Quaternary Research **58**, 210–211 (2002)
doi:10.1006/qres.2002.2364

LETTER TO THE EDITOR

Comment on "Tree-Ring δD as an Indicator of Asian Monsoon Intensity"

Feng *et al.* (1999) measured δD of tree rings (δD_t) from two modern spruce trees (*Picea meyeri*) and a 10,000-yr-old timber (*Picea jezoensis*) from southeastern Inner Mongolia, China. They attributed the δD_t depletion of the old tree (46‰) to intensified summer monsoons early in the Holocene and a change in the ratio of summer/winter precipitation and/or southwest/southeast monsoons between the early Holocene and the present. Their arguments were based on two assumptions: (1) in the Asian summer monsoon domain (ASMD), $\delta^{18}O$ and δD of precipitation ($\delta^{18}O_p$ and δD_p) are indicators of the intensity of the summer monsoon; and (2) the δD_t depletion of the old tree was not influenced by relative humidity (RH). The work by Feng *et al.* (1999) is interesting, but the interpretation needs improvement.

$\delta^{18}O_p$ and δD_p are usually used as indicators of temperature. However, in recent years Wei and Lin (1994) suggested that in the ASMD, $\delta^{18}O_p$ and δD_p were indicators of the intensity of the summer monsoon rather than of temperature. This seems to be supported by Rozanski *et al.* (1993), Fontes *et al.* (1996) and Hoffmann and Heimann (1997), but most of the evidence is controversial. (i) The negative relation between temperature and $\delta^{18}O$ from the Dunde ice core suggested by Wei and Lin (1994) is less clear than the positive relation suggested by Yao and Thompson (1992). (ii) Although for some places in the ASMD, summer $\delta^{18}O_p$ ($\delta^{18}O_{ps}$) is lower than winter $\delta^{18}O_p$ ($\delta^{18}O_{pw}$) (Rozanski *et al.*, 1993; Wei and Lin, 1994), this is not the case everywhere. Table 1 shows that in the ASMD, ($\delta^{18}O_{ps} - \delta^{18}O_{pw}$) generally increases with latitude. $\delta^{18}O_{ps}$ at the sampling site (42°37.14′N) should be higher, not lower than $\delta^{18}O_{pw}$. In addition, the negative relations based on the seasonal time scale may not be applicable to longer time scales (Rozanski *et al.*, 1993). (iii) If precipitation seasonality is considered, the negative relation for Hong Kong between long-term interannual changes of $\delta^{18}O_p$ and precipitation (Rozanski *et al.*, 1993) disappears (Table 2). (iv) Although Fontes *et al.* (1996) suggested that a stronger summer monsoon might be responsible for ^{18}O-depleted lacustrine carbonates from Lake Bangong between 9600 and 6000 ^{14}C yr B.P., they interpreted other ^{18}O-depleted lacustrine carbonates with dry spells.

Yapp and Epstein (1982a) demonstrated that RH as well as δD of source water influenced δD_t. Later, White *et al.* (1994) argued that in areas where there was a linear relation between air vapor δD (δD_a) and RH, the influence of RH on δD_t was cancelled by that of δD_a. However, prerequisites for the model of White *et al.* (1994) were that δD_a-humidity feedback was strong and that source water and air vapor were not in isotopic equilibrium. For the areas where there is an isotopic equilibrium between source water and air vapor, for example near lakes, the influence of RH on δD_t cannot be ignored. Stratigraphy at the sampling site (Cui *et al.*, 1997) indicated that there was probably a lake there in the early Holocene. So the influence of RH on δD_t must be considered.

If the modern RH over the area where *Picea jezoensis* is distributed today is used to represent the RH at the sampling site early in the Holocene, a difference in RH of roughly 14–23% between the early Holocene and present is estimated for the sampling site (Table 3). It would have the effect of decreasing the δD_t of the older tree by 14–23‰ (cf. Yapp and Epstein, 1982a). Although no attempt has been made to estimate the temperature

TABLE 1
Seasonal Variations of $\delta^{18}O_p$ in Two Connective Years for Some Stations in the ASDM

Station	Latitude	Period	$\delta^{18}O_{ps}$/‰	$\delta^{18}O_{pw}$/‰	($\delta^{18}O_{ps} - \delta^{18}O_{pw}$)/‰
Hong Kong	22.32°N	89.01–90.12	−6.50	−3.01	−3.49
Kunming	25.01°N	88.01–89.12	−11.36	−4.62	−6.74
Xian	34.30°N	89.01–90.12	−8.03	−8.23	0.20
Zhengzhou	34.72°N	90.01–91.12	−7.30	−6.91	−0.39
Shijiazhuang	38.02°N	89.01–90.12	−7.04	−9.09	2.05
Qiqihar	47.23°N	89.01–90.12	−9.66	−22.13	12.47

Note. $\delta^{18}O_{ps}$ and $\delta^{18}O_{pw}$ are arithmetic averages of monthly $\delta^{18}O_p$ of the summer (May–October) and winter half-year (November–April), respectively. The original monthly data were downloaded from the web site of the International Atomic Energy Agency–World Meteorological Organization, http://www.iaea.org/programs/ri/gnip/gnipmain.htm, on September 14, 2000.

0033-5894/02 $35.00

TABLE 2
Long-Term δ^{18}O-Precipitation Coefficients for Hong Kong and Tokyo, Two Stations in the ASMD

Station	$\Delta\delta^{18}O_a/\Delta P$ (per mil per mm)	r^2	$\Delta\delta^{18}O_w/\Delta P$ (per mil per mm)	r^2
Hong Kong (1961–1965, 1973–1997)	-0.006 ± 0.001	0.266	-0.005 ± 0.003	0.058
Tokyo (1961–1979)	-0.016 ± 0.006	0.160	-0.012 ± 0.006	0.071

Note. In parentheses are periods indicating length of the available δ^{18}O and precipitation records. r stands for correlation coefficient. $\Delta\delta^{18}O_a$ is calculated according to the method of Rozanski *et al.* (1993), not considering the precipitation seasonality. $\Delta\delta^{18}O_w$ represents long-term $\delta^{18}O_p$ trend considering the precipitation seasonality. Data source is the same as for Table 1.

change at the sampling site since the early Holocene, the reconstructed curves from neighboring areas usually show a difference in temperature of at least 2–4°C between ca 10,000 years ago and the present (Shi *et al.*, 1992). These differ from some model simulations (COHMAP Members, 1988), possibly because of the low spatial resolution of the models. If this temperature difference is accepted, a δD_t depletion of 17.4–34.8‰ should be observed in the old tree (cf. Yapp and Epstein, 1982b).

Thus, the average δD_t depletion of 46‰ measured for the old tree is reasonable and may result from the integrated effect, 31.4–57.8‰, of lower temperatures and higher RH early in the Holocene. However, whether there were stronger summer monsoons ca. 10,000 years ago is not clear. A monsoonal signal in

TABLE 3
The Relative Humidities (%) from 1991 to 1998 at the Stations Close to the Sampling Site or in the Area Where *Picea jezoensis* Is Distributed at Present

Station	91	92	93	94	95	96	97	98	Ave.
Jiamusi	66	66	65	67	66	63	66	63	65.3
Hailun	66	67	68	69	70	63	66	67	67
Shangzhi	73	74	73	74	73	67	69	69	71.5
Suifenhe	67	66	67	68	69	67	65	65	66.8
Jixi	66	64	64	67	65	62	65	62	64.4
Dunhua	70	69	71	71	69	66	65	68	68.6
Tonghe	72	72	74	75	76	72	73	71	73.1
Mudanjiang	69	66	68	68	66	62	67	64	66.3
Ave.	69	68	69	70	69	65	67	66	**67.9**
Linxi	53	53	52	49	50	49	48	52	50.8
Duolun	62	76	63	61	61	60	59	58	62.5
Chifeng	49	50	49	50	50	51	50	52	50.1
Ave.	55	61	56	55	55	55	54	54	**50.5**[a]

Note. Data source is National Meteorological Center, Chinese Humidity Annual, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998. Stations close to the sampling site are in italics.

[a] Average for *Linxi* and *Chifeng*. *Duolun* is not used because it close to marshes and the sampling site is near the Otindag sandy desert (Cui *et al.*, 1997).

δD_t is still a possibility. In addition, as suggested by Feng *et al.* (1999), many nonclimatic factors also affect δD_t. In interpreting δD_t in terms of early Holocene climate, attention should be paid to these effects in addition to the impacts of temperature and RH.

REFERENCES

COHMAP Members (1988), Climatic changes of the last 18,000 years: Observations and model simulations. *Science* **241,** 1043–1052.

Cui, H., Liu, H., and Yao, X. (1997), The finding of a paleo-spruce timber in Hunshandak sandy land and its paleoecological significance. *Science in China (D)* **40,** 599–604.

Feng, X., Cui, H., Tang, K., and Conkey, L. E. (1999), Tree-ring δD as an indicator of Asian monsoon intensity. *Quaternary Research* **51,** 262–266.

Fontes, J. C., Gasse, F., and Gibert, E. (1996), Holocene environmental changes in Lake Bangong basin (Western Tibet). 1. Chronology and stable isotopes of carbonates of a Holocene lacustrine core. *Palaeogeography, Palaeoclimatology, Palaeoecology* **120,** 25–47.

Hoffmann, G., and Heimann, M. (1997), Water isotope modeling in the Asian monsoon region. *Quaternary International* **37,** 115–128.

Rozanski, K., Araguás-Araguás, L., and Gonfiantini, R. (1993), Isotopic patterns in modern global precipitation. *In* "Climate Changes in Continental Isotopic Records" (P. K. Swart, K. C. Lohmann, L. McKenzie, and S. Savin, Eds.), Geophysical Monograph **78,** pp. 1–36. American Geophysical Union, Washington, DC.

Shi, Y., Kong, Z., Wang, S., Tang, L., Wang, F., Yao, T., Zhao, X., Zhang, P., and Shi, S. (1992), Climatic fluctuations and some important events in Holocene Optimum in China. *Science in China (B)* **35,** 1300–1308. [In Chinese]

Wei, K., and Lin, R. (1994), An enquiry into palaeoclimatic information from oxygen isotopic profile of Dunde ice core in Qilianshan. *Geochimica* **23,** 311–320. [In Chinese with English abstract]

White, J. W. C., Lawrence, J. R., and Broecker, W. S. (1994), Modeling and interpretating D/H ratios in tree rings: A test case of white pine in the northeastern United States. *Geochimica et Cosmochimica Acta* **58,** 851–862.

Yao, T., and Thompson, L. G. (1992), Dunde ice core record and temperature variation during the past 5 ka. *Science in China (B)* **22,** 1089–1093. [In Chinese]

Yapp, C. J., and Epstein, S. (1982a), A reexamination of cellulose carbon-bound hydrogen δD measurements and some factors affecting plant-water D/H relationships. *Geochimica et Cosmochimica Acta* **46,** 955–965.

Yapp, C. J., and Epstein, S. (1982b), Climatic significance of the hydrogen isotope ratios in tree cellulose. *Nature* **297,** 636–639.

Houyun Zhou

Guangzhou Institute of Geochemistry
Chinese Academy of Sciences
Wushan, Guangzhou 510640
People's Republic of China
and
Institute of Earth Environment
Chinese Academy of Sciences
Xi'an 710054
People's Republic of China
E-mail: hyzhou@gig.ac.cn

https://doi.org/10.1006/qres.2002.2364 Published online by Cambridge University Press