Original article

Shuichi Noshiro¹, Mitsuo Suzuki² and Sei-ichiro Tsuji³: Latest Pleistocene forests buried by Asama tephra in the Minami-Karuizawa basin, central Japan

能城修一¹・鈴木三男²・辻 誠一郎³: 長野県南軽井沢に広がる浅間火山テフラに覆われた更新世最末期の埋没林

Abstract Forests buried by latest Pleistocene tephra layers from Asama volcano were studied in the Minami-Karuizawa basin, Nagano Prefecture. A number of tephra layers were deposited since ca. 25,000 yBP in the Minami-Karuizawa basin, and peat, peaty sediments, and soil were deposited between them. Buried forests were found from below Asama-Kumoba pumice flow deposit (As-Kb) to above an unnamed tephra layer (MK-15) and were especially extensive below Asama-Itahana yellow pumice (As-YP) dated at 13,320±130 to 13,710 ± 130 yBP. Buried forests below As-YP were dominated by *Picea* and *Pinus* cf. *pumila*, accompanied by *Juniperus*, and were more developed on herbaceous peat than on moss peat. At localities or horizons where *Picea* and *Pinus* cf. *pumila* were not dominant, *Picea*, *Abies*, and *Larix* dominated. In the Minami-Karuizawa basin, coniferous forests similar to the present subalpine ones seem to have grown in drier areas, whereas open *Picea* sect. *Picea*-*Pinus pumila* forests seem to have grown in wetter areas. Contemporaneous fossil wood assemblages buried by As-YP in the Maebashi area was dominated by *Picea*, accompanied by *Larix* and *Pinus* subgen. *Haploxylon*, and coniferous forests seem to have had an extensive distribution at this period. Key words: Asama volcano, Asama-Itahana yellow pumice, buried forests, latest Pleistocene, Minami-Karuizawa

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要 旨 浅間火山の東南部に位置する長野県北佐久郡軽井沢町の南軽井沢において、更新世最末期の埋没林の樹種 を検討した。ここには浅間火山を起源とする過去 25,000 年にわたる多数の降下テフラと火砕流堆積物が堆積し、盆 地状の地形の底にあたる部分に、標高 950 m ほどの平坦な面が広がっている。降下テフラ層や火砕流堆積物層の間 には泥炭あるいは泥炭質の堆積物や土壌が堆積しており、しばしば埋没林を含んでいた。埋没林は浅間-雲場軽石 流堆積物 (As-Kb)の下位から MK-15 の上位の更新世最末期の堆積物中に見られ、浅間-板鼻黄色軽石 (As-YP; 13,320 ± 130 ~ 13,710 ± 130 yBP)直下でとくに発達していた。浅間-板鼻黄色軽石 (As-YP)直下の埋没林は トウヒ属とハイマツ近似種を主体とし、ネズミサシ属が伴っていた。埋没林は苔泥炭上と比べて草本泥炭上のほうが 発達していた。トウヒ属とハイマツ近似種の植生が発達しない地域や層準では、トウヒ属とモミ属、カラマツ属が優 占しており、乾いた立地上には現在の亜高山帯の針葉樹林のような森林が成立し、より湿った立地上にトウヒ属とハ イマツ近似種の林が成立していたと想定された。As-YPで埋積された群馬県前橋市の同時期の木材化石群ではトウ ヒ属が優占し、カラマツ属とマツ属単維管東亜属がともなう組成となっており、この時期、針葉樹を主体とした森林 がかなりの標高に渡って広がっていたことが想定された。

キーワード:浅間-板鼻黄色軽石、浅間火山、更新世最末期、埋没林、南軽井沢

Introduction

In northern Japan, buried forests of the latest Pleistocene have been studied at several areas, such as the Tomizawa site, Sendai (Morita, 1992; Noshiro & Suzuki, 1992; Suzuki, 1992), Sanpachi-kamikita area east of Towada volcano (Noshiro et al., 1997; Terada et al., 1994; Nasu et al., 2002), Ikenai, Akita southwest of Towada volcano (Terada & Tsuji, 1999), Ooyazawa, Aomori (Noshiro et al., 2002; Nasu et al., 2002), and Oshima Peninsula, Hokkaido (Kawamura & Kito,

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2000). In these areas, coniferous forests consisting of *Picea* sect. *Picea*, *Larix gmelinii* (Rupr.) Gordon, *Abies sachalinensis* Masters, and *Pinus koraiensis* Siebold et Zucc. prevailed during the latest Pleistocene. In central Japan, on the contrary, forests buried in this period have rarely been studied, and past vegetation was studied only from pollen and plant macrofossil assemblages (Tsukada, 1987; Sohma & Tsuji, 1988; Morita et al., 1998).

In the Minami-Karuizawa basin, forests buried by latest Pleistocene tephra from Asama volcano occurred extensively (Tsuji et al., 1984a; Nakamura et al., 1997). In this basin, two major pyroclastic flow deposits dammed the Kumoba River and formed marshy environment (Unozawa & Sakamoto, 1972), and many tephra layers and intercalating layers of peat, peaty sediments, or soil were deposited into so-called "Minami-Karuizawa Lake Deposits" (Aramaki, 1963, 1968). In a buried forest just below As-YP, Nasu et al. (1999) studied macrofossil assemblages and pointed out the existence of *Picea* sect. *Picea–Pinus pumila* (Pall.) Regel forests with a moss forest floor and the habitat segregation in the moss flora. However, they did not study fossil woods that formed the buried forests and studied assemblages from only one horizon.

Here we studied fossil woods of buried forests in several horizons in the Minami-Karuizawa basin and clarified the characteristics of the most extensive forest below As-YP. As a comparison to the buried forests in this area, we also studied fossil wood assemblages below As-YP in the Maebashi area, whose data was partly published by Tsuji et al. (1985).

Localities and stratigraphy

Minami-Karuizawa at Karuizawa machi, Kita-saku Gun, Nagano Prefecture, is the flat bottom of a basin at the southeastern foot of Asama volcano at 920– 950 m in altitude (Fig. 1; 36°18'N–20'30"N 138°36'E –38'30"E). This area was formed by various tephra deposits from Asama volcano and intercalated soil, loam, and peaty deposits (Aramaki, 1968; Unozawa & Sakamoto, 1972; Tsuji et al., 2004). Tsuji et al. (2004) clarified tephrostratigraphy and chronology of Asama volcano in the Minami-Karuizawa basin and named



Fig. 1 Sampling sites in the Minami-Karuizawa basin, central Japan.



Fig. 2 Stratigraphy at sampling sites in the Minami-Karuizawa basin (modified from Tsuji et al., 2004).

the deposits as "Minami-Karuizawa Tephra Formation". Below the first major tephra layers from the Asama volcano (As-BP-1–6), Aira-Tn Ash (AT) dated at ca. 24,500 cal BP marks the start of tephra deposition in this area. Since then, deposition of tephra from Asama volcano occurred continually through the latest Pleistocene and the Holocene up to the deposition of Asama A Pumice (As-A) dated at 1783 A.D. The Minami-Karuizawa Tephra Formation is contemporaneous with the "Minami-Karuizawa Lake Deposits" (Aramaki, 1963, 1968) and intercalates marshy deposits and soil. The Minami-Karuizawa Tephra Formation can be divided into Lower and Upper Members based on an oblique relationship above MK-13 and facies changes in soil and peat (Tsuji et al., 2004).

Peaty deposits with fossil woods were developed in the Lower Member, i.e., below Asama-Kumoba pumice flow deposit (As-Kb), Asama-Okubozawa pumice Nos. 1 and 2 (AS-OkP-1, AS-OkP-2), Asama-Itahana yellow pumice (As-YP), MK-14, and MK-15 and above MK-15 (Fig. 2). Except for fossil woods collected at KIZ-32 below As-Kb and those collected at KIZ-17 above MK-15, all the fossil woods were collected directly below the tephra layers. Below As-YP, buried forests with erect stumps were extensive at around KIZ-22 (Fig. 3). The forest floor showed marked effect of involution, ca. 45 cm deep, and was covered with herbaceous and moss peat. Besides fallen stem- or branchwoods, several upright stumps existed at KIZ-22 showing gentle deposition of As-YP and MK-13 (Figs. 3, 6).

Radiocarbon dates obtained for the tephra layers were as follows: $19,520 \pm 240$ to $19,800 \pm 190$ yBP for As-Kb, $16,880 \pm 130$ yBP for AS-OkP-1, $16,500 \pm 440$ yBP for AS-OkP-2, $13,320 \pm 130$ to $13,710 \pm 130$ (to $16,640 \pm 450$) yBP for As-YP, $12,340 \pm 150$ to $12,820 \pm 190$ yBP for MK-14, and $11,240 \pm 290$ to $12,180 \pm 150$ yBP for MK-15 (Nakamura et al., 1997; Tsuji et al., 2004).

The Maebashi Peat Layer occurs on the riverside of the Tone River (130–140 m in altitude, 36°25'30"N 139°2'E) and intercalates As-YP in the middle (Tsuji et al., 1985). Fossil woods were obtained directly below As-YP at two localities, GM-10 and GM-12.



Fig. 3 A buried forest below Asama-Itahana yellow pumice (As-YP). — 1: profile at KIZ-9, 2: an upright stump at KIZ-22.

Sampling and identification

We studied 201 fossil woods collected at seven localities in the Minami-Karuizawa basin (Fig. 1) and 18 fossil woods collected in the Maebashi area. Because localities KIZ-9 and KIZ-23 were adjacent to KIZ-22 and showed nearly the same stratigraphy to KIZ-22, fossil woods from these two localities are treated together with those from KIZ-22. The number of specimens from each horizon was as follows: 13 from below As-Kb, 18 from below As-OkP-1, 6 from below As-OkP-2, 157 in the Minami-Karuizawa basin and 18 in the Maebashi area from below As-YP, 5 from below MK-14, 1 from below MK-15, and 1 from above MK-15 (Fig. 2; Table 1). At KIZ-22, we recorded the position and occurrence of each fossil wood along the buried soil surface, but did not record the diameter of the fossil woods. The diameter of the largest upright stump was less than 20 cm.

Specimens were sectioned manually and were mounted with Gumchloral (a mixture of Chloral Hydrate 50 g, Arabic Gum 40 g, Glycerin 20 ml, and pure water 50 ml). The specimens were numbered from KRZ-1 to KRZ-219 and were identified by comparing with specimens of extant species deposited at xylariorums of the University of Tokyo (TOFOw) and the Forestry and Forest Products Research Institute (TWTw). The specimens of the present study are deposited in the Tsuda Herbarium, Tohoku University, Sendai, Japan.

Results

1. Identification of fossil specimens

Thirteen taxa were recognized among the 408 specimens (Table 1). Four taxa included both stem- and rootwoods, and one taxon included only one rootwood. All the taxa will be briefly described to show the basis of identification. For rootwoods whose stemwoods have already been described, only distinctive features for the recognition of rootwoods from stemwoods will be described.

Abies Pinaceae (Fig. 4, 1a-1b: stemwood, 1c: root-wood)

Stemwood. Coniferous wood without vertical or horizontal resin canals. Earlywood tracheids square or polygonal; growth ring boundaries distinct. Transition from early- to latewood gradual; latewood conspicuous. Marginal axial parenchyma cells occasional. Rays consisting solely of parenchyma cells with nodular endwalls. Cross-field pits small taxodioid, 2–4 per cross-field.

Rootwood. Coniferous wood consisting of large thin-walled tracheids with occasional marginal axial parenchyma.

Larix Pinaceae (Fig. 4, 2a–2c: stemwood, 2d: branch-wood, 2e: rootwood)

Stemwood (*Branchwood*). Coniferous wood with vertical and horizontal resin canals. Earlywood tracheids thin-walled, radially elongated rectangular,



Fig. 4 Fossil woods of the latest Pleistocene from the Minami-Karuizawa basin (1). — 1a–1c: *Abies* (1a, 1b: stemwood, KRZ-22, TS (1a), RLS (1b). 1c: rootwood, KRZ-21, TS). — 2a–2e: *Larix* (2a–2c: stemwood, KRZ-212, TS (2a), TLS (2b), RLS (2c). 2d: branchwood, KRZ-97, TS. 2e: rootwood, KRZ-18, TS). — 3a–3d: *Picea* (3a–3c: stemwood, KRZ-131, TS (3a), TLS (3b), RLS (3c). 3d: rootwood, KRZ-177, TS). — 4a–4c: *Pinus* cf. *pumila* (stemwood, KRZ-164, TS (4a), TLS (4b), RLS (4c)). TS: transverse section, scale bar = 200 μ m. TLS: tangential section, scale bar = 80 μ m. RLS: radial section, scale bar = 20 μ m.

large; latewood tracheids thick-walled, flattened. Transition from early- to latewood abrupt; latewood conspicuous. Epithelial cells thick-walled. Marginal axial parenchyma occasional in branchwood (Noshiro & Fujii, 1994). Rays consisting of parenchyma cells and ray tracheids. Cross-field pits small piceioid to taxodioid, 3–7 per cross-field. Bordered pit-pairs of ray tracheids usually with large apertures and tapered margins (Bartholin, 1979; Anagnost et al., 1994).

Rootwood. Coniferous wood consisting of irregular large polygonal tracheids, up to 65 µm in radial diameter. Transition from early- to latewood rather abrupt.

Picea Pinaceae (Fig. 4, 3a-3c: stemwood, 3d: root-wood)

Stemwood. Coniferous wood with vertical and horizontal resin canals. Earlywood tracheids square or polygonal. Transition from early- to latewood gradual or rather abrupt; latewood conspicuous. Resin canals scattered in the latewood or the latter half of the earlywood. Rays consisting of parenchyma cells and ray tracheids. Cross-field pits small piceioid, 3–5 per cross-field. Bordered pit-pairs of ray tracheids usually with narrow apertures and dentate borders (Bartholin, 1979; Anagnost et al., 1994).

Rootwood. Coniferous wood consisting of large polygonal tracheids. Transition from early- to latewood gradual.

Pinus cf. *pumila* Pinaceae (Fig. 4, 4a–4c: stemwood; Fig. 5, 1a: rootwood)

Stemwood. Coniferous wood with vertical and horizontal resin canals. Earlywood tracheids round or square. Epithelial cells of resin canals large, thinwalled, occupying the canals. Transition from earlyto latewood very gradual; latewood not conspicuous. Rays consisting of parenchyma cells and ray tracheids. Cross-field pits large window-like, usually 1–2 per cross field. Ray tracheids uncommon, horizontal walls of ray tracheids smooth.

Rootwood. Coniferous wood consisting of large thin-walled tracheids with very narrow latewood.

Note. This taxon was characterized by 1) prevalence of compression wood with round tracheids and large proportion of latewood; 2) narrow irregular growth rings, 20–350 μ m wide; 3) short rays; and 4) rare occurrence of ray tracheids. In qualitative features, however, this taxon could not be distinguished from other species of *Pinus* subgen. *Haploxylon* and was identified as *Pinus* cf. *pumila*.

Pinus subgen. *Haploxylon* Pinaceae (Fig. 5, 2a-2b: stemwood)

Coniferous wood with vertical and horizontal resin canals. Earlywood tracheids square or polygonal.

Epithelial cells of resin canals large, thin-walled, usually missing. Transition from early- to latewood very gradual; latewood conspicuous. Rays consisting of parenchyma cells and ray tracheids. Cross-field pitting large window-like, 1–2 per cross-field. Ray tracheids common, horizontal walls of ray tracheids smooth.

Juniperus Cupressaceae (Fig. 5, 3a–3c: stemwood, 3d: rootwood)

Stemwood. Coniferous wood without vertical or horizontal resin canals. Earlywood tracheids square or round, thick-walled; growth ring boundaries distinct. Transition from early- to latewood gradual; latewood conspicuous. Axial parenchyma tangentially zonate in the latewood or the latter half of the earlywood. Rays consisting solely of parenchyma cells with smooth or nodular end-walls. Cross-field pits small taxodioid to cupressoid, 2–4 per cross-field.

Rootwood. Coniferous wood consisting of large thinwalled tracheids, up to 75 μ m in radial diameter, with very narrow latewood.

Hydrangea paniculata Saxifragaceae (Fig. 5, 4a–4b: rootwood)

Diffuse-porous wood with evenly scattered, slightly angular, exclusively solitary vessels, 30–60 µm in diameter; perforation plates scalariform with 20–40 bars; horizontal tyloses common; vessel-ray pits scalariform. Axial parenchyma scanty paratracheal. Rays heterocellular, uniseriate or multiseriate; multiseriate rays 2–3 cells wide, with 1–8 marginal cells; uniseriate rays and marginal wings of multiseriate rays consisting of tall upright cells.

Spiraea Rosaceae (Fig. 5, 5a-5b: stemwood)

Diffuse-porous wood with evenly distributed, slightly angular vessels, 15–45 μ m in diameter; quite dense, especially in the earlywood; perforation plates mostly simple, occasionally reticulate; intervessel pits dense alternate, minute, ca. 2.5 μ m in diameter; gum deposits often in vessels. Rays heterocellular, uniseriate or multiseriate of two distinct sizes; uniseriate rays consisting of upright cells, 1–6 cells tall; multiseriate rays 5–12 cells wide, up to 1.5 mm tall, with 1–2 marginal cells and incomplete sheath cells.

Lonicera Caprifoliaceae (Fig. 5, 6a–6b: stemwood)

Semi-ring-porous wood; growth rings narrow, 50 $-450 \mu m$ wide; larger vessels, 20-45 μm in diameter, forming a discontinuous line at the beginning of growth rings, smaller solitary vessels, 8–20 μm in diameter, sparse in the latewood; transition from early-to latewood gradual in inner three rings, rather abrupt in outward rings; perforation plates exclusively simple. Wood parenchyma scanty paratracheal, diffuse. Rays heterocellular, mostly consisting of square to upright



Fig. 5 Fossil woods of the latest Pleistocene from the Minami-Karuizawa basin (2). — 1a: *Pinus* cf. *pumila* (rootwood, KRZ-143, TS). — 2a–2b: *Pinus* subgen. *Haploxylon* (stemwood, KRZ-213, TS (2a), RLS (2b)). — 3a–3d: *Juniperus* (3a–3c: stemwood, KRZ-184, TS (3a), TLS (3b), RLS (3c). 3d: rootwood, KRZ-79, TS). — 4a–4b: *Hydrangea paniculata* (rootwood, KRZ-206, TS (4a), TLS (4b)). — 5a–5b: *Spiraea* (stemwood, KRZ-102, TS (5a), TLS (5b)). — 6a–6b; *Lonicera* (stemwood, KRZ-199, TS (6a), TLS (6b)). — 7a–7b: Dicotyledon rootwood (KRZ-64, TS (7a), TLS (7b)). TS: transverse section, scale bar = 200 µm. TLS: tangential section, scale bar = 80 µm. RLS: radial section, scale bar = 20 µm.

		Minami-Karuizawa basin													Maebashi area	
			KIZ-17			KI	Z-32	KIZ-22		KIZ- 8	KIZ- 7				GM-10**	GM-12
Taxon		above MK-15	MK-1	5 MK-	14 As-`	YP A	s-Kb	As-YP*	As- OkP-1	As-YP	As-YP	As- OkP-2	As- OkP-1	As-Kb	As-YP	As-YP
Abies	S										2	2	6			
	R				1	_						1				
Larix	S			2								2	1	1	2	
	R											1	3			
Picea	S		1	3	15	5		24		2	19		4		1	
	R							15			3		3			1
	-							10		1					9	3
Pinus cf. pumila	S						11	25			20					
	R							4								
	-							10								
Pinus (Haploxylon)	S										1					
	-															1
Juniperus	S							3								
	R							1								
Hydrangea paniculata	R														1	
Spiraea	S	1														
Lonicera	S						1		1							
Dicotyledon wood	R										1					
Total		1	1	5	16	5	12	92	1	3	46	6	17	1	13	5

Table 1 Fossil wood taxa from the Minami-Karuizawa basin and the Maebashi area

* inclusive of 7 and 1 specimens from KIZ-9 and KIZ-23, repectively. ** Tsuji et al. (1985).

S: stem-/branchwood, R: rootwood, -: indistinguishable.

cells, 1–3 cells wide; multiseriate rays with incomplete sheath cells.

Dicotyledon rootwood (Fig. 5, 7a–7b)

Rootwood without growth rings; vessels 30–180 µm in diameter, solitary or in clusters of 2–6, evenly distributed; thick-walled, walls ca. 4 µm thick; perforation plates exclusively simple. Wood parenchyma vasicentric. Rays heterocellular, 1–3 cells wide. Uniseriate rays, parenchyma strands, and vessel elements storied.

2. Composition of fossil wood assemblages

In the buried forest below As-YP at KIZ-22, *Picea* and *Pinus* cf. *pumila* dominated, occupying 53% and 42% respectively, and were accompanied by *Juniperus* occupying 4.3% (Table 1). The profile of the buried forest shows that dominant *Picea* and *Pinus* cf. *pumila* grew together throughout the forest, irrespective of surface profile, but *Juniperus* grew only at one location (Fig. 6). In the southern half where moss peat developed, upright stumps were thinner and rarer than those in the northern half on herbaceous peat. Spatial distribution and height of upright stumps show that *Picea* individuals were larger than *Pinus* cf. *pumila* individuals and had upright stems.

Similar dominance of *Picea* and *Pinus* cf. *pumila* was observed below As-YP at KIZ-7, where *Abies* and *Pinus* subgen. *Haploxylon* accompanied these taxa. Except for these horizons and below As-Kb at KIZ-32, however, *Pinus* cf. *pumila* was not detected at other localities or horizons. *Abies* and *Larix* accompanied *Picea* in horizons at KIZ-17 and in lower horizons at KIZ-7.

At two localities in the Maebsashi area, *Picea* dominated, accompanied by *Larix*, *Pinus* subgen. *Haploxylon*, and *Hydrangea paniculata*.

Discussion

If *Pinus* cf. *pumila* had the same habitat preference as shade intolerant *Pinus pumila* in the buried forest at KIZ-22, *Picea* must have formed the open canopy layer, and *Pinus* cf. *pumila* occupied the uncovered forest floor with *Juniperus*. *Picea* and *Pinus* cf. *pumila* grew evenly in the buried forest, which agrees with the even distribution of their macrofossils studied near KIZ-23 by Nasu et al. (1999). According to their macrofossil study, *Picea* and *Pinus* cf. *pumila* are correlated to *Picea* sect. *Picea* and *Pinus pumila*, respectively, and were accompanied by *Vaccinium vitis-idaea*



Fig. 6 A forest buried by Asama-Itahana yellow pumice (As-YP) at KIZ-22. Herbaceous peat developed in the northern end and the middle part of the upper profile, and moss peat developed at the southern end of the upper profile and throughout the lower profile.

L. and mosses such as Sphagnum girgensohnii Russ., Sphagnum squarrosum Crome, Aulacomnium palustre (Hedw.) Schwaegr., Pleurozium schreberi (Brid.) Mitt., and Ptilium crista-castrensis (Hedw.) De Not. Nasu et al. (1999) compared the reconstructed Picea sect. Picea -Pinus pumila forests with extant ones in Hokkaido, considering the composition of moss assemblages on the forest floor, and pointed out the closest correlation with open Picea glehnii (Rupr.) Gordon-Pinus pumila forests at Numano-hara marsh on Mts. Daisetsu. The buried forest in the Minami-Karuizawa basin seems to have developed more on herbaceous peat than on moss peat, judging from the size of upright stumps in the profile of the buried forest (Fig. 6). Correlation with extant forests should also be sought in those forests established on drier habitat based on a further study of plant macrofossils of the herbaceous peat in the buried forest.

In the Minami-Karuizawa basin, the distribution of *Pinus* cf. *pumila* seems to have been limited in the central area and was detected only at two horizons, below As-Kb at KIZ-32 and below As-YP at KIZ-22 and KIZ-7. In other horizons or localities, *Abies*, *Larix*, and *Picea* seem to have grown together. Among plant macrofossils below As-OkP-1 and As-OkP-2 near KIZ-8, Keiji Suzuki identified Abies, Larix leptolepis (Siebold et Zucc.) Gordon, Picea cf. maximowiczii Regel ex Masters, Picea cf. shirasawae Hayashi, Tsuga, Rumex, and Menyanthes trifoliata L. (Unozawa & Sakamoto, 1972). At three localities outside the Minami-Karuizawa basin, coniferous taxa prevalent in the present subalpine forests were dominant in plant macrofossil assemblages of the latest Pleistocene. At the western foot of Mt. Yatsu-ga-take (910-950 m in altitude), Picea maximowiczii, Picea shirasawae, Picea koyamai Shirasawa?, Picea jezoensis (Siebold et Zucc.) Carrièrre, Larix, and Prunus cf. salicina Lindley were detected from horizons radiocarbon dated at 31,600 to 29,100 yBP (Iida, 1973). From the Tochu conifer bed at Akashina Machi (600 m in altitude), radiocarbon dated at 15,750 ± 390 yBP, Pinus koraiensis Siebold et Zucc., Picea maximowiczii?, Picea jezoensis var. hondoensis (Mayr) Rehder?, Tsuga diversifolia (Maxim.) Masters, and Abies veitchii Lindl. were identified (Kobayashi, 1965). At Kisohirasawa (920 m in altitude), Picea sect. Picea, Picea jezoensis var. hondoensis, Tsuga diversifolia, Abies veitchii, Larix leptolepis, Pinus parviflora Siebold et Zucc., Betula ermanii Cham., and Betula platyphylla Sukaczev var. japonica (Miq.) Hara were detected from horizons radiocarbon dated at 22,840 \pm 950 to 21,510 \pm 930 yBP (Sakai et al., 1979). In pollen assemblages, *Pinus*, *Picea*, *Abies*, and *Tsuga* were dominant both at the western foot of Mt. Yatsugatake (Iida, 1973) and Kisodaira (Sakai et al., 1979). Thus, coniferous forests similar to the present subalpine ones seem to have grown on drier areas in and around the Minami-Karuizawa basin, and *Picea* sect. *Picea–Pinus pumila* forests must have been restricted to wetter places within the sedimentary basin where such coniferous forests could not be established.

Coniferous forests of *Abies*, *Larix*, *Picea*, and *Tsuga* in the Minami-Karuizawa basin are physiognomically similar to contemporaneous buried forests in northern Japan consisting of *Picea*, *Larix*, and *Abies* (Kawamura & Kito, 2000; Noshiro & Suzuki, 1992; Noshiro et al, 1997, 2002; Suzuki, 1992), but the latter lacked *Tsuga*. Moreover, buried forests in northern Japan consisted of different species from those in central Japan: *Larix leptolepis* and *Abies veitchii* in central Japan and *Larix gmelinii* and *Abies sachalinensis* Mast. in northern Japan (Tsuji et al., 1984b; Suzuki, 1985, 1992; Nasu et al., 2002; review in Morita, 2000).

Coniferous forests seem to have dominated on the slopes down to the Maebashi area, 800 m below the Minami-Karuizawa basin in altitude, but dominant elements in the forests changed from *Picea* sect. *Picea*, *Larix*, *Abies*, and *Tsuga* in the Minami-Karuizawa basin to *Pinus koraiensis*, *Picea* sect. *Picea*, and *Larix* in the Maebashi area (Tsuji et al., 1985). The lower coniferous forest seems to have prevailed during the Tachikawa Period in the eastern and southern Kanto District (Tsuji et al., 1984c).

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また動物化石の本を紹介しているとお叱りを受けそうで あるが、『三葉虫の謎』から紹介する。著者は英国自然史 博物館の古生物学者で三葉虫の専門家である。著者が、少 年時代にその魅力に取りつかれ、一生をかけて研究してき た生物群を扱っているだけあって、三葉虫の多様化とその 研究史をみごとに描きだしている。また添えられている写 真や図もさすがに専門家が選んだだけあって、極度に多様 化した分類群の面白さを如実に示している。やや唐突に博 物館学的な話が入ってきたりして構成に緻密でないところ も見られるが、文学と音楽への造詣に裏付けられた挿話や 英国人独特のユーモアがこの本を魅力的にしている。

『生命 40 億年全史』はより大部なだけあって、より重厚 な内容である。本書は、自分の研究史の上に生命の全歴史 を重ね合わせるように記述されている。このため導入部で は、ケンブリッジ大学の学部学生のときのスッピツベルゲンへの調査行が詳細に描かれるなど、読者をやや戸惑わせる部分もあるが、これを覚悟して読みすすむとプレカンブリア紀以降の生物の歴史とそれを見いだしてきた古生物学の歴史が生き生きと描かれる。欧米の大博物館のキュレーターならではと思われる情景描写で、何億年も前の生物の生き様が語られる。

『The earth』はプレートテクトニクス理論にもとづいた 地球史とその解釈の歴史を描きだしている。筆者の専門外 のため慎重になったのか,前2著に比べて語り口が重く, 遊びも少ない。またナポリ湾やアルプス,ハワイ,ニューファ ウンドランド,英国といった世界各地の地史と地理に関す る記述が多く,世界地図を傍らに置いておかないと,取っ つきにくいであろう。 (能城修一)