Dissolved organic carbon and nitrogen in precipitation, throughfall and stemflow from *Schima superba* and *Cunninghamia lanceolata* plantations in subtropical China

GUO Jian-fen[1,2], YANG Yu-sheng[2*], CHEN Guang-shui[2], LIN Peng[1]

[1] *College of Life Science, Xiamen University, Xiamen 361005, P. R. China*

[2] *College of Geography Science, Fujian Normal University, Fuzhou 350007, P. R. China*

Abstract: Despite growing attention to the role of dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) in forest nutrient cycling, their monthly concentration dynamics in forest ecosystems, especially in subtropical forests only were little known. The goal of this study is to measure the concentrations and monthly dynamics of DOC and DON in precipitation, throughfall and stemflow for two plantations of *Schima superba* (SS) and Chinese fir (*Cunninghamia lanceolata,* CF) in Jianou, Fujian, China. Samples of precipitation, throughfall and stemflow were collected on a rain event base from January 2002 to December 2002. Upon collection, all water samples were analyzed for DOC, NO_3^--N, NH_4^+-N and total dissolved N (TDN). DON was calculated by subtracting NO_3^--N and NH_4^+-N from TDN. The results showed that the precipitation had a mean DOC concentration of 1.7 mg·L^{-1} and DON concentration of 0.13 mg·L^{-1}. The mean DOC and DON concentrations in throughfall were 11.2 and 0.24 mg·L^{-1} in the SS and 10.3 and 0.19 mg·L^{-1} in the CF respectively. Stemflow DOC and DON concentrations in the CF (19.1 and 0.66 mg·L^{-1} respectively) were significantly higher than those in the SS (17.6 and 0.48 mg·L^{-1} respectively). No clear monthly variation in precipitation DOC concentration was found in our study, while DON concentration in precipitation tended to be higher in summer or autumn. The monthly variations of DON concentrations were very similar in throughfall and stemflow at both forests, showing an increase at the beginning of the rainy season in March. In contrast, monthly changes of the DOC concentrations in throughfall of the SS and CF were different to those in stemflow. Throughfall DOC concentrations were higher from February to April, while relatively higher DOC concentrations in stemflow were found during September-November period.

Keywords: Dissolved organic carbon (DOC); Dissolved organic nitrogen (DON); Precipitation; Throughfall; Stemflow; *Schima superba*; *Cunninghamia lanceolata*; Plantation

CLC number: S712.5; S791.27 **Document Code**: A **Article ID**: 1007-662X(2005)01-0019-04

Introduction

Dissolved organic carbon (DOC) and nitrogen (DON) are thought to contribute significantly to the C and N cycle in terrestrial ecosystems, to soil formation and to pollutant transport. Several investigations have sought to understand the nature and dynamics of DOC (Cronan *et al.* 1985; McDowell *et al.* 1988; Neff *et al.* 2001), but there were only few reports about DON in ecosystems. In some ecosystems, dissolved organic N represents the major form of nitrogen in solution (Hedin *et al.* 1995; Stuanes *et al.* 1995; Currie *et al.* 1996), and DON losses may occur despite overall ecosystem demand for N (Hedin *et al.* 1995; McHale *et al.* 2000). Further, most present studies focus on a single element at a time, and few have evaluated on the relative changes of C and N in dissolved organic matter (DOM) with solution movement through ecosystems (Qualls *et al*. 1991).

Recently, the measurements of DOC and DON concentrations in throughfall and stemflow have indicated that interception by the canopies and stems of trees can greatly alter DOC and DON concentrations in precipitation among different species of trees (Inagaki *et al*. 1995; Currie *et al*. 1996) and seasonally (McDowell *et al.* 1988). Besides rainfall volume, leaching of compounds from leaves and stems is considered to be the primary factors influencing variability in carbon and nitrogen concentrations among solutions. Although the dynamics of DOC and DON have been addressed in several temperate and tropical forests (McDowell *et al.* 1988; Inagaki *et al.* 1995; Currie *et al.* 1996; Michalzik *et al.* 1999; Michalzik *et al*. 2001), little is known about DOC and DON in forests of southern China, an area of the most important world subtropical forests. The objective of this study is, thus, to determine monthly changes of DOC and DON concentrations in precipitation, throughfall and stemflow of two plantation forests of *Schima superba* (SS) and Chinese fir (*Cunninghamia lanceolata,* CF) in northern Fujian.

Foundation item: This study was supported by the Teaching and Research Award program for MOE P. R. C. (TRAPOYT).

Biography: GUO Jian-fen (1977-), female, Ph. Doctor in College of Life Science, Xiamen University, Xiamen 361005, P.R. China. Email: gjf53135@yahoo.com.cn

Received date: 2004-10-27

Responsible editor: Zhu Hong

*Corresponding author. E-mail: geoyys@fjnu.edu.cn.

Study area

The study was carried out at the Long-Term Ecological Research site in Jianou, Fujian (27°20′N, 118°57′E). It borders Jiufeng Mountain on the southeast, with Wuyi Mountain on the northwest. The region has a middle sub-tropical monsoonal climate, with a mean annual temperature of 18.7 ºC and a relative humidity of 80%. The mean annual precipitation is 1 664 mm, mainly occurs from March to August (Fig. 1). Mean annual evapotranspiration is 1466 mm. The parent material of the soil is granite and soils are classified as red soils (humic Planosols in FAO system). Thickness of the soil exceeds 1.0 m.

Two adjacent stands consisting of *Schima superba* (SS) and Chinese fir (*Cunninghamia lanceolata*, CF) plantations were investigated. Both of SS and CF were derived from a shaw. The shaw was clear-cut and planted with *S. superba* and Chinese fir

15 years ago. Selected stand characteristics and some properties of the surface soil (0-20cm) of the two stands are described in Table 1.

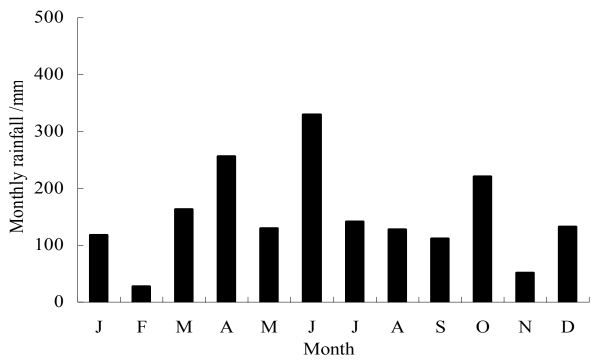

Fig. 1 Rainfall patterns for the study area in 2002

Table 1. Forest characteristics and soil properties of the study sites

Parameters	Forest type	
	Schima superba	Chinese fir
Forest characteristics		
Stand age (year)	15	15
Mean tree height (m)	9	11
Mean tree diameter at breast height (cm)	8.9	10.6
Stand density (stem ha^{-1})	1700	2390
Soil properties (top 0-20cm depth)		
Bulk density (g cm^{-3})	1.06	1.07
Organic matter ($g \cdot kg^{-1}$)	29.9	27.9
Total N ($g \cdot kg^{-1}$)	0.938	0.808
Total P ($g \cdot kg^{-1}$)	0.622	0.401
Hydrolyzable N ($mg \cdot kg^{-1}$)	94.3	110.3
Available P ($mg \cdot kg^{-1}$)	4.84	4.52

Materials and methods

Water sample collection and analysis

Samples of precipitation, throughfall and stemflow were collected on a rain event base from January 2002 to December 2002. Bulk precipitation was gathered by using 3 rain collectors of 314 cm^2 in an open area about 100 m away from the site, where there was a meteorology station.

Each throughfall collector consisted of two 20−cm diameter funnels was mounted about 1 m above the ground and arranged in a crossed shape with an upright projection area of 1.8 m^2; the funnels were connected to a 10−L sampling tank with polyethylene tubes. In order to keep out leaves, small branches, and insects, 3−mm mesh plastic screen was used to cover the funnels. Five such throughfall collectors were installed randomly in each stand.

The stemflow collector was consisted of tygon tubing (3.8 cm outer and 3.0 cm inner diameters) which was longitudinally split. The tubing was wrapped on a downward spiral around the tree bole, fastened with stainless steel staples and sealed to the bark with silica gel. The lower and unsplit end of the tubing was inserted into a hole in the lid of a 10–L plastic sampling tank. Nine standard trees of a stand were chosen to collect stemflow in both stands.

Upon collection, all water samples were filtered through Gelman GN-6 grid with 0.45-μm membrane filters and stored at 4℃ until analyzed for DOC, NO_3^--N, NH_4^+-N and total dissolved N (TDN). DON was calculated by subtracting NO_3^--N and NH_4^+-N from TDN. The DOC concentration of each filtered water sample was determined by using a TOC analyzer with high temperature combustion system (Elementar Analysensysteme GmbH, Germany). NO_3^--N was determined colorimetrically by using an autoanalyser and NH_4^+-N was analyzed by the indophenol blue method (DSTMF 1992), while TDN was determined by UV-persulphate digestion (Ameel *et al*. 1993). Analyses were carried out in triplicate.

Statistical analyses

Duncan's multiple range test was used for mean comparison if the results of the *F*-test were significant at the 5% level.

Results

Concentrations of DOC and DON

The mean DOC and DON concentrations in both forests increased in the following order: bulk precipitation < throughfall < stemflow (Table 2). DOC and DON concentrations in precipitation averaged at 1.7 and 0.13 $mg \cdot L^{-1}$, respectively. The DOC concentrations in throughfall of the SS and CF were 6.6 times and 6.1 times as much as that in precipitation, respectively. Concentrations of DOC in stemflow of both forests were significantly higher than that in precipitation (p <0.05). Compared with precipitation, throughfall and stemflow in the two forests also had significantly higher DON concentrations (p < 0.05). In the SS, concentrations of DOC and DON in throughfall were both higher than those of the CF. In contrast, the DOC and DON concentrations in stemflow in the SS were lower than those in the CF.

Table 2. Average solution concentration (mean±SE) of DOC and DON in two forest types ($mg \cdot L^{-1}$)

Parameters	DOC	DON
Bulk precipitation	1.7±0.2d	0.13±0.02d
Schima superba forest		
Throughfall	11.2±1.5c	0.24±0.03c
Stemflow	17.6±2.6b	0.48±0.06b
Chinese fir forest		
Throughfall	10.3±1.3c	0.19±0.03c
Stemflow	19.1±3.1a	0.66±0.09a

Notes: Means for each measurement at DOC and DON concentrations followed by the different letter on the same column are significantly different at the 5% level using Duncan-Waller multiple range test.

Monthly variations in concentrations of DOC and DON

Concentrations of DOC and DON in throughfall and stemflow in every month were generally higher than those in precipitation (Fig. 2-4). In precipitation, DOC concentration did not show a distinct monthly variation (Fig. 2), however, there was an increasing trend of DOC concentrations during drier periods in autumn and winter. The DON concentration in precipitation tended to be relatively lower during March to May than in other months. In the SS and CF, the monthly variations of DON concentrations were very similar in throughfall and stemflow, showing an increase at the beginning of the rainy season in March. In contrast to DON, the monthly variations of the DOC concentrations were different in throughfall and in stemflow (Fig. 3 and 4); The DOC concentrations in throughfall were higher from February to April during the year, while in stemflow, relatively higher DOC concentrations were found during September to November in the year.

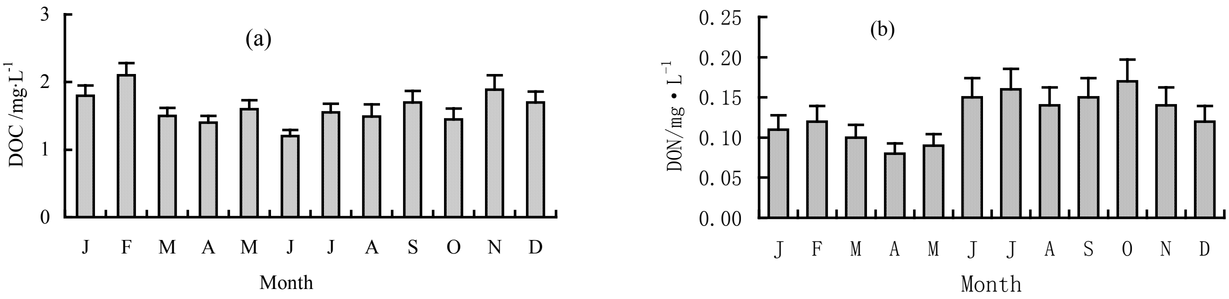

Fig. 2 Monthly variation in concentrations of DOC (a) and DON (b) in precipitation

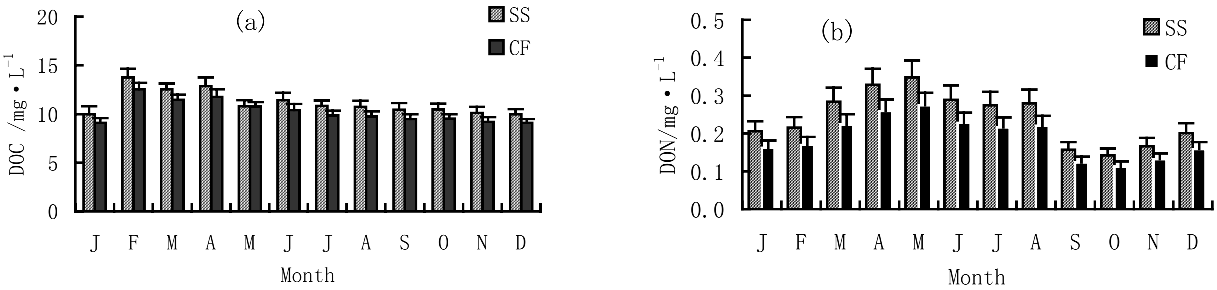

Fig. 3 Monthly variation in concentrations of DOC (a) and DON (b) in throughfall in *Schima superba* (SS) and Chinese fir (CF) forests

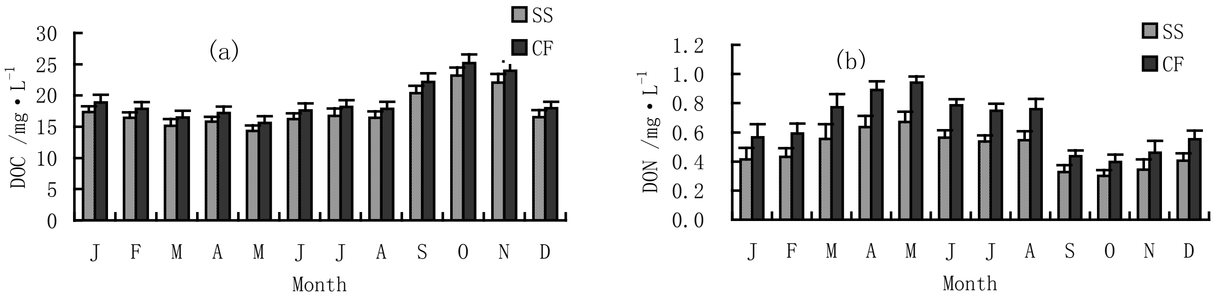

Fig. 4 Monthly variation in concentrations of DOC (a) and DON (b) in stemflow in *Schima superba* (SS) and Chinese fir (CF) forests

Discussion

Concentrations of DOC and DON

Precipitation is a significant source of DOC and DON for subtropical forest ecology (Likens *et al*. 1983). In this study, the mean concentrations of DOC and DON in precipitation were comparable to other studies (Currie *et al*. 1996; Michalzik *et al.* 1999; Solinger *et al.* 2001). For example, Solinger *et al.* (2001) found mean concentrations of DOC and DON for 2.0 mg·L^{-1} and 0.2 mg·L^{-1} in rainfall above a deciduous forest in northern Bavaria, Germany. Currie *et al*. (1996) reported DOC concentrations of 1.8 mg·L^{-1} in precipitation in a hardwood forest in Massachusetts, USA. But the concentration of DOC in precipitation in our study was much lower relative to the coniferous forest (2.9 mg·L^{-1}) in Wisconsin, USA (Quideau *et al.* 1997). Overall, our values of DOC and DON concentrations entering the ecosystems by precipitation were close to those reported for many temperate forests (average concentrations of DOC and DON for 1.8 mg· L^{-1}, 0.17 mg· L^{-1}), (Michalzik *et al.* 2001).

The mean DOC and DON concentrations in throughfall for both forests (10.8 mg·L^{-1} and 0.22 mg·L^{-1}) were lower at concentrations range in throughfall of temperate forests (DOC concentrations for 3–35 mg·L^{-1}; DON concentrations for 0.24-1.11 mg·L^{-1}), (Michalzik *et al.* 2001), but DOC and DON concentrations in throughfall in this study were close to mean DOC concentration in throughfall of a hardwood forest in South Sweden (9.9 mg·L^{-1}; Bergkvist *et al.* 1992) and to mean DON concentration in throughfall of a deciduous forest in southern Appalachians, North Carolina (0.25 mg·L^{-1}; Qualls *et al.* 1991). Further, dissolution of soluble organic material deposited on the surface of the plants, soluble animal or microbially-derived organic material in the canopy, and leaching of leaves or needles may cause significantly higher DOC and DON concentrations in throughfall than those in precipitation (Ciglasch *et al.* 2004).

The differences between DOC and DON concentrations in throughfall for the two forests were attributable to the different structure of the vegetation canopy. The SS canopy covered a higher surface area than that of the CF. Consequently, the area of water contacting with the plant surfaces through the SS canopy were more than that through the CF canopy. This resulted in a stronger increase in DOC concentrations in throughfall of SS than those of CF.

The concentrations of DOC and DON in stemflow at the study sites were lower than mean DOC and DON concentrations in the stemflow of forests in temperate and cold climates (23–356 mg·L^{-1} and 0.81-1.80 mg•L^{-1}; Hinton *et al*. 1998), probably because of different forest structure and climatic conditions. Frangi & Lugo (1985) reported mean DOC concentrations of 9.2 mg•L^{-1} in stemflow of a subtropical Puerto Rican palm forest being much less than the DOC concentrations in the SS and CF. This is probably attributable to a pronounced dilution of the Puerto Rican stemflow because of the higher annual rainfall of 3725 mm (vs. 1664 mm at the study sites). The strong enrichment of DOC and DON in stemflow, compared with that in throughfall, particularly in CF, indicated that organic material was leached from the trunks. In addition, the two forests in the present study had similar mean tree height. Moreover, stand age of the CF and SS are same (Table 1). Thus the higher DOC and DON concentrations in stemflow of the CF than those of the SS were mainly related to different bark morphology of the trees (Inagaki *et al.* 1995). Chinese fir has a multi-layered rough fibrous bark which could retain precipitation longer time than single-layered bark thus leaching more DOC and DON. The causes of the variations in these concentrations are complex and warrants further study.

Monthly changes of DOC and DON concentrations

The monthly changes of DON concentrations in precipitation in our study are similar to the findings by Michalzik & Matzner (1999) and Michalzik *et al.* (2001) who found higher DON concentration in precipitation usually occur in late summer or autumn. But this is still open to speculation as to why. Further, concentrations of DOC in precipitation had been observed to decrease in the course of the rainy months (Fig. 2). Similarly, Hoffman *et al.* (1980) and Andreae *et al.* (1990) also reported this trend. Higher DOC concentrations at lower rainfall volumes may be attributable to a concentration effect or to the deposition of dust containing soluble organic matter that is favored by dry conditions (Ciglasch *et al.* 2004).

Higher DOC and DON concentrations in throughfall occurred at the beginning of the rainy season (Fig. 3) because soluble organic material accumulated during the dry season was washed from the plants (Stadler *et al* 1998). The accumulated material probably resulted from deposited dust and degraded biological material. During the first rain events after the dry season, usually in March, the DON concentrations in stemflow of both forests also increased. Thus, there was a similar initial flush as for throughfall. In this study, the monthly variation in DOC concentrations in stemflow is different from other studies (Liu *et al*. 2003; Ciglasch *et al.* 2004), where the maximum DOC concentrations in the spring/summer has been demonstrated. These short-term and monthly variations (only 1 year) in our study appear difficult to the assessment of the primary factors influencing variability of DOC and DON concentrations, thus, indicating the need for a long-term and intensive sampling program.

References

Ameel, J.J., Axler, R.P., Owen, C.J. 1993. Persulfate digestion for determination of total nitrogen and phosphorus in low-nutrient waters. Am [J]. Environ. Lab., **10**: 1–11.

Andreae, M.O., Talbot, R.W., Berresheim, H., *et al.* 1990. Precipitation chemistry in central Amazonia [J]. Journal of Geophysical Research, **95D**: 16987–16999.

Bergkvist, B., Folkeson, L. 1992. Soil acidification and element fluxes of a *Fagus sylvatica* forest as influenced by simulated nitrogen deposition [J]. Water, Air and Soil Pollution, **65**: 111–133.

Ciglasch, H., Lilienfein, J., Kaiser, K., *et al*. 2004. Dissolved organic matter under native Cerrado and *Pinus caribaea* plantations in the Brazilian savanna [J]. Biogeochemistry, **67**: 157–182.

Cronan, C. S., Aiken, G. R. 1985. Chemistry and transport of soluble humic substances in forested watersheds of the Adirondack Park, New York. Geochim. Cosmochim [J]. Acta, **49**: 1697–1705.

Currie, W.S., Aber, J.D., McDowell, W.H., *et al.* 1996. Vertical transport of dissolved organic C and N under long-term N amendments in pine and hardwood forests [J]. Biogeochemistry, **35**: 471–505.

Department of Science and Technology, the Ministry of Forestry (DSTMF). 1992. The Collection of Forestry Criteria (Ⅲ) (in Chinese) [M]. Chinese Forestry Press, Beijing.

Frangi, J.L., Lugo, A.E. 1985. Ecosystem dynamics of a subtropical floodplain forest [J]. Ecological Monographs, **55**: 351–369.

Hedin, L.O., Armesto, J.J., Johnson, A.H. 1995. Patterns of nutrient loss from unpolluted, old-growth temperate forests [J]. Evaluation of biogeochemical theory. Ecology, **76**: 493-509.

Hinton, M.J., Schiff, S.L., English, M.C. 1998. Sources and flowpaths of dissolved organic carbon during storm events in two forested watersheds of the Precambrian Shield [J]. Biogeochemistry, **41**: 175–197.

Hoffman, W.A. Jr, Lindberg, S.E., Turner, R.R. 1980. Some observations of organic constituents in rain above and below a forest canopy [J]. Environment Science and Technology, **14**: 999–1002.

Inagaki, M., Sakai, M., Ohnuki, Y. 1995. The effects of organic carbon on acid rain in a temperate forest in Japan [J]. Water, Air and Soil Pollution, **85**: 2345-2350.

Likens, G.E., Edgerton, E.S., Galloway, J.N. 1983. The composition and deposition of organic carbon in precipitation [J]. Tellus, **35B**: 16–24.

Liu, C.P., Sheu, B.H. 2003. Dissolved organic carbon in precipitation, throughfall, stemflow, soil solution, and stream water at the Guandaushi subtropical forest in Tainwan [J]. Forest Ecology and Management, **172**: 315–325.

McDowell, W.H., Likens, G.E. 1988. Origin, composition and flux of dissolved organic carbon in the Hubbard Brook Valley. Ecological Monographs, **58**: 177–195.

McHale, M. R., Mitchell, M. J., McDonnell, J. J., *et al*. 2000. Nitrogen solutes in an Adirondack forested watershed: Importance of dissolved organic nitrogen [J]. Biogeochemistry, **48**(2): 165–184.

Michalzik, B., Kalbitz, K., Park, J. H., *et al.* 2001. Fluxes and concentrations of dissolved organic carbon and nitrogen - a synthesis for temperate forests [J]. Biogeochemistry, **52**(2): 173-205.

Michalzik, B., Matzner, E. 1999. Dynamics of dissolved organic nitrogen and carbon in a Central European Norway spruce ecosystem [J]. European Journal of Soil Science, **50**: 579–590.

Neff, J.C., Asner, G.P. 2001. Dissolved organic carbon in terrestrial ecosystems: synthesis and a model [J]. Ecosystems, **4**: 29–48.

Qualls, R.G., Haines, B.L., Swank, W.T. 1991. Fluxes of dissolved organic nutrients and humic substances in a deciduous forest [J]. Ecology, **72**: 254–266.

Quideau, S.A., Bockheim, J.G. 1997. Biogeochemical cycling following planting to red pine on a sandy prairie soil [J]. Journal of Environment Quality, **26**: 1167–1175.

Solinger, S., Kalbitz, K., Matzner, E. 2001. Controls on the dynamics of dissolved organic carbon and nitrogen in a Central European deciduous forest [J]. Biogeochemistry, **55**: 327–349.

Stadler, B., Michalzik, B. 1998. Aphid infested Norway spruce are ‘hot spots’ in throughfall carbon chemistry in coniferous forests [J]. Canadian Journal of Forest Research, **28**: 1717–1722.

Stuanes, A.O., Kjønaas, O.J., Van Miegroet, H. 1995. Soil solution response to experimental addition of nitrogen to a forested catchment at Gardsjön, Sweden [J]. Forest Ecology and Management, **71**: 99–110.

05-01-005

木荷和杉木人工林天然降水、穿透雨和树干茎流 DOC 和 DON 浓度及动态/郭剑芬（厦门大学生命科学学院，厦门 361005，中国；福建师范大学地理科学学院，福州 350007），杨玉盛 (福建师范大学地理科学学院，福州 350007)，陈光水(福建师范大学地理科学学院，福州 350007，中国)，林鹏 (厦门大学生命科学学院，厦门 361005，中国)//Journal of Forestry Research. –2005,16(1): 19–22.

尽管溶解有机碳（DOC）和溶解有机氮（DON）在森林养分循环中的作用日渐为人们所关注，但对它们的浓度及动态，特别是对亚热带森林 DOC 和 DON 的研究甚少。本文于 2002 年通过野外天然降水及亚热带木荷和杉木人工林（monoculture plantations of Schima superba and Cunninghamia lanceolata，15 年生）穿透雨和树干茎流各水样的收集及室内各水样中 DOC、NO_3^--N、NH_4^+-N 和总溶解有机氮（TDN）浓度的测定，其中 DON 浓度通过 TDN 与 NO_3^--N、NH_4^+-N 的浓度差值来计算，结果表明，天然降水 DOC 和 DON 浓度分别为 1.7 和 0.13 mg·L^{-1}。木荷人工林穿透雨 DOC 和 DON 浓度分别为 11.2 和 0.24 mg·L^{-1}，高于杉木人工林的 DOC 和 DON 浓度（10.3 和 0.19 mg·L^{-1}）。杉木人工林树干茎流 DOC 和 DON 浓度（分别为 19.1 和 0.66 mg·L^{-1}）明显高于木荷人工林（分别为 17.6 和 0.48 mg·L^{-1}）。天然降水 DOC 浓度的月变化不明显，而 DON 浓度在夏季和秋季较高。两林分穿透雨 DON 浓度的月动态与树干茎流的十分相似，均在雨季开始时（3 月）浓度增大。两林分穿透雨 DOC 浓度在 2-4 月间较高，而树干茎流 DOC 浓度在 9-11 月间较高。图 4 表 2 参 24。

关键词：溶解有机碳（DOC）；溶解有机氮（DON）；天然降水；穿透雨；树干茎流；木荷；杉木；人工林

CLC number: S712.5; S791.27 Document code: A

Article ID: 1007-662X(2005)01-0019-04

05-01-006

亚热带地区杉木人工林和阔叶林土壤活性有机质研究/王清奎（中国科学院沈阳应用生态研究所，沈阳 110016；中国科学院研究生院，北京 100039，中国），汪思龙（中国科学院沈阳应用生态研究所，沈阳 110016，中国），邓仕坚（中国科学院沈阳应用生态研究所，沈阳 110016，中国）//Journal of Forestry Research. –2005, 16(1): 23–26.

土壤活性有机质对土壤养分如氮、磷、硫的生物化学循环具有作用，其含量和质量影响土壤的初级生产力。本试验在中国科学院会同森林生态实验站通过对第一代、第二代杉木纯林和地带性阔叶林土壤活性有机质组分的对比研究，发现杉木纯林土壤活性有机质的含量低于地带性阔叶林。第一代杉木纯林易氧化有机碳、微生物生物量碳、水溶性有机碳和水溶性碳水化合物的含量分别比第二代杉木纯林高 35.9%、13.7%、87.8%和 50.9%，比地带性阔叶林的低 15.8%、47.3%、38.1%和 30.2%。在调查的三种林地内，土壤微生物生物量碳和水溶性有机碳含量下降幅度较大，其次为水溶性碳水化合物，而易氧化有机碳的变化最小。同时，杉木纯林土壤养分等理化性质也比地带性阔叶林低。这表明在杉木纯林取代地带性阔叶林以及杉木纯林连栽后林地的土壤肥力降低。图 3 表 2 参 26。

关键词：土壤活性有机质；杉木人工林；地带性阔叶林；土壤养分

CLC number: S714.5; S791.27 Document code: A

Article ID: 1007-662X(2005)01-0023-04

05-01-007

采伐作业对长白山阔叶红松林林下植被影响的研究/王惠（中国科学院沈阳应用生态研究所，沈阳 110016；中国科学院研究生院，北京 100039），邵国凡（美国普度大学林业和自然资源系，印第安娜州），代力民，许东（中国科学院沈阳应用生态研究所，沈阳 110016），谷会岩（中国科学院沈阳应用生态研究所，沈阳 110016；东北林业大学林学院，哈尔滨 150040），王飞（中国科学院沈阳应用生态研究所，沈阳 150040）//Journal of Forestry Research. –2005, 16(1): 27–30.

森林采伐是森林经营中的一个关键环节。采伐对树木天然更新的影响直接关系到森林的结构、组成及森林的可持续经营。本文以长白山阔叶红松林为研究对象，对择伐 5 年后不同作业迹地（集材道、楞场和采伐后林窗）的幼苗更新及灌木、草本的多样性进行研究，并以没有进行采伐干扰的林地作为对照。共设计样地 23 块，在各个小样地内调查幼树的种类、树木、高度；灌木和草本植物的种类、树木、高度和盖度，应用 SPSS 软件进行一元方差分析。结果表明，择伐作业影响幼苗的更新，灌木和草本的多样性在作业迹地增加，尤其在林隙处的多样性最高。适当采伐能促进幼苗的更新，特别是阔叶树种的更新。集材道对幼苗密度的影响比对幼苗高度的影响大，幼苗密度在集材道上密度最高；采伐作业对针叶树种有严重的影响，在三种作业迹地上针叶树种的密度都比对照低。为了维持森林的结构和组成，在森林收获和楞场的建立时，必须采取科学措施保护针叶树种。此外，采伐林窗和楞场的面积都应该减小。为了确保采伐迹地建群树种的更新，经营中应该在保护生物多样性的前提下，适当控制过于旺盛的灌木和草本层的生长。本研究结果将为采伐后作业迹地的恢复和森林的可持续经营提供科学的依据。图 1 表 4 参 14。

关键词：采伐；作业立地；干扰；更新；多样性

CLC number: S718.5 Document code: A

Article ID: 1007-662X(2005)01-0027-04

05-01-008

岷江上游景观格局变化研究/赵永华（中国科学院沈阳应用生态研究所，沈阳 110016，中国；中国科学院研究生院，北京 100039），何兴元，胡远满，常禹（中国科学院沈阳应用生态研究所，沈阳 110016，中国）//Journal of Forestry Research. –2005, 16(1): 31–34.

岷江上游地区位于青藏高原向四川盆地的过渡地段，其源头到都江堰市，包括汶川县、茂县、理县、黑水县和松潘县五个县。它是四川省乃至全国的一个重要的林区。在过去的几十年里，其景观结构发生了重要的变化。本文应用 3S 技术研究了该区在 1986 年到 2000 年之间的景观变化情况。该区的景观被划分为 10 个景观生态类型，即耕地、有林地、灌木林地、经济林、草地、居民用地、河流、湖泊、沼泽和未利用地。研究结果表明，在岷江上游地区林地和草地是该区主要的景观类型，约占全区面积的 91%，景观类型之间的变化主要发生在有林地、灌木林地、草地、耕地、居民用地和经济林之间，并且有林地面积从 51.17%下降到 47.56%。分析结果表明，岷江上游地区在过去的几十年里其景观的破碎化在加剧。图 1 表 2 参 20。

关键词：景观变化；岷江；四川；中国

CLC number: Q149 Document code: A

Article ID: 1007-662X(2005)01-0031-04

05-01-009

东北东部天然次生林的景观格局及破碎化分析——以黑龙江省帽儿山林场为例/李淑娟，隋玉正（中国海洋大学，青岛 266003,中国），孙志虎，王凤友，李玉文（东北林业大学,哈尔滨 150040，中国）//Journal of Forestry Research. –2005,16(1): 35–38.

帽儿山地区是东北东部山区较典型的天然次生林区，随着天然林保护工程的实施，森林经营管理越来越要求集约化，对天然次生林区的景观格局分析及评价是极其必要的。利用帽儿山林场 1：10000 的林相图（根据 1999 年航测照片及 1999 年调查材料绘制而成），1：10000 的土地利用现状图（1999）和实地调查资料，在 ARC/INFO 支持下，应用地理信息系统技术，对帽儿山林场各种景观类型的形状指数，破碎化指数进行了分析。自然景观的形状指数，形状破碎化指数均大于人工景观，而景观斑块数破碎化指数取决于斑块数目的多少。其中，天然林受人为干预较