Shuichi Noshiro* and Hisashi Fujine**: Holocene Fossil Woods of *Chionanthus retusus* Lindl. et Paxton from Southern Gifu Prefecture, Central Japan

能城修一*・藤根　久**：岐阜県南部から出土したヒトツバタゴの完新世の木材化石

Chionanthus retusus Lindl. et Paxton of Oleaceae is distributed widely from Japan to southern China, but in Japan it currently is restricted in two small areas: one in the bordering area of Gifu, Nagano, and Aichi Prefectures of central Japan (Ueda, 1989) and another around a small bay at the northern tip of Tsushima Island, western Japan. Ueda (1988) included this species as one specific phytogeographically to the Tokai Hilly Land Elements that typically grow in mires in the hills surrounding the Ise Bay. These elements include taxa not only endemic or nearly endemic to this area, such as *Magnolia tomentosa* Thunb. (Ueda, 1988), *Berberis sieboldii* Miq., *Drosera tokaiensis* (Komiya et Shibata) Nakamura et Ueda, *Acer pycnanthum* K. Koch, *Pedicularis resupinata* L. var. *microphylla* Honda, *Vaccinium sieboldii* Miq., *Veratrum staminerum* Maxim. var. *micranthum* Satake, and *Eriocaulon nudicspe* Maxim., but taxa with disjunct distribution such as *Drosera indica* L. f. *indica, Pyrus calleryana* Decne., *Chionanthus retusus, Utricularia minutissima* Vahl., and *Eulalia speciosa* (Debeaux) O. Kunze (Ueda, 1989).

Fossils of *Chionanthus* have been discovered sporadically, but continually in wide areas of Japan. The oldest record is a Cretaceous fossil wood from Chiba Prefecture (Suzuki & Nishida, 1974) and the second oldest is a report of Oligocene fossil leaves from the Kushiro coal field, east Hokkaido (Tanai, 1970). In the Quaternary period, fossil woods have been discovered from the Tsuzura-iri Formation of the middle Pleistocene at Tokorozawa, Saitama Prefecture (Noshiro & Suzuki, 1991) and fossil fruits and woods from the Nishiyagi Formation of the late Pleistocene at Akashi, Hyogo Prefecture (Momohara *et al.*, 1987; Noshiro & Suzuki, 1987). Thus *Chionanthus* seems to have existed in Japan continuously since Cretaceous or Oligocene period.

In the Holocene, however, no fossil woods or wooden artefacts of *Chionanthus* have been reported so far (Shimaji & Itoh, 1988; Itoh, 1990; Yamada, 1993). The discovery of *C. retusus* fossil woods (Fujine *et al.*, 1993) from the Nakahazama Site, Gifu Prefecture, is the first one for the Holocene period. This paper will record this discovery together with the anatomical description of the fossil woods and will discuss the palaeoenvironmental conditions of the *Chionanthus* forest.

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Locality and Stratigraphy

The Nakahazama Site is located at Aza Nakahazama, Tajima 4, Minokamo City, Gifu Prefecture, 35° 27′N, 137° 2′E. The site is on the lower terrace (L2′; Shikano, 1990) of the Kiso and Hida Rivers at 74 m in altitude. This site yielded artefacts and construction remains from the Middle Jomon to Edo Periods.

Fossil wood assemblages with *C. retusus* were found in the layer 6 of this site (Fujine *et al.*, 1993). This layer is about 50 cm thick and consists of brown peaty sands including numerous fossil woods ; it is conformably overlain by layer 5 consisting of black-brown silty sands with conspicuous facies changes. Layer 7 forms the bottom layer and consists of sandy gravel with flattened round gravel up to 40 cm in diameter. Many perpendicular roots ran from layer 5 through layer 6 down to layer 7, but were severed by layer 4 at the top. Layers 5 and 6 did not yield any archaeological remains. The radiocarbon date of layer 5 was 6390 ± 110 yr BP for black organic silty clay, and those of layer 6 were 9730 ± 160 yr BP for a fossil wood of *Zelkova serrata* and 6970 ± 110 yr BP for a fossil wood of *C. retusus*. Thus layers 5 and 6 are considered as deposits of the Earliest to Early Jomon Periods based on the radiocarbon dates (Keally & Muto, 1982). The deposition of peaty layers on a river terrace is considered to be the results of ample subsurface water during their deposition.

Description of fossil woods and comparison with the present one

Sample: A-XV-1 (Fig. 1), C-XVII-1, C-XIV-1

Wood ring-porous, with large pores in one layer at the beginning of growth rings and small latewood pores in a dendritic pattern. Earlywood pores 80-250 and 100-300 μm in tangential and radial diameters; solitary and round, slightly elongated radially, thick walled; earlywood ring of wide vessels often dissected by inclusion of small pores or vascular tracheids. Small pores round, mostly solitary, occasionally in clusters of two; aggregating and forming continuous tangential band outside the earlywood layer in wide growth rings, and dendritic or radial pattern in the rest of latewood; 25-60 and 20-70 μm in tangential and radial diameters. Vessel elements 140-260 μm long; perforations exclusively simple; spiral thickenings in narrow vessels. Vascular tracheids round in transverse section, 15-25 μm in diameter; filling gaps in layers of large earlywood pores and forming dendritic or radial pattern together with small pores; spiral thickening present. Fibers thick-walled, 10-20 μm in diameter; with distinctly bordered pits, ca. 3-4 μm in diameter, both in radial and tangential walls. Wood parenchyma terminal and scattered at the edges of dendritic or radial pattern of small pores and vascular tracheids. Rays usually homocellular, but with occasional upright or square marginal cells; 2-3(-4) cells wide, short fusiform in tangential section, up to 260 μm tall; vessel-ray pits half-bordered, dense, alternate, ca. 3 μm in diameter. Crystals not observed.

The above character combination generally is similar to the extant species, but the size of earlywood pores and ray height are more similar to Pleistocene fossil woods found at Akashi. Extant species have vessels less than 190 and 270 μm in tangential and radial diameters, but fossil woods of Akashi had vessels up to 250 and 320 μm in tangential and radial diameters (Noshiro & Suzuki, 1987). Earlywood pores are mostly less than 250 μm in radial diameter even among fossil woods of the present study and Akashi, but individuals with larger pores occurs frequently. This may be due to the scarcity of specimens of the extant species in Japan.

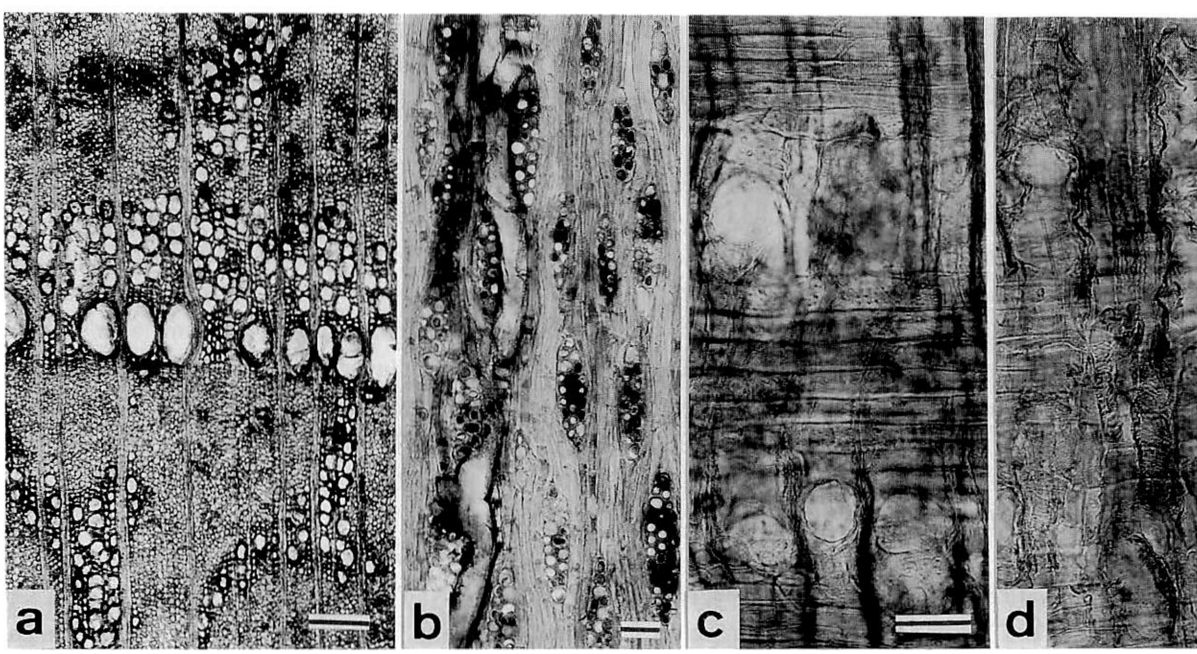

Fig. 1 Stemwood of *Chionanthus retusus* from the Nakahazama Site (A-XV-1)
a: transverse section x 40, ring-porous wood with one layer of large earlywood pores and small latewood pores in dendritic pattern. b: tangential section x 10, 2-3-seriate, short fusiform, homocellular rays. c: radial section x 200, simple perforations and dense alternate vessel-ray pits. d: radial section x 200, spiral thickenings in vascular tracheids. Scale bar=200 μm (a), 50 μm (b, c).

Table. 1 Fossil wood assemblage of the layer 6 of the Nakahazama Site

Taxon	No	%	%*
Cryptomeria japonica (L.f.) D.Don	2	2%	2%
Alnus sect. Gymnothyrsus (stemwood)	14	13%	16%
Alnus sect. Gymnothyrsus (rootwood)	22	20%	-
Quercus sect. Prinus	35	32%	41%
Quercus sect. Aegilops	4	4%	5%
Zelkova serrata (Thunb.) Makino	2	2%	2%
Wisteria floribunda	2	2%	2%
Acer (stemwood)	1	1%	1%
Hovenia	1	1%	1%
Styrax	3	3%	3%
Chionanthus retusus Lindl. et Paxt.	22	20%	26%
Total	108	(108)	(86)

* Percentages excluding rootwoods of Alnus sect. Gymnothyrsus

Composition of the fossil wood assemblage

Layer 6 yielded 108 fossil woods (Table 1). *Alnus* sect. *Gymnothyrsus* (stemwood plus rootwood) and *Quercus* sect. *Prinus* occupy one third of the assemblage respectively, and *C. retusus* 20%. The other taxa are all below 4% incidence and include *Cryptomeria japonica, Quercus* sect. *Aegilops, Zelkova serrata, Wisteria floribunda, Acer, Hovenia*, and *Styrax*. Except for *A.* sect. *Gymnothyrsus*, all the other specimens are stemwoods. Through layer 6, however, most rootwoods ran perpendicularly and can be taken to be an intrusion of a later period during the deposition of layer 5. If the rootwoods are excluded from calculation, *Q.* sect. *Prinus* is the most abundant (41%), and *C. retusus* (26%) is the second, followed by *A.* sect. *Gymnothyrsus* (16%). These figures indicate that *A.* sect. *Gymnothyrsus, Q.* sect. *Prinus* and *C. retusus* are dominant in the past forest at this site.

Comparison with the other palaeoenvironmental data and reconstruction of past vegetation

Diatom and pollen assemblages were studied (Fujine *et al*, 1993). In the diatom assemblages of layer 5, planktonic species such as *Melosira italica* and *M. ambigua*, and occasionally *M. distans*, occupy over 70%, and establishment of a pond supplied by ample spring water can be reconstructed during the deposition of this peaty sand layer. In pollen assemblages of this layer, arboreal pollen dominates with percentages over 80%. Among arboreal taxa, *Quercus* subgen. *Lepidobalanus* is 50-60%, and is followed by *Alnus* (10- 30%) and Taxaceae-Cephalotaxaceae-Cupressaceae (about 5 %). Water plants such as *Typha, Hydrilla verticellata, Aneilema, Brasenia, Nuphar,* and *Nymphaea* also occur in these assemblages. Pollen of *C. retusus* was not detected.

These results and the composition of the fossil wood assemblage indicate that there was a pond with a flow of spring water great enough to remove muddy particles, and that it was surrounded by a deciduous forest dominated by *Q.* sect. *Prinus* and *C. retusus*, and *A.* sect. *Gymnothyrsus*. The present typical habitat of the Tokai Hilly Land Elements is small peatless marsh supplied by numerous springs derived from silty layers intercalated in late Pliocene to Quaternary gravel layers (Ueda, 1989), and the deciduous forest reconstructed at this site may have grown on similar marsh around the pond.

The composition of Pleistocene fossil wood assemblages with *C. retusus* differs from the Nakahazama site. The Pleistocene fossil wood assemblage was dominated by *Fraxinus*, subfam. Maloideae of Rosaceae, and *Syringa reticulata* in the Tsuzurairi Formation at Tokorozawa, Saitama Prefecture (Noshiro & Suzuki, 1991), and *C. retusus* was dominant, followed by *Fraxinus* and subfam. Maloideae including *Sorbus, Prunus* and *Ligustrum* in the Nishiyagi Formation at Akashi, Hyogo Prefecture (Suzuki &

Noshiro, 1987). Thus these two Pleistocene assemblages are similar in composition to each other in the common existence of *C. retusus*, *Fraxinus* and subfam. Maloideae, but differ from the composition of the Nakahazama site in the obscure presence of *Q.* sect. *Prinus* and *A.* sect. *Gymnothyrsus*. The composition of present-day forests including *C. retusus* is not clearly studied due to the sporadic occurrence of extant individuals, but seems not to deviate greatly from that of the Nakahazama site in the coexistence of *A.* sect. *Gymnothyrsus*, and *Q.* sect. *Prinus* and sect. *Aegilops*.

Thus this discovery of *C. retusus* at the Nakahazama site shows that this species continued to exist during the Holocene period in the same area as the present one, probably in a similar habitat, and that the Holocene forest composition was similar to the present-day and differed from that of the Pleistocene assemblages.

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