered at the burned areas in Japan mainly consist of seedlings from buried seeds but others of vegetative sprouts from the survived roots, rhizomes and bases of scorched trunks. For example, seedlings are prominent in the initial stage of post-fire vegetation at a burned *Quercus serrata* and *Cryptomeria japonica* forest in northeastern Honshu Island (TSUDA *et al*., 1988). However, vegetative sprouts predominate the burned *Pinus densiflora* forest at Setouchi region, southwestern Honshu (NAKAGOSHI *et al*., 1980). Furthermore, first year vegetation at the burned *Moliniopsis japonica* moor in Hakkoda Mountains, northeastern Honshu, is characterized by a few seedlings and many sprouts and, thus, the vegetation recovery is basically carried out vegetatively (TSUDA *et al*., 1989).

The objective of this study was to examine the vegetation recovery at the burned *Phragmites australis* marsh, particularly the effects of fire on marsh plant in relation to such regeneration types as vegetative sprouting and seed germination.

Study Sites and Methods

An accidental fire occurred at Kushiro marsh located in the eastern part of Hokkaido, Japan, on April 30 and burned itself out on May 2, 1985. Investigations were carried out on August 9, 1985 in the first summer following the fire, and on August 30, 1989, four years later of the first investigation. This fire burned about 2200 ha which is equivalent to 10.3 % of the whole of Kushiro marsh, 21440 ha. Fig. 1 shows the burned area and study sites.

Most of the burned area was dominated by *Phragmites australis* before the fire (TSUJII, 1986). Four 1×1m quadrats were set at this burned site and other four quadrats at an adjacent, unburned *P. australis* site in 1985. Four quadrats in the same size were again established at the burned

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site in 1989. The number of individuals of each species occurring inside of each quadrat was counted in both investigation. Individuals of plants occurring at the burned site in the first summer were distinguished into seedlings and vegetative sprouts. In the present study, we regarded vegetative sprouts as individuals when they grew separate one from the other above the ground surface even though they were conected with other sprouts under the ground. The maximum height of each species was also examined in both investigations.

Results

The *Phragmites australis* community was divided into two strata ; the upper stratum consisting of only *P. australis* and the lower one of other grass, forb and fern species at every investigation sites unburned. The maximum heights of *P. australis* investigated at the burned site in 1985 and 1989 and the unburned site were 136-170, 144-175 and 140-162 cm, respectively. The maximum height of *Calamagrostis langsdorffii*, the dominant species in the lower stratum, was 100-130, 76-120 and 105-120 cm, respectively, in the same investigations. Other species as well as those dominant species also showed little changes in maximum height after the fire. The most species in the *P. australis* community little changed in the maximum heights following the fire.

Table 1 shows the species composition indicated by species density at both of the burned and unburned sites.

P. australis, the dominant of the upper stratum, always occurred at the unburned site and its density was approximately 30 culms per square meter. *Equisetum limosum*, *C. langsdorffii* and *Urtica angustifolia* in the lower stratum also occurred at the unburned site. Among them, *C. langsdorffii* was the most abundant species. Its density was 92 to 364 and density of other two species were usually 10-odd individuals per square meter. Several individuals of *Stellaria radians*, *Stellaria alsine* var. *undulata*, *Lastrea thelypteris*, *Lathyrus palustris* ssp. *pilosus*, *Polygonum sieboldi*, and so on appeared at several quadrats. 110 individuals of *Carex* sp. occurred at only one quadrat.

There were four species restricted to the burned

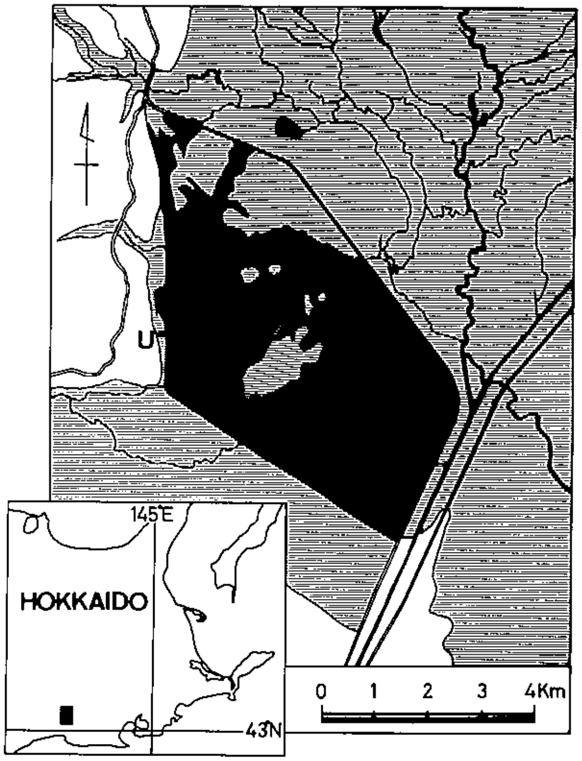

FIG. 1. Map of Kushiro marsh. Hatched and shaded area show the marsh and the burned marsh area, respectively. B and U are study site at the burned and unburned area, respectively.

site. Among them, *Artemisia montana* was found only in 1985, the first post-fire year, and *Polygonum thunbergii* in 1989, fifth post-fire year. *Rubia jesoensis* and *Cicuta virosa* occurred in both years. There were few species disappeared after the fire.

Among the common species found at both of the burned and unburned sites, *E. limosum* increased in density just after the fire, then decreased with the lapse of time. Its average density at the burned site in 1985, 1989 and unburned site were 42.5, 13.3 and 9.0, respectively. On the other hand, *P. australis* was slightly decreased in density immediately after the fire: average densities of *P. australis* at the burned site in 1985 and 1989 and the unburned site were 26.5, 40.0 and 30.3, respectively. In the present study, some species such as *A. montana*, *R. jesoensis*, *C. virosa*, *E. limosum* in the lower stratum were increased in number after the fire, while *P. australis* in the upper stratum were hardly influenced by the fire occurred in the

TABLE 1. Species composition of the plant communities indicated by density of burned and unburned sites. (individuals/m²)

	Burned								Unburned			
	1985 (1st year)				1989 (5th year)							
Species Quad. No.	B11	B12	B13	B14	B21	B22	B23	B24	U01	U02	U03	U04
Equisetum limosum	45	53	23	49	9	15	18	11	11	9	6	10
Phragmites australis	27	24	37	18	53	27	39	41	42	25	21	33
Calamagrostis langsdorffii	220	156	216	192	80	198	45	60	195	364	288	92
Urtica angustifolia		2	4	14	1	1	2	6	18	22	3	6
Stellaria radians		5	2	2		3		3	2	6		1
Stellaria alsine var. *undulata*	25	5	7	8		3					29	17
Lastrea thelypteris	6	15		22			2				27	10
Lathyrus palustris ssp. *pilosus*		11		4			1	1	4			1
Carex sp.	160	150		60				320		110		
Caltha palustris var. *membranacea*	1		6		1		2		1			
Stachys riederi var. *villosa*				1		2	1	4				1
Senecio cannabifolius		1	1				4					2
Oenanthe javanica					9		1					1
Athyrium brevifrons				1				1				3
Solidago virga-aurea ssp. *asiatica*											1	
Rubia jesoensis	51	15	8	5	4	13	4	0				
Cicuta virosa	6	70	6	3		1	2	3				
Artemisia montana	8	2	7	1								
Onoclea sensibilis var. *interrupta*			9	14								
Achillea ptarmica ssp. *macrocephala*	1											
Lobelia sessilifolia		3										
Thalictrum minus var. *hypoleucum*				2								
Polygonum thunbergii					2	2	1	4				
Carex rhynchophysa							29					
Polygonum sieboldii					1	7		1	7	1		
Total	550	512	326	396	160	272	151	455	280	537	375	177

spring.

Table 2 shows the density of seedlings and vegetative sprouts in the first year vegetation after the fire. The predominant species such as *P. australis* and *C. langsdorffii* of this burned marsh were regenerated by vegetative sprouts along with other prominent species such as *E. limosum, L. thelypteris, Carex* sp., and so on at both of burned and unburned sites. On the other hand, *A. montana, R. jesoensis, C. virosa* and *S. alsine* var. *undulata* were seedlings rather than vegetative sprouts. *S. alsine* var. *undulata* is a annual plant but other three are perennials and these perennials established by seed germination were found at only the burned site as shown in Table 1.

Discussion

THOMPSON and SHAY (1985) showed that the height of *Phragmites australis* was shorter by spring burning. But, there were no significant difference in maximum heights among our three investigations. Other species also showed little changes in maximum height after the fire. Thus, the physiognomy of the *P. australis* community little changed after the fire at Kushiro marsh.

Average densities of *P. australis* at the burned site in the first summer and the unburned site were 26.5 and 30.3, respectively, and density of *P. australis* was slightly decreased after the fire in the present study. On the other hand, *P. australis* indicates a 85 % decrease in density after a winter burning in north-central Nebraska, USA (SCHLICHTEMEIER, 1967) but an increase by about three times after spring, fall and summer burning in Manitoba, Canada (THOMPSON and SHAY, 1985). Increase or decrease of density of *P. aus-*

TABLE 2. Densities of seedlings and vegetative sprouts in the first year vegetation after the fire. (individuals/m²)

	Seedlings				Sprouts			
Species　Quad. No.	B11	B12	B13	B14	B11	B12	B13	B14
Rubia jesoensis	40	9	4	2	11	6	4	3
Stellaria alsine var. *undulata*	25	5	7	7				1
Cicuta virosa	6	70	6	2				1
Artemisia montana	8	2	7					1
Stellaria radians		5					2	2
Thalictrum minus var. *hypoleucum*				2				
Urtica angustifolia				8		2	4	6
Lathyrus palustris ssp. *pilosus*				2		11		2
Phragmites australis					27	24	37	18
Calamagrostis langsdorffii					220	156	216	192
Equisetum limosum					45	53	23	49
Lastrea thelypteris					6	15		22
Carex sp.					160	150		60
Caltha palustris var. *membranacea*					1		6	
Senecio cannabifolius						1	1	
Onoclea sensibilis var. *interrupta*							9	14
Achillea ptarmica ssp. *macrocephala*					1			
Lobelia sessilifolia						3		
Stachys riederi var. *villosa*								1
Athyrium brevifrons								1
Total	79	91	24	23	471	421	302	373

tralis might depend on physical condition such as thermal value, burning time, wind velocity, and so on during the fire. This assumption must be verified by the experimental facts by burning.

Plants are injured or sometimes killed by combustion and high temperature induced by fire. Besides such direct effect of fire, there are some indirect effects also important to establishment of plant community at the burned fields (DAUBENMIRE, 1968). The soil tends to rapidly warm up in the sunshine at a burned site because of loss of plant cover and blackened soil surface after a fire and it induces large fluctuation in temperature (KUCERA and EHRENREICH, 1962; MALLIK, 1986; TSUDA and HIRATSUKA, 1991). Some species require light (WESSON and WAREING, 1968; KEELEY, 1987), high temperature (IWATA, 1966; TAKAHASHI and KIKUCHI, 1986; WASHITANI and TAKENAKA, 1986) or the fluctuations of temperature (THOMPSON *et al.*, 1977; HIRATSUKA, 1991) for their seed germination. Other species germinate best on bare ground (LUTZ,1956) because the inhibiting substances for germination are contained in the litter (OOYAMA, 1954). Burned site is in extremely good condition for seed germination.

The *P. australis* marsh investigated in the present study little changed in its physiognomy after the fire. However, many seedlings of the species such as *R. jesoensis, C. virosa, A. montana,* and so on appeared immediately after the fire and grew under the dominant, upper layer of *P. australis*. Many seedlings appeared at the burned site, because the site condition was affected by the indirect effects of the fire such as heating of soil, removal of litter, increasing light intensity, and so on and became confortable for seed germination. It should be revealed that such change induced by seedling emergence is transitory at the initial stage of vegetation after a fire and introduce a long-term vegetation change of Kushiro marsh.

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摘　要

1985 年 4 月 30 日に釧路湿原で発生した野火は，ヨシ群落を中心に約 2200 ヘクタールの湿原植生を焼失した。この火事の焼失地では 1985 年と 1989 年の夏に，また，隣接の非焼失地では 1985 年の夏にそれぞれ植生調査をおこない，火事が湿原のヨシ群落

に与えた影響を検討した。

焼失地におけるヨシをはじめとする多くの植物の最大高は，非焼失地に出現する植物の最大高とほとんど差がなかった。ヨシ群落の第一層を占める優占種のヨシの密度は約30(m^{-2})で，焼失地と非焼失地の差はほとんどなかった。第二層の種では火事直後にミズトクサの密度が高かった。また，アカネムグラ，ドクゼリ，オオヨモギなどは非焼失地には出現せず，焼失地だけに出現した。一方，非焼失地だけに出現した種はほとんどなかった。

ヨシ群落で優占度の高いヨシ，イワノガリヤス，ミズトクサなどは焼け残った地下部からの栄養的な再生によって出現した。これに対して，アカネムグラ，ドクゼリ，オオヨモギなどは栄養再生よりも種子発芽に依存して固体数を増やした。湿原のヨシ群落でも，火事の後の直射日光による地表面の温度上昇や変動幅の拡大などの火事の間接的な影響が存在し，山火事跡地などと同様に休眠していた種子が発芽したものと推定される。

湿原のヨシ群落の火事では，大きく相観を変えるような植生の変化はおきないが，種子発芽固体の増加という一時的な変化がおこり，このことが将来にわたって植生に変化を及ぼしていく可能性はある。

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○　志村義雄　**日本のイノデ属（シダ植物）**　B5判，160頁。平成4年9月1日発行。自費出版，〒420静岡市大岩2-20-11。定価6500円（送料別500円）。

金沢大学理学部では少数派のシダ屋として全国から当大学の標本庫に集まるシダ植物標本の同定のほとんどを任されている私だが，毎度頭を抱える苦手な分類群がある。それがイノデ *Polystichum*（オシダ科）だ。単に種類数が多いだけでなく，形態がお互いに似通ったものが多く，さらに雑種もこれまた多い。手元の図鑑や分布図集を総動員しても結局名前を決められない場合さえある。

今回志村氏が出版されたこの著書は，そんな私にとって大変参考になる手引きであった。日本産の全種，全雑種（33種4変種4品種10奇形53雑種）をそれぞれ解説するのは勿論のこと，形態，染色体数，分布，果ては和名の由来まで，多角的な情報が盛り込まれている。とくに重宝しそうなのは近似的種類間の比較を行っている項目である。ここではカラクサイノデとアズミイノデ，イノデとアイアスカイノデとアスカイノデなど区別が難しい種類同士の特徴を比較・整理しており，検索表を補うものとして歓迎したい。また，文献に関する情報が充実している点も見逃せない。

自費出版ということで頁数を絞り込んだのだろうか，使い勝手という点では最近の立派な図鑑には及ばないのが残念である。しかし，我々シダ屋にとって役に立つ一冊であることには変わりはない。

最後になってしまったが，志村氏の長年に及ぶ研究活動に心から敬意を表したい。　　（栗原智昭）

○　山口県立山口博物館　**ふるさと山口・江戸時代の動植物図**　B5判，256頁（カラー約）80枚，モノクロ約130枚）。平成5年4月28日発行。2500円＋〒450円。

幕府の参勤交替の政策により，諸大名は隔年，江戸に出仕した。この結果，藩主は江戸城で地方の情報交換を行ない，それぞれの藩内の天産物を活用し，産業を振興することに努めた。

本書は258年前（徳川吉宗の時代）行なわれた，全国の産物調査において，毛利藩より幕府に提出された「長門国産物之内江戸被差登候地下図正控，元文3年（1738），山口県文書館蔵」と「周防国産物之内絵形，元文年間，萩市立図書館蔵」を紹介したもので，内容は第1～第4部からなり，第1部では原本を1／4に縮少し，全容をしめし，第2部ではその図の解説，第3部では産物帳の成立の背景と絵図作成の過程，第4部では産物調査の過程で作成された「長防産物名寄」を加えている。購入御希望の方は山口県立山口博物館（〒753　山口市春日町8番2号）宛に申込まれると送本される。　　（里見信生）

○　尾川武雄・小川信正・吉田三喜男　**伊豆大島植物目録**　B5判，38頁＋索引12頁。平成5年8月，大島自然愛好会発行。非売品。

私は大島に昭和32年頃，幾度も渡島した。伊豆七島では最も東京に近い島でありながら，行く度に未記録の種類が，次々と追加出来るので，興味深かったのである。

この頃知り合い，御一緒に歩いた方が，著者の一人である尾川武雄さんで，役は家業のかたわら，この目録の共著者の方と大島自然愛好会を創立し，島の調査を続けて居られる。

本書はその成果であって，シダ以上の植物118件，410属，716種が登載されている。この中で，ラン科を見てもコオロギラン・アキザキヤツシロラン・カゲロウラン・ヒメノヤガラなど，甚だ面白い発見と思うが，少々気になった事はこれ等の貴重な標本を虫害やその他の損傷から護り，散逸させない方策を考えておられるであろうか。　　（里見信生）