鮮新統大阪層群から算出したカリア属(クルミ科)堅果化石

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journal or publication title	The journal of phytogeography and taxonomy
volume	37
number	2
page range	107-112
year	1989-12-25
URL	http://doi.org/10.24517/00055961

J. Phytogeogr. & Taxon.
37: 107-112, 1989

Arata MOMOHARA*: Pliocene *Carya* Nuts (Juglandaceae) from the Osaka Group, Southwest Japan

百原　新*：鮮新統大阪層群から産出したカリア属（クルミ科）堅果化石

Abstract

Carya striata nuts obtained from the lowermost part of the Osaka Group (Pliocene) at east of Wakagashi, Izumi City, Osaka, are described. This is probably the latest occurrence of *Carya* nuts in Japan. Plant macrofossil assemblage including the *Carya* nuts consists of 45 arboreal taxa and 29 herbaceous taxa, in which 13 extinct taxa are included. Prevalence of subtropical and warm temperate taxa indicates that a warm climate prevailed when *Carya* grew, and it is suggested that the habitat of the fossil *Carya* was probably similar to that of the modern species in China.

Key Words: *Carya striata*—Fossil nuts—Osaka Group—Plant macrofossil assemblage—Pliocene

Carya (Juglandaceae) includes about 20 species, of which four are native in China and Vietnam, and others in the eastern part of North America. They are tall, deciduous trees, and their fruits are round to oblong nuts surrounded by husk.

Fossil nuts have been found from the Pliocene and Miocene of Central and Southwest Japan (MIKI, 1955). MIKI (1941, 1955) described four species: *Carya leiocarpa*, *C. nanacarpa*, *C. striata*, and *C. ovatocarpa*. Most of the fossil nuts were collected from the Seto Porcelain Clay Formation (MIKI, 1941, 1955), which is regarded as the late Miocene (MAKINOUCHI, 1985). In the Kinki District, *Carya* nuts were reported from Kosoku, Nara Prefecture, by MIKI (1948). MIZUNO and MOMOHARA (in press) also found a *Carya* nut in this area and regarded those *Carya*-bearing horizons as the lowermost member of the

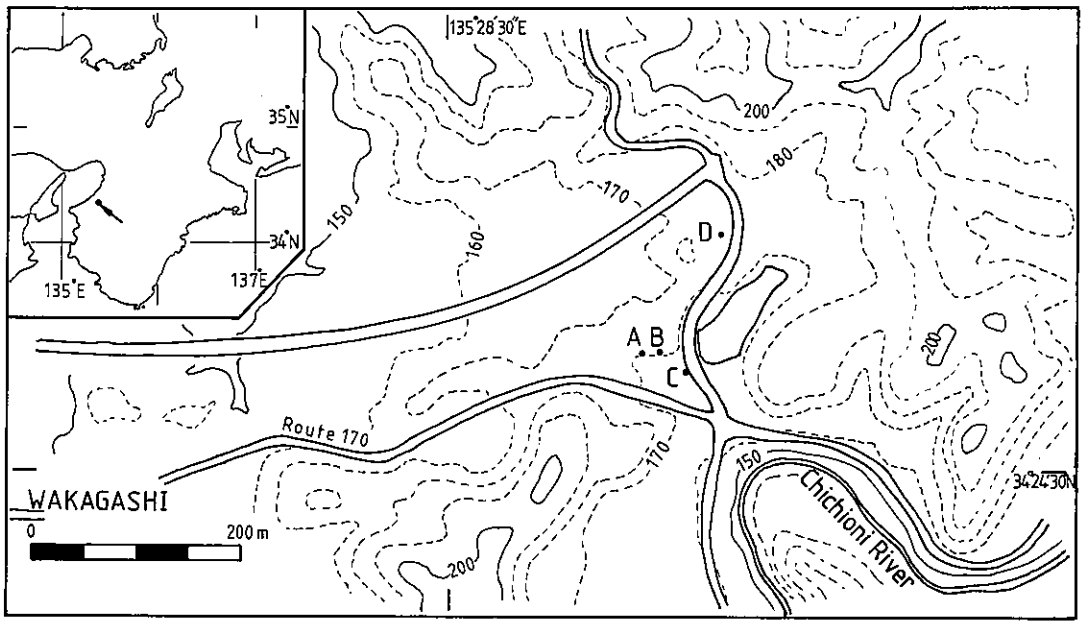

Fig. 1. Locality of the study site. A is the locality of the fossil assemblage. C is the point where the Osaka Group unconformably overlies the granite. D is the point where the reverse fault is observed.

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Shobudani Formation, Pliocene. Recently the author collected well-preserved *Carya* nuts from the lowermost part of the Osaka Group, Pliocene. This is the first record of this genus from the Osaka Group, and probably the latest occurrence of *Carya* in Japan. In this paper, the fossil *Carya* nuts and accompanied plant macrofossil assemblage at this site are described. The paleoclimate in which *Carya* grew is also discussed.

Stratigraphy and occurrence of fossils

The sampling site is east of Wakagashi, Izumi City, Osaka Prefecture (Fig. 1). In this area, the Osaka Group consists of gravel, which intercalates silt and peaty layers. The Osaka Group unconformably overlies the basement rock (granite) along the southern border (site C in Fig. 1). To the north of the sampling site (site D in Fig. 1), a reverse fault extends east-west. This fault is probably the Wakagashi Fault (ITIHARA *et al.*, 1986). Fossil *Carya* nuts and other fossils were found in a peaty mud layer at site A (Figs. 1 and 2). This horizon is 8 m above the basement granite. ITIHARA *et al.* (1986) correlated this peaty layer to the horizon of the Habutaki I tuff layer in the lowermost part of the Osaka Group, late Pliocene. The peaty layer is 30 cm thick, and laterally extends about 10 m. The matrix is massive silty mud with sand and granules. At site B, the peaty mud changes into silt without plant macrofossils (Fig. 2).

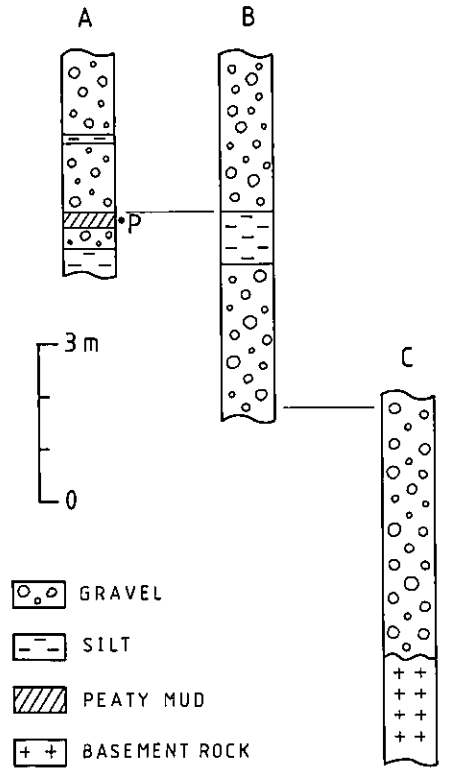


Fig. 2. Columnar sections at points A, B and C in Fig.1. P in section A is the horizon of the plant macrofossils, about 8 m above the basement rock in section C.

Method

Plant macrofossils were obtained by sieving sediments, and some large ones were collected at the outcrop. Sediments were macerated in water for a week, and washed through sieves of 2 mm, lmm, 0.5 mm, and 0.25 mm meshes. The residue was examined under a binocular microscope, and all identifiable fossil parts were picked up and counted. All specimens were preserved in 70% alcohol after applying MOMOHARA's specimen numbers (AM222-, 1-80), and have been stored at the Natural History Museum and Institute, Chiba.

Results

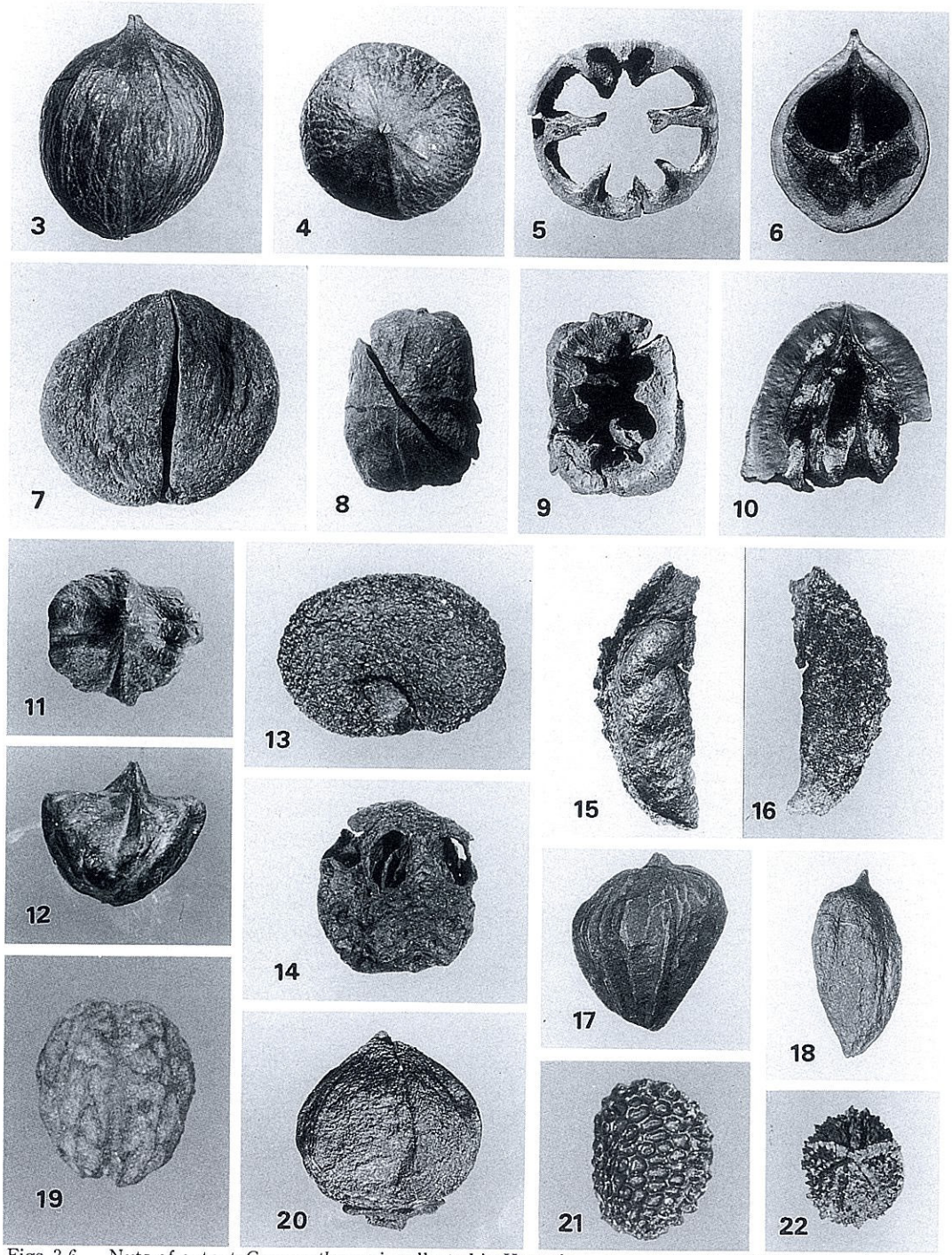
Description of fossil *Carya* nuts

Carya striata MIKI (Figs. 7-10). AM222-77-, 1, 2.

Carya cathayensis SARG. 1941, Jap. Jour. Bot. 11 : 264, Fig. 9-D ; Pl. 6-D. *Carya striata* MIKI 1955, Jour. Inst. Polytech. Osaka City Univ., Ser. D 6 : 132, Fig. 1-B, C ; Pl. 1-B, C.

Description. Nuts rounded to oblong, 24 mm long, 19-26 mm wide, with round apex and base ; outer surface finely striate with four distinct longitudinal ridges ; shell wall thick, about 3 mm thick in the middle part, without lacunae ; primary septum thin but well-developed ; secondary septum thin, developed only in the middle part ; inner ribs thick, well-developed, about 2.5 mm in height, without lacunae.

Remarks. These specimens are identified with *C. striata* because of their striated shell surface and absence of lacunae in the shell, while *C. leiocarpa* MIKI and *C. nanacarpa* MIKI have smooth shell surface, and *C. ovatocarpa* MIKI has lacunae in the upper part of the shell (MIKI, 1955). Although MIKI (1955) considered *C. nanacarpa* to



Figs. 3-6. Nuts of extant *Carya cathayensis* collected in Hangzhou, eastern China (KOKAWA, S. collection in Osaka City University). Lateral view (3) and apical view (4) of the same nut, cross section (5), and inner view (6). All×1.5. Figs. 7-10. Fossil nuts of *C. striata* from east of Wakagashi. Lateral view of AM222-77-1 (7), and apical view (8), cross section (9), and inner view (10) of AM222-77-2. All×1.5. Figs. 11-22. Other plant macrofossils from the study site. 11, 12: *Pterocarya* A, nut, apical (11) and lateral view (12), AM222-47-1, ×5. 13: *Schisandra megasperma*, seed, AM222-57-1, ×4. 14: *Choerospondias axillaris*, endocarp, AM222-63-1, ×3. 15, 16: *Reevesia* A, inner surface of the divided fruit (15) showing the cast of seed, and outer surface (16), AM222-79-1, ×2.5. 17, 18: *Melliodendron*, fruits, AM222-78-1, 2, ×1.5. 19: *Ehretia ovalifolia*, endocarp, AM222-5-1, ×10. 20: *Stewartia* cf. *monadelpha*, fruit, AM222-3-1, ×3. 21: *Actinidia* cf. *rufa*, seed, AM222-33-1, ×15. 22: *Styrax* cf. *rugosa*, seed, AM222-64-1, ×3.

Taxa	Fossil Parts	Habitat	Numbers
ARBORS			
• *Pterocarya A*	N		3
• *Carya striata* MIKI	N		1
Carpinus tschonoskii MAXIM.	N	WC	38
Carpinus cf. *japonica* BL.	N	WC	3
• *Fagus* cf. *microcarpa* MIKI	Cu		1
Quercus sect. *Cerris*	Cu		1
Quercus sect. *Prinus*	Cu		1
Quercus	N		1
Zelkova	F	WC	7
• *Hemiptelea mikii* MINAKI	F	WC	1
Morus	S		1
Broussonetia	E	W	1
• *Schisandra megasperma* MIKI	S		1
Rubus	E		4
Zanthoxylum ailanthoides SIEB. et ZUCC.	S	WC	1
Phyllanthus aff. *flexuosus* (SIEB. et ZUCC.) MUELL.-ARG.	S	WC	1
Choerospondias axillaris (ROXB.) BURTT et A.W.HILL	E	S	1
Buxus	L		7
Acer	F		2
• *Paliurus nipponicus* MIKI	F	S	1
Meliosma	E		1
Berchemia	E		1
• *Vitis labruscoidea* MIKI	S		1
Vitis A	S		1
Tilia	F		1
• *Reevesia A*	F	S	1
Actinidia cf. *rufa* (SIEB. et ZUCC.) PLANCH.	S	S	1
Actinidia A	S		1
Stewartia cf. *monadelpha* SIEB. et ZUCC.	F	C	4
	S		1
Lagerstroemia	F	S	1
Aralia elata (MIQ.) SEEM.	E	WC	1
Acanthopanax	E		1
Araliaceae	E		1
Cornus kousa BUERG. ex HANCE	E	WC	1
• *Cornus* aff. *mas* L.	E		1
cf. *Clethra*	S		1
Symplocos sect. *Palura*	E		1
Symplocos A	E		1
• *Styrax* cf. *microcarpa* MIKI	S		1
• *Styrax* cf. *rugosa* MIKI	S		1
Styrax A	S		1
• *Melliodendron*	F	S	1
Ehretia ovalifolia HASSK.	E	W	3
Callicarpa	E	-	22
Premna japonica MIQ.	F	S	1
Sambucus siedoldiana BL. ex GRAEBN.	E		1
HERBS			
• *Selaginella* A	Ms		10
Sparganium	F		3
Carex A	F		25
Carex B	F		3
Carex C	F		3
Carex D	F		1
Carex E	F		1
Cyperaceae A	F		18
Cyperaceae B	F		5
Cyperaceae C	F		1
Cyperaceae D	F		1
Aneilema keisak HASSK.	S	W	1
Fatoua villosa (THUNB.) NAKAI	S	W	5
Pellionia	F	W	9
Boehmeria	F		590
Urticaceae A	F		2
Polygonaceae	F		2
Stellaria cf. *diversiflora* MAXIM.	S	WC	1
Nuphar	S		1
Isopyrum trachyspermum MAXIM.	S	WC	1
Chrysosplenium	S		2
Potentilla A	F		14
Potentilla B	F		41
Oxalis	S		1
Euphorbia	S		3
Ampelopsis brevipedunculata (MAXIM.) TRAUTV.	S	WC	1
Viola	S		1
Ludwigia	S		1
Mosla cf. *punctulata* (J.F.GMELIN) NAKAI	F	WC	28

Table 1. Plant macrofossils obtained east of Wakagashi, Izumi City, Osaka. Extinct taxa are indicated with asterisks. Cu, cupule; E, endocarp; F, fruit; L, leaf; Ms, macrospore; N, nut; S, seed. S, subtropical; W, warm temperate; WC, warm temperate to cool temperate; C, cool temperate. Numbers are the counts per 1000 cm^3 sediment. Fossils collected at the outcrop are also counted as one.

be a synonym of the European fossil species, *C. ventricosa* UNGER, MANCHESTER (1987) properly regarded them as different species since *C. ventricosa* has prominent intrawall lacunae and minor development of the secondary septum. Among modern species, *C. cathayensis*, distributed in south China, bears nuts that are similar to the present fossils in the characters of striated shell surface (Figs. 3 and 4) and no lacunae in the shell (Fig. 5). But it is distinguishable from the fossils for its thinner shell wall: less than 1.5 mm (Fig. 5). Nuts of *C. striata* have been reported from the lowermost member of the Shobudani Formation, Pliocene (MIKI, 1948, 1955; MIZUNO and MOMOHARA, in press), and the Seto Porcelain Clay Formation, late Miocene (MIKI, 1941, 1955).

Plant macrofossil assemblage

From the peaty sediment which bears *Carya striata* nuts, 74 taxa were identified, including 45 arboreal taxa and 29 herbaceous taxa (Table 1). All arbors are broad-leaved trees. Among the 74 taxa, twelve arboreal taxa and one herbaceous taxa are extinct in Japan: *Pterocarya* A, *Carya striata*, *Fagus* cf. *microcarpa*, *Hemiptelea mikii*, *Schisandra megasperma*, *Paliurus nipponicus*, *Vitis labruscoidea*, *Reevesia* A, *Cornus* aff. *mas*, *Styrax* cf. *microcarpa*, *S.* cf. *rugosa*, *Melliodendron*, and *Selaginella* A.

Common taxa in the fossil assemblage are *Carpinus tschonoskii*, *Callicarpa*, *Selaginella* A, *Carex* A, Cyperaceae A, *Pellionia*, *Boehmeria*, *Potentilla* A, *P.* B, and *Mosla* cf. *punctulata*.

Habitats of the taxa are estimated based

on their present habitats and/or those of their close allies (Table 1). Subtropical taxa amount to seven, including *Choero-spondias axillaris*, *Paliurus nipponicus*, *Reevesia* A, *Actinidia* cf. *rufa*, *Lagerstroemia*, *Melliodendron*, and *Premna japonica*. Warm temperate taxa amount to five, including *Broussonetia*, *Ehretia ovalifolia*, *Aneilema keisak*, *Fatoua villosa*, and *Pellionia*. Warm temperate to cool temperate taxa amount to 12, including *Carpinus tschonoskii*, *C.* cf. *japonica*, *Phyllanthus* aff. *flexuosus*, *Cornus kousa*, *Stellaria* cf. *diversiflora*, *Isopyrum trachyspermum*, *Mosla* cf. *punctulata*, etc. There is only one cool temperate taxa, *Stewartia* cf. *monatemperate taxa*, *Stewartia* cf. *monadelpha*. Thus subtropical taxa and warm temperate taxa are common, while cool temperate taxa are rare in this assemblage.

Discussion

The records of *Carya* from the Pliocene in Japan are rather rare. MIKI (1955) described *C. leiocarpa* from the "marine bed" in Hanasaki, Toyama Prefecture, *C. nanacarpa* from Mori, Ehime Prefecture, and *C. striata* from Kosoku, Nara Prefecture. However, those horizons have not been correlated stratigraphically in detail. The horizon of this paper was correlated with the Habutaki I tuff layer of the lowermost part of the Osaka Group (late Pliocene) by ITIHARA *et al.* (1986), and it can be regarded as the latest horizon of *Carya* in Japan.

Subtropical taxa such as *Actinidia* cf. *rufa* and *Premna japonica* are now distributed along the coast in southwestern Japan, and *Reevesia*, *Melliodendron* and *Choerospondias* are in the subtropical regions of south China. They require a warm and mild winter climate. Therefore, the prevalence of those subtropical and warm temperate taxa in the fossil assemblage may indicates that a warm climate prevailed when *Carya* grew.

Fossil records from the other localities in Japan also indicate that *Carya* grew under a warm and mild climate. The Miocene and Pliocene fossil *Carya* species are generally accompanied by subtropical and warm temperate taxa. For example, plant macrofossil assemblages in the Seto Porcelain Clay Formation including many *Carya* nuts are rich in subtropical and warm temperate taxa, such as *Keteleeria*, *Cycloba-lanopsis*, *Fortunearia sinensis*, *Choerospondias axillaris*, and *Paliurus* (MIKI, 1941, 1963).

Modern *Carya* species in China are distributed in the lower altitudes of the mixed mesophytic forests with subtropical and warm temperate taxa, such as *Cyclobalanopsis*, *Cinnamomum*, *Paliurus*, *Choerospondias*, *Schima*, etc. (WANG, 1961). This will suggest that fossil *Carya* species grew under conditions similar to that of the modern species in China.

I am grateful to Prof. S. KOKAWA of Osaka City University for his instruction and for lending me extant *Carya* specimens; to Mr. M. HICHINO of Katsuragi Junior High School, Kishiwada, who found the study site and fossil specimens; and to Prof. M. ITIHARA and Dr. S. TSUJI of Osaka City University., Mr. K. MIZUNO of the Geological Survey of Japan, and Dr. M. MINAKI of the University of Marketing and Distribution Sciences for their valuable suggestions.

References

ITIHARA, M., ICHIKAWA, K., and YAMADA, N. 1986. Geology of the Kishiwada District, with geological sheet map at 1: 50,000. 148pp. Geol. Surv. Japan (in Japanese).

MAKINOUCHI, T. 1985. Some problems in the generation stage of the "Second Setouchi Sedimentary Province", with special reference to the sedimentary basin of Lake Tokai. *In*: The association for the geological collaboration in Japan (Ed.), Monograph 29: Characteristics of the Setouchi Geologic Province, Southwest Japan, 53-64 (in Japanese).

MANCHESTER, S. R. 1987. The fossil history of the Juglandaceae. Monogr. Syst. Bot. Missouri Bot. Garden 21. 137pp. Allen Press, Kansas.

MIKI, S. 1941. On the change of flora in Eastern Asia since Tertiary Period (1). The clay or lignite beds flora in Japan with special reference to the *Pinus trifolia* beds in Central Hondo. Jap. Jour. Bot. **11**: 237-303.

——. 1948. Floral remains in Kinki and adjacent districts since the Pliocene with description of 8 new species. Kobutsu To Chishitsu 2: 105-144 (in Japanese).

——. 1955. Nut remains of Juglandaceae in Japan. Inst. Polytech. Osaka City Univ. Ser. D

6 : 131-144, pls. 1-3.
——. 1963. Further study of plant remains in *Pinus trifolia* beds, Central Hondo, Japan. Kobutsu To Chishitsu, Special no. 31-th founding anniversary : 80-93 (in Japanese).
MIZUNO, K. and MOMOHARA, A. (in press). Shobudani Formation and terrace and alluvial deposits. *In* : ITIHARA, M (Ed.) : Osaka Group, Sogen-sya, Osaka (in Japanese).
WANG, C. W. 1961. The forests of China, with a survey of grassland and desert vegetation. 313pp. Harvard Univ. Press.

摘　要

大阪府和泉市若樫東方の大阪層群最下部(鮮新統)から，カリア属堅果化石を発見した。これは層位が確かなものではいちばん時代の新しいカリア属の産出例である。この堅果は表面に細かい溝があり，果壁に空隙がないことから *Carya striata* MIKI に同定した。*C. striata* を産出する層準の大型植物化石群集は，木本45分類群，草木29分類群から構成され，このうち13分類群は消滅種である。その構成をみるとチャンチンモドキ，チャセンギリ属，セツリミアサガラ属，チシャノキなど，亜熱帯や暖温帯に分布する分類群が多く，冷温帯に分布する分類群は少ないことから温暖な古気候が復元された。日本での他の地点の産出例も合わせて考えると，カリア属は中新世から鮮新世には温暖な気候下で生育していたと考えられ，これは中国の現生種の生育環境と類似している。

(Received May 16, 1989)

○　大場秀章　**秘境崑崙を行く—極限の植物を求めて—**　岩波書店，1989年6月20日発行。岩波新書，194頁，490円。

今年6月の天安門事件で水を差されたとはいえ，近年の日中共同の植物調査にはめざましいものがある。その中で，本書は著者が1988年に多数の中国人科学者からなるカラコルム・崑崙（こんろん，くんるん）総合科学考察隊の唯一の外国人隊員として参加した時の記録である。

著者はこれまでネパール，インドヒマラヤや中国の雲南地方へ何度も植物調査に行っており，ヒマラヤ山脈を中心とした地域の高山植物について強く興味を持ち，研究を続けてきている。今度の崑崙山脈はチベットとタクラマカン砂漠にはさまれた乾燥地帯のまっただ中の高山であり，ヒマラヤの高山帯や高山植物との比較が随所でなされていて興味深い。ただ，充分承知して行ったとはいえ，植生の余りの貧弱さに参っている様子が，植物がときたま見られたときの喜びの深さとなって行間に滲んでいる。近年の学術調査は各種技術の進歩や調査地域の開化にともない以前より安全となって，「学術探検」という感じは殆ど失われてきたが，この調査隊はまだまだ探検に値する地域があることを教えてくれる。氷河の午後の洪水であわやの目にあったことや，広大な砂漠を山を目指してひたすら走り続けるジープ，砂漠の中に忽然と湧き出す泉，ウイグル族の風習，シルクロードを彷彿とさせる市場など，自分もぜひ行ってみたい，という気になってしまう。

著者が「わが国では崑崙の名は広く知られているが，崑崙山脈そのものについての実際の知見は乏しい」と書いているように，我々，温帯の湿潤地帯にすんでいるものにとっては植物や植生についてのイメージを喚起することはほとんど出来ない。その意味で著者の目を借りて崑崙の植物に触れることが出来る本書ははるか離れたかの地への夢を誘うものである。ただ残念なことは岩波新書としてどうしようもないことだが本文中に出てくる風景や植物がカラー写真でみれたらとつい思ってしまう。それは著者の研究の成果とともに別なかたちでお目にかかれることを期待してやまない。　（鈴木三男）

○　**表紙写真の説明：刀装に用いられた牡丹の彫金**

中国で，花の王と言えば牡丹で，その栽培が盛となったのは，唐の玄宗皇帝の時代と言われるが，当時遣唐使として入唐した人々により，わが国に持ち帰られたという証拠は無い。

降って平安時代には，栽培されたようで，時の権力の座に着いた藤原氏一族の近衛・九條・鷹司家は，紋章に使用し，天皇家の菊紋とともに権威のあるものであった。したがって，絵画・彫刻の題材として，しばしば用いられているが，中でも狩野山楽筆，京都大覚寺の障屏画（重文）や日光東照宮本殿（国宝）ならびに陽明門（国宝）の彫刻は，はなやかであり，夙に知られている。

写真は，戦災から免れ，わずかながら残った拙宅の道具の中にあったもので，刀の外装に用いられた金具(上は縁頭，下は栗形）で，銀に牡丹を彫ってある。（里見信生，本多郁夫氏撮影）