Distribution and isotopic composition of *n*-alkanes from grass, reed and tree leaves along a latitudinal gradient in China

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Molecular composition and compound-specific carbon and hydrogen stable isotope ratios of *n*-alkanes are presented for leaves of grass, reeds and trees from five regions extending between latitudes 22° and 39°, China. The distribution of *n*-alkanes ranges from C_{15} to C_{35} with a high odd over even predominance and carbon-number maxima at C_{27}, C_{29} or C_{31}. The carbon preference index (CPI) values are from 3.49 to 17.25, with mean values increasing following tree leaf > reed > grass. The average chain length (ACL) values are between 26.24 and 30.26 and the mean values increase following grass > reed > tree leaf. It is observed that C_{max}, CPI and ACL values of *n*-alkanes in plants from low latitudes are higher than those from high latitudes. The $\delta^{13}C$ values of C_{27} and C_{29} *n*-alkanes in plants range from –25.3 to –35.5‰ and the grass has a lighter mean carbon isotopic composition than the reed and tree leaf. The δD values of C_{27} and C_{29} *n*-alkanes in the plants are between –132.1 and –192.6‰ and the mean hydrogen isotopic compositions of C_{27} and C_{29} *n*-alkanes in the grass are lighter than those in the reed and tree leaves. C_{27} and C_{29} *n*-alkanes in the grass and tree leaves from high-latitude and elevation area have relatively lighter hydrogen isotopic composition, indicating that these δD values can be used as excellent indicators of environment and climate.

Keywords: plant, *n*-alkanes, carbon isotopes, hydrogen isotopes, China

INTRODUCTION

Long-chain *n*-alkanes are mostly derived from epicuticular waxes of vascular higher plant leaves (Eglinton and Hamilton, 1967; Rieley *et al*., 1991a, 1993). Being resistant to biodegradation during burial, they exist almost everywhere in soils, sediments, atmospheric dust and fossil fuels. Composition of long-chain *n*-alkanes is affected by sources (plants), environments of formation and organic matter diagenesis (Poynter *et al*., 1989; Poynter and Eglinton, 1990; Simoneit *et al*., 1991; Chikaraishi and Naraoka, 2007). Therefore, some indexes of long-chain *n*-alkanes, such as carbon number maximum (C_{max}), *n*-alkane average chain length (ACL) and carbon preference index (CPI) (Cranwell, 1973; Cranwell *et al*., 1987; Simoneit *et al*., 1991; Duan, 2000; Duan and Ma 2001; Rommerskirchen *et al*., 2003), are used as indicators of the source and evolution of organic matter (e.g., Cranwell, 1973; Meyers, 2003; Pancost and Boot, 2004; Duan *et al*., 1998), and palaeoenvironments (e.g., Pancost and Boot, 2004; Collister *et al*., 1993; Ohkouchi *et al*., 1997; Simoneit *et al*., 1991).

Carbon and hydrogen isotopic ratios of individual *n*-alkanes (Freeman *et al*., 1990; Hayes *et al*., 1990; Sessions *et al*., 2001) are becoming increasingly popular for tracing organic sources (Rieley *et al*., 1991b; Lichtfouse *et al*., 1994; Duan *et al*., 1996; Freeman and Colarusso, 2001; Duan and Wang, 2002; Dahl *et al*., 2005; Huang *et al*., 2006; Chikaraishi and Naraoka, 2006) and paleoenviroments of formation (Xie *et al*., 2000; Huang *et al*., 2002; Sachse *et al*., 2004; Smith and Freeman, 2006; Sachse *et al*., 2006; Sessions, 2006). Most studies showed C and H isotopic variations between C_3 and C_4 plant groups (Collister *et al*., 1994; Chikaraishi *et al*., 2004; Bi *et al*., 2005; Smith and Freeman, 2006) and within C_3 higher plants (Chikaraishi *et al*., 2004; Pedentchouk *et al*., 2008). Carbon and hydrogen isotopic ratios of long-chain *n*-alkanes in plants are controlled by isotopic fractionation during photosynthesis (Hayes, 1993; Sessions *et al*., 1999; Chikaraishi *et al*., 2004). At the same time, hydrogen isotopic compositions of long-chain *n*-alkanes in plants primarily reflect the isotopic composition of precipitation and the D-enrichment of the source water is caused by transpiration and soil evaporation (Smith and Freeman, 2006; Sachse *et al*., 2006; Chikaraishi and Naraoka, 2007). However, the relationship between carbon and hydrogen isotopic compositions of *n*-alkanes in plants and environmental factors such as

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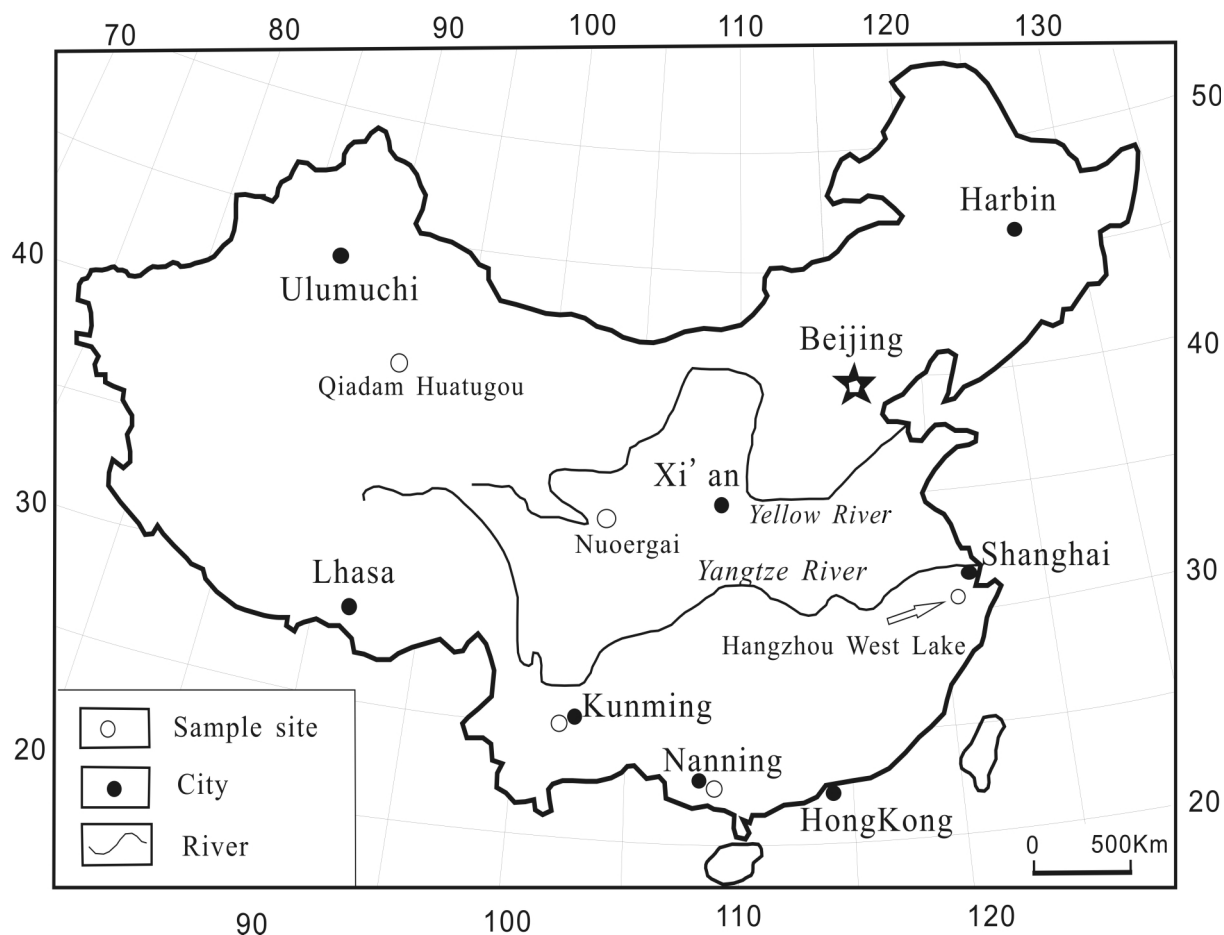
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Fig. 1. Sampling sites. Site location information is given in Table 1.

latitude and temperature is poorly known (Smith and Freeman, 2006; Sachse *et al.*, 2006). We present here the composition of *n*-alkanes and their C and H isotopic composition in grass, tree leaves and reed from five regions of China selected along a latitude gradient from 22° to 39°.

SAMPLES AND ANALYTICAL METHODS

Living terrestrial higher plants including grass, reed and tree leaves were collected in spring and autumn of 2001–2005 from salt marshes at Huatugou, Qaidam basin; the Ruoergai grassland, Sichuan; the banks of the Xihu Lake (West Lake), Hangzhou; the bank of the Dianchi Lake, Yunnan; and Nanning in Guangxi (Fig. 1 and Table 1).

Immediately after collection, non-indigenous material in leaves was removed and the leaves were washed repeatedly with tap water and then rinsed with distilled water. All samples were dried at room temperature and crushed to fine powder. Powders were kept frozen until analysis. Powdered samples were extracted in a Soxhlet apparatus with a mixture of dichloromethane-methanol (2:1, v/v). The extracts were filtered and evaporated, and then fractionated with a column chromatography on alumina over silica gel (Duan *et al.*, 2004, 2005). Saturated hydrocarbons, aromatic hydrocarbons, ketones and alcohol fractions were separated using successive elution with *n*-hexane, dichloromethane, 10% ethyl acetate in *n*-hexane and 20% ethyl acetate in *n*-hexane, respectively.

In saturated hydrocarbons, *n*-alkanes were identified with a 6890N GC/5973N mass spectrometer (GC-MS) equipped with a HP-5 capillary column (30 m × 0.32 mm i.d., 0.25 μm film thickness) and helium as carrier gas. The GC oven temperatures were programmed from 80 to 300°C at 4°C min^{-1}, and then maintained at this temperature for 30 min. MS conditions were EI ionization at 70 eV with an ion source temperature at 250°C. The GC-MS system was operated in the full scan mode and scanned from *m/z* 20 to *m/z* 750.

Analyses of carbon and hydrogen isotopes of individual *n*-alkanes were performed by gas chromatography-combustion-isotope ratio mass spectrometry using a

Table 1. Basic parameters for the studied samples

Sample number	Region	Latin name	Plant type	Latitude	Longitude	Elevation (m)	Mean annual temperature (°C)	Mean annual rainfall (mm)	δD of mean annual precipitation*
CPL	Huatugou	*Phragmites australis* (Cav.) Trin. ex Steud.	Reed	38°32′ N	91°30′ E	3000	7.1	200	−83
RP-1	Ruoergai	*K. Tibetica*	Grass	33°27′ N	102°10′ E	3300	1.1	710	−83
RP-4	Ruoergai	*Salix* sp.	Tree leaf	33°27′ N	102°10′ E	3300	1.1	710	−83
SP-1	Xihu Lake	*Salix L.*	Tree leaf	30°16′ N	120°12′ E	77	17.8	1046.5	−42
KP-1	Dianchi	*Phragmites australis* (Cav.) Trin. ex Steud.	Reed	25°03′ N	102°42′ E	1891	15	985	−67
KP-2	Dianchi	*Salix L.*	Tree leaf	25°03′ N	102°42′ E	1891	15	985	−67
KP-3	Dianchi	*Poa L.*	Grass	25°03′ N	102°42′ E	1891	15	985	−67
GP-1	Nanning	*Phragmites australis* (Cav.) Trin. ex Steud.	Reed	22°47′ N	108°21′ E	500	21.6	1323.6	−44
GP-2	Nanning	*Cinnamomum* Trew.	Tree leaf	22°47′ N	108°21′ E	500	21.6	1323.6	−44
GP-3	Nanning	*Elymus L.*	Grass	22°47′ N	108°21′ E	500	21.6	1323.6	−44

δD (‰ relative to SMOW) of mean annual precipitation are taken from the OIPC.

Finnigan Delta plus XP mass spectrometer interfaced to a Thermo Finnigan GC Combustion III interface (for $\delta^{13}C$) and a high-temperature conversion system (for δD) (Tuo *et al.*, 2006). The combustion was performed in a micro-volume ceramic tube with CuO, NiO and Pt wires at 850°C. Pyrolysis was performed in a micro-volume ceramic tube with graphite at 1450°C. Individual *n*-alkanes were separated using a SE-54 fused silica capillary column (60 m × 0.32 mm i.d., 0.25 μm film thickness) and helium as carrier gas with a flow rate of 1 ml/min. The GC oven temperature was isothermal for 5 min at 80°C and then programmed from 80 to 300°C at 3°C/min. $\delta^{13}C$ and δD values are expressed relative to the PDB and V-SMOW, respectively. The reproducibility and accuracy of the analysis were evaluated routinely using laboratory standards of known δD and $\delta^{13}C$ values (C_{18}, C_{23}, C_{28}, C_{32} *n*-alkanes). Samples were analyzed once to three times. For most of the *n*-alkanes, the standard deviation of carbon and hydrogen isotope analyses was better than 0.5‰ and 5‰, respectively.

Additionally, the online isotopes in precipitation calculator (OIPC), accessible at http://www.waterisotopes.org, were used for this study (Table 1), which relies on the IAEA (2001) meteoric water database. The mean hydrogen isotope fractionation ($\varepsilon_{w/a}$) between the environmental water δD values from OIPC and the mean *n*-alkane δD values of all plants was calculated following:

$$\varepsilon_{w/a} = 1000[(\delta D_{n\text{-alkane}} + 1000)/(\delta D_{water} + 1000) - 1]. \quad (1)$$

The $\varepsilon_{w/a}$ values are presented in Table 2.

RESULTS AND DISCUSSION

Compositions of n-alkanes in plants

Compositions of *n*-alkanes are reported in Table 2 and Fig. 2. The distribution of *n*-alkanes is in the range of C_{15}–C_{35} with high odd over even predominance and carbon-number maxima (C_{max}) at C_{27}, C_{29} or C_{31}. The C_{max} distribution is at C_{29} or C_{31} for the grass, C_{27}, C_{29} or C_{31} for the reed and C_{27} or C_{29} for the tree leaves. This is in some sort inconsistent with C_{max} at C_{31} for herbaceous plant and C_{27} or C_{29} for woody plant, as previously reported (Cranwell, 1973; Cranwell *et al.*, 1987). In this study, it is found that the same type plant from low latitudes has higher carbon-number maxima than those from high latitudes, as shown in Table 2. One possible explanation is that plants at low latitudes have a longer growth period and more potential incoming radiation that protect their leaves with longer chain *n*-alkanes from water loss.

The $(C_{27} + C_{29})/\Sigma(C_{23} + \cdots + C_{33})$ ratio has been proposed as proxy of the defoliation plant contribution

Table 2. Parameters and isotopic values of n-alkanes in the studied samples

Sample number	CPL	RP-1	RP-4	SP-1	KP-1	KP-2	KP-3	GP-1	GP-2	GP-3
Plant type	Reed	Grass	Tree leaf	Tree leaf	Reed	Tree leaf	Grass	Reed	Tree leaf	Grass
Region	Huatugou	Ruoergai	Ruoergai	Xihu Lake	Dianchi	Dianchi	Dianchi	Nanning	Nanning	Nanning
Range of carbon number	C_{16}–C_{31}	C_{15}–C_{31}	C_{15}–C_{29}	C_{17}–C_{31}	C_{17}–C_{31}	C_{21}–C_{29}	C_{21}–C_{35}	C_{19}–C_{35}	C_{25}–C_{33}	C_{18}–C_{33}
C_{max}	C_{27}	C_{29}	C_{27}	C_{27}	C_{29}	C_{27}	C_{31}	C_{31}	C_{29}	C_{31}
$C_{31}/(C_{27} + C_{29} + C_{31})$	0.03	0.29	0.00	0.01	0.02	0.00	0.46	0.55	0.46	0.54
CPI	4.55	9.27	6.43	10.69	14.98	18.70	12.76	14.00	17.25	3.49
ACL	26.91	28.88	26.24	27.06	27.83	26.47	29.69	30.35	30.26	29.79
$C_{27}\ \delta^{13}C$ (‰)	–31.8	—35.5	—27.2	–32.2	–35.3	–29.2	–31.9	–27.3	–33.6	–34.5
$C_{29}\ \delta^{13}C$ (‰)	–34.4	—33.8	—31.2	–33.3	–34.2	–30.4	–30.5	–25.3	–33.4	–33.5
$C_{31}\ \delta^{13}C$ (‰)	NA	–34.6	NA	–36.9	NA	NA	–27.3	–25.2	–34.7	–33.0
$C_{27}\ \delta D$ (‰)	–142.6	–186.0	–185.7	–147.6	–157.8	–154.2	–189.0	–163.6	–149.9	–174.7
$C_{29}\ \delta D$ (‰)	–155.5	–192.6	–142.0	–134.0	–152.1	–145.4	–173.2	–145.9	–132.1	–183.5
$C_{31}\ \delta D$ (‰)	–136.9	–188.2	NA	NA	NA	NA	–172.4	–131.6	–126.6	–201.6
$\varepsilon_{w/a}\ C_{27}$ (‰)	–65.0	–113.0	–112.0	–110.2	–97.3	–93.5	–130.8	–125.1	–110.8	–136.7
$\varepsilon_{w/a}\ C_{29}$ (‰)	–79.1	–119.5	–64.3	–96.0	–91.2	–84.0	–113.8	–106.6	–92.2	–145.9
$\varepsilon_{w/a}\ C_{31}$ (‰)	–58.8	–114.7	NA	NA	NA	NA	–113.0	–91.6	–86.4	–164.9

$CPI = [(C_{25} + C_{27} + \cdots + C_{33})/(C_{24} + C_{26} + \cdots + C_{32}) + (C_{25} + C_{27} + \cdots + C_{33})/(C_{26} + C_{28} + \cdots + C_{34})]/2.$
$ACL = [25(nC_{25}) + 27(nC_{27}) + 29(nC_{29}) + 31(nC_{31}) + 33(nC_{33})]/(nC_{25} + nC_{27} + nC_{29} + nC_{31} + nC_{33}).$
NA = not analyzed; $\varepsilon_{w/a} = 1000 \times [(\delta D_a + 1000)/(\delta D_w + 1000) – 1].$

(Hanisch *et al.*, 2003). The other proxies are the ratios of the C_{31}/C_{29} (Schwark *et al.*, 2002), $C_{31}/(C_{29} + C_{31})$ (Schefuss *et al.*, 2003) and $C_{31}/(C_{27} + C_{29} + C_{31})$ (Zhang *et al.*, 2008). These ratios reflect the relative proportion of waxy hydrocarbons derived from herbaceous plants to woody plants. We calculated the ratio of the C_{31} *n*-alkane to $(C_{27} + C_{29} + C_{31})$ *n*-alkanes in the studied plant samples (Table 2). This value is from 0.29 to 0.54 for grass, from 0.03 to 0.55 for reed and from 0 to 0.46 for tree leaves.

Land higher plants generally contain *n*-alkanes with 25–31 carbon atoms with a strong odd over even carbon number predominance (expressed as the CPI) (Rieley *et al.*, 1991a; Collister *et al.*, 1994, Duan and Ma, 2001). Therefore, the *n*-alkane CPI in sediment is an indicator of the sources of organic matter (Volkman *et al.*, 1983; Simoneit *et al.*, 1991; Duan, 2000). The CPI values of C_{25}–C_{33} *n*-alkanes in the samples range from 3.49 to 12.76 for grass, 4.55 to 14.98 for reed and 6.43 to 17.25 for tree leaves (Table 2). The average CPI is 8.51 for grass, 11.17 for reed and 13.27 for tree leaves. On the other hand, the CPI values seem to be related to latitude. For instance, with the exception of sample GP-3, the CPI values in the plants from the low-latitude Dianchi and Nanning regions (12.76 to 18.70) are higher than CPI values in plants from high-latitude Huatugou, Ruoergai and Xihu Lake regions (4.55 to 10.69; Table 2 and Fig. 3). These results show that plants growing at low latitudes synthesize *n*-alkanes with higher CPI value and carbon-number maxima.

Previous studies have shown that vegetation types and environmental factors mainly control the higher plant *n*-

alkane average chain length (ACL) (Cranwell, 1973; Cranwell *et al.*, 1987; Schwark *et al.*, 2002; Huang *et al.*, 2000; Rommerskirchen *et al.*, 2003). The ACL values of our study in three type plants from different latitudes further support this observation. The ACL values range from 28.88 to 29.79 for grass, 26.91 to 30.35 for reed and 26.24 to 30.26 for tree leaves. The average ACL is 29.5 for grass, 28.4 for reed and 27.9 for tree leaf, exhibiting a trend as grass > reed > tree leaf. This shows an effect of C_3 vegetation type on the ACL value. The ACL values within the same type plants decrease with increasing latitude from South to North (Fig. 4). This phenomenon was also observed by Sachse *et al.* (2006) and considered to result from environmental factors. In this study, a change of ACL units per 1° latitude was found to be 0.08 for grass, 0.22 for reed and 0.36 for tree leaf (Table 3).

Carbon and hydrogen isotopic compositions of n-alkanes in the plants

Because of different carbon fixation pathway, the difference in *n*-alkane $\delta^{13}C$ between C_3 and C_4 plants is obvious. In general, C_3 plants are more enriched in ^{12}C than C_4 (Rieley *et al.*, 1991b, 1993; Collister *et al.*, 1994; Chikaraishi *et al.*, 2004; Duan *et al.*, 1996, 2004). In addition, a considerable different $\delta^{13}C$ value is also recognized among different C_3 higher plants (Chikaraishi *et al.*, 2004; Duan *et al.*, 2005). Therefore, plant type can be identified by compound-specific $\delta^{13}C$ values. C_{27} and C_{29} *n*-alkanes were found in every studied plant and they are also the most abundant, while C_{31} *n*-alkanes are only present in some studied plants due to their relatively low
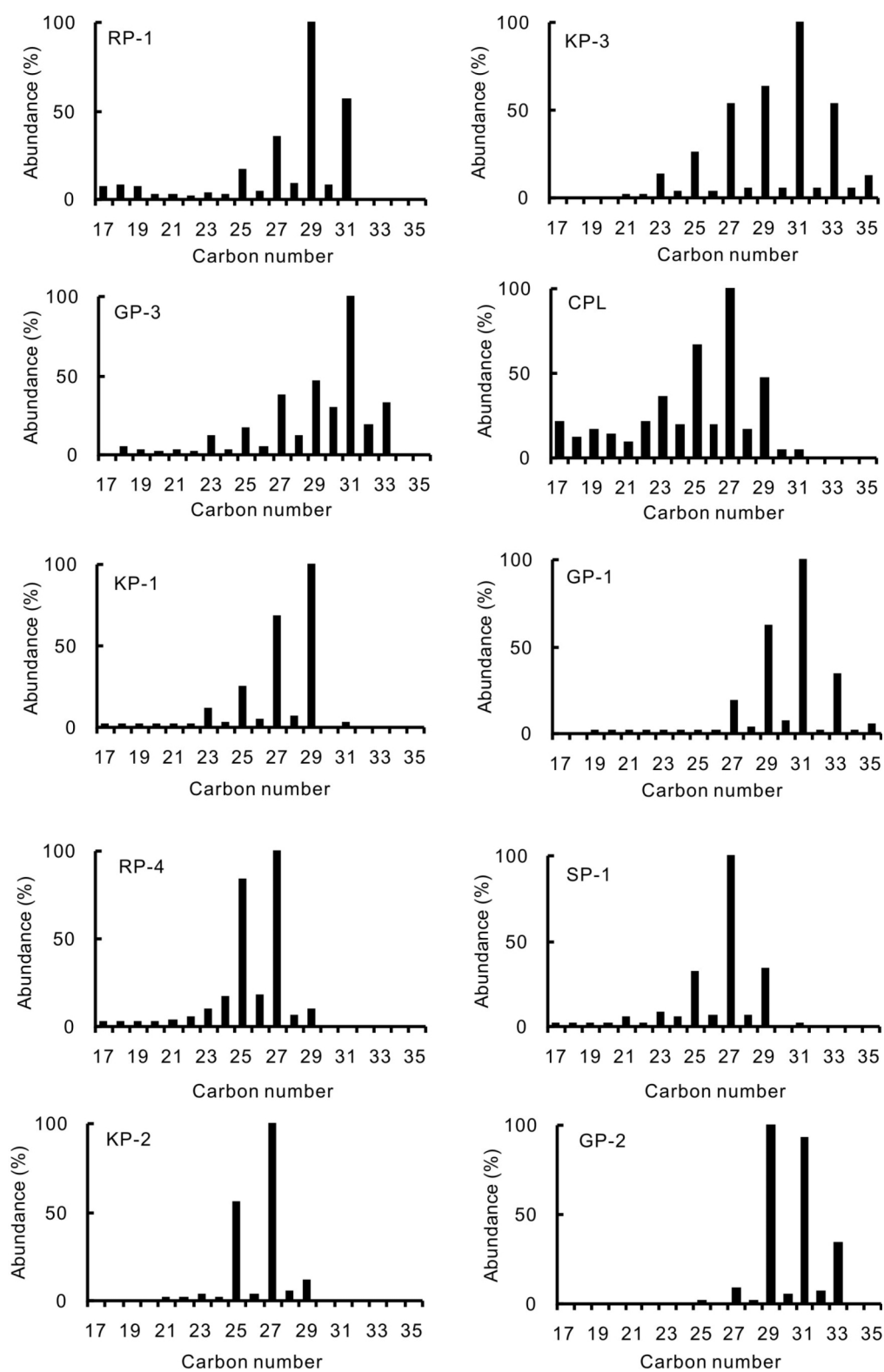
Fig. 2. Histograms of the molecular distributions of n-alkanes in the studied samples.

Plant types	Grass	Reed	Tree leaf
Mean CPI	8.51	11.17	13.27
Mean ACL	29.5	28.4	27.5
a change of ACL units for crossing 1° latitude	0.08	0.22	0.36
Mean C_{27} $\delta^{13}C$ (‰)	−34.0	−31.5	−30.6
Mean C_{29} $\delta^{13}C$ (‰)	−32.5	−31.3	−32.1
Mean C_{27} δD (‰)	−182.6	−154.7	−159.4
Mean C_{29} δD (‰)	−183.1	−151.2	−138.4
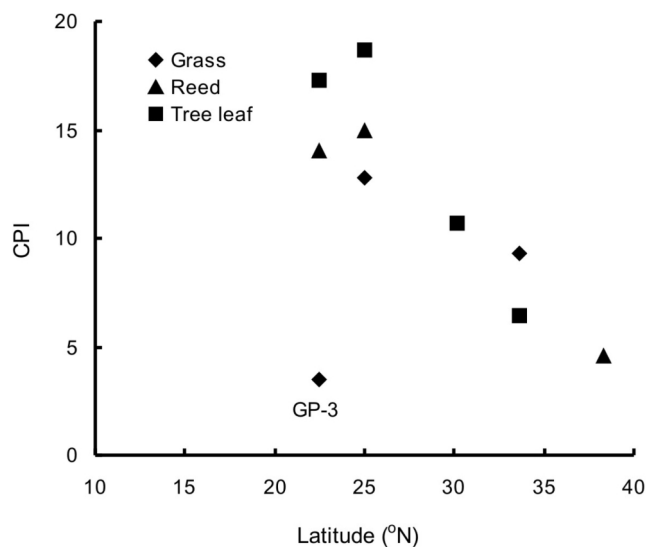
Fig. 3. CPI values of n-alkanes in the studied samples vs. latitude.

Fig. 4. ACL values of n-alkanes in the studied samples vs. latitude.

content. Here, we report carbon and hydrogen isotopic composition of the studied C_{27}, C_{29} and C_{31} n-alkanes. $\delta^{13}C$ values of C_{27} n-alkane in grass, reed and tree leaf samples range from −31.9 to −35.5‰, from −27.3 to −35.3‰ and from −27.2 to −33.6‰, respectively (Table 2). Their mean values are −34.0‰, −31.5‰ and −30.6‰ (Table 3), showing that grass has a lighter mean carbon isotopic composition than reeds and tree leaves. A similar difference in the $\delta^{13}C$ value for C_{29} n-alkane is also existent in the three types of plants. The $\delta^{13}C$ values of C_{27} and C_{29} n-alkanes in the samples are consistent with general isotopic distribution of long-chain n-alkanes in C_3 plants previously reported (Collister *et al*., 1994; Lockheart *et al*., 1997; Bi *et al*., 2005; Chikaraishi and Naraoka, 2006; Pedentchouk *et al*., 2008).

The δD values of C_{27}, C_{29} and C_{31} n-alkanes in the three types of plants range from −127 to −202‰ (Table 2), which are in δD value range of C_3 plants (Bi *et al*., 2005; Smith and Freeman, 2006; Chikaraishi and Naraoka,
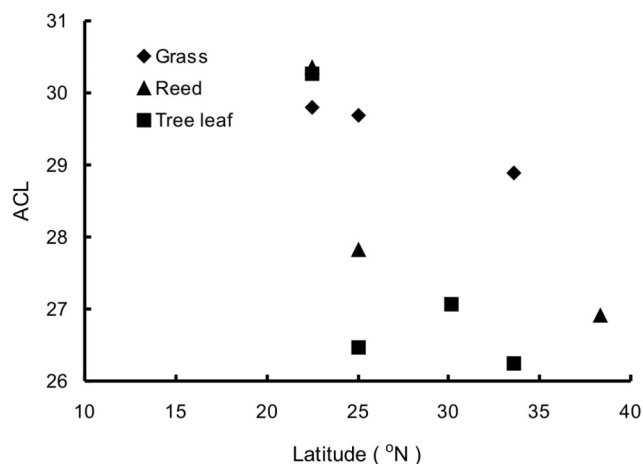
2006, 2007; Pedentchouk *et al*., 2008). For grass, reed and tree leaf, the mean δD value of C_{27} n-alkane is −183, −155 and −160‰ (Table 3), respectively. C_{29} n-alkane in the grass and reed samples has a mean δD value similar to that found in the C_{27} n-alkanes in the same plant type. However, the C_{29} n-alkane in the tree leaf has a heavier hydrogen isotopic composition compared to that of C_{27} n-alkane. Table 3 shows that n-alkanes in grass have lighter mean hydrogen isotopic composition than those in reed and tree leaf. This indicates that different kinds of plants have different hydrogen isotopic compositions possibly related to the hydrogen isotopic fractionation during plant growth. Grass has thin leaves and grows clinging to ground, while reeds and trees have wide leaves and grow far from the ground. This is likely to lead grass leaf water to have smaller evaporation compared to reed and tree leaves, so grass leaf is enriched in H. This is also consistent with grass having more negative mean $\varepsilon_{w/a}$ values than the reed and tree (Table 2). It is also observed that the δD values of C_{27} and C_{29} n-alkanes in the same type of plant are different among the different studied regions (Table 2). The δD value of C_{27} n-alkane in grass
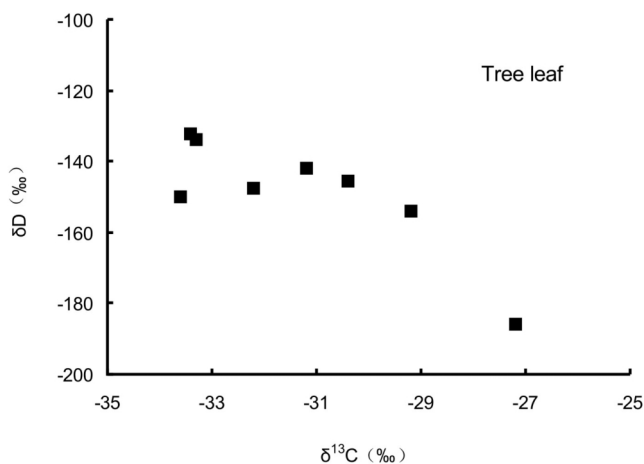
Fig. 5. δD vs. δ¹³C values of C_{27} and C_{29} n-alkanes in tree leaves.

from Ruoergai and Dianchi is lighter than that from Nanning, while the δD value of C_{29} n-alkane in grass from Ruoergai is lighter than that from Dianchi and Nanning. C_{29} n-alkane in tree leaf from Ruoerga has lighter hydrogen isotopic composition compared to C_{29} n-alkane from other studied regions. The δD values of C_{29} n-alkane in tree leaves from Ruoergai and Dianchi are similar and lighter than those from other studied regions. These facts seem to show that the δD values of C_{27} and C_{29} n-alkanes in the grass and tree leaf samples are related to their latitude and elevation (Table 1). C_{27} and C_{29} n-alkanes in the grass and tree leaf samples from high latitudes and altitudes have light hydrogen isotopic composition. Smith and Freeman (2006) have reported that δD values of C_{29} n-alkane in C_3 and C_4 plants were more negative in the North of the US Great Plains and less negative in the South of the US Great Plains. Our results support this observation. The reason of this phenomenon is that the hydrogen isotopic composition of long-chain n-alkanes in plants is related to that of the precipitation in the region where the plants grow (Table 1). Rainfall contributes to water used during photosynthesis. Studies of the isotopic effects associated with precipitation have showed that the δD value is closely related to latitude (Rozanski et al., 1993; Criss, 1999). When evaporated water condenses in clouds and produces raindrops, $_1^1H$ in the cloud is enriched due to the relative concentration of $_1^2H$ (D) in the liquid phase. The D-enriched waters condense preferentially because their saturation vapor pressures are lower than that of the H-enriched waters. As the cloud move towards the poles, the rainout of heavy isotopes causes the cloud to become isotopically lighter with increasing the latitude. Therefore, precipitation at high latitudes is depleted in D relative to one at low latitudes. In addition, δD value decreases

with increasing elevation above sea level duo to the reduced raindrop evaporation. Therefore, the variation in δD values of C_{27} and C_{29} n-alkanes in the same type plant is in agreement with the δD distribution of precipitation in the studied regions.

Bi et al. (2005) have reported a strong positive correlation between mean $\delta^{13}C$ and δD values of long-chain n-alkanes from C_3 trees. However, Chikaraishi and Naraoka (2007) did not observed such a correlation. In this study, we observed a negative correlation between the $\delta^{13}C$ and δD values of C_{27} and C_{29} n-alkanes in the tree leaves (Fig. 5). The reason of such a relationship is not clear yet.

Recognizing sedimentary organic matter sources and paleoenvironments

The results of this study have great significance for interpreting organic matter sources in modern and ancient sedimentary environments. The C_{max} value of n-alkanes has been thought to be related to vegetation types (e.g., Simoneit et al., 1991). The present study shows that latitude seems to affect the distribution of carbon-number maxima of n-alkanes in the same type plant. Therefore, C_{max} of n-alkanes may be a potential paleoenvironmental proxy. The CPI might be a proxy of the n-alkane organic source. Hydrocarbon mixtures originating from land plant material show a predominance of odd-numbered carbon chains (e.g., Rieley et al., 1991a). Our result indicates that n-alkane distributions have different CPI in tree leaf, reed and grass, and the CPI values seem to be related to latitude. It has been suggested that the higher plant n-alkane average chain length (ACL) could be related to vegetation types and latitude (Poynter et al., 1989; Simoneit et al., 1991; Schwark et al., 2002; Rommerskirchen et al., 2003). Data obtained in this study further support this hypothesis. In this study, it is observed that C_{27} and C_{29} n-alkanes in grass have a lighter mean carbon and hydrogen isotopic composition. C_{27} and C_{29} n-alkanes in the grass and tree leaf samples from high latitude and elevation area have relatively light hydrogen isotopic composition. These provide the basic data for recognizing organic matter sources and sedimentary environments using compound-specific $\delta D–\delta^{13}C$ analyses of n-alkanes.

CONCLUSIONS

In this study, a variation of the composition of n-alkanes and their carbon and hydrogen isotopic composition in leaves of grass, reeds and trees from five regions of China spanning from 22° to 39° latitude has been observed. The mean CPI and ACL values of n-alkanes increase following the trend of tree leaf > reed > grass and grass > reed > tree leaf, respectively. It is also observed

that C_{max}, CPI and ACL values of *n*-alkanes in the studied plants from low latitudes are higher than those from high latitudes. The distribution of δ^{13}C and δD values of C_{27} and C_{29} *n*-alkanes clearly shows that grass has a lighter mean isotopic composition than those measured in reed and tree leaves. C_{27} and C_{29} *n*-alkanes in the grass and tree leaves from high latitudes and elevations have relatively light hydrogen isotopic composition. These results provide the basic data for a better understanding of past vegetation type changes and the reconstruction of palaeoenvironments.

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