

行政院國家科學委員會補助專題研究計畫成果報告

台灣東部海域之脂質

計畫類別：個別型計畫

計畫編號：NSC 92-2611-M-002-015

執行期限：92年8月1日至93年7月31日

計畫主持人：鄭偉力

共同主持人：林斐然

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執行單位：國立台灣大學海洋研究所

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一、中文摘要

本計畫於東部外海北緯 24°40' 至 23°30' 間採集到十二個表層(水深五公尺)懸浮物，並且分析其所含脂肪族碳氫化合物、脂肪醇與固醇。七個由浮游生物所衍生的烴類變化區間是 33% 至 79% 平均值為 63%，脂肪族碳氫化合物中主要成分是 C_{21:6} and squalene；其平均濃度分別為 27.2 μg/g (範圍是 2.28-82.0 μg/g) 與 24.5 μg/g (範圍是 2.99-94.6 μg/g)，高濃度出現於北方測站，然而較高濃度的 *n*-C₁₇ 與 *n*-C₁₈ 則出現於南方測站。碳優指數 *n*-C₂₅-*n*-C₃₃ 變化從 0.64 到 1.78 平均值為 1.25 略高於沖繩海槽(1.01)。值得一提的是 *n*-C₃₅ 展現相對高含量，*n*-C₃₅/*n*-C₃₃ 比值的變化範圍是 1.48-4.91。四個主要脂肪醇為 C₁₆, C₁₈, 與 C₂₂ 正脂肪醇以及葉綠素醇，最重要的是葉綠素醇其平均濃度為 91.5 μg/g (範圍是 19.9-264 μg/g)，C_{22:1} alkenol 出現於每一標本，其平均值為 2.06 μg/g (範圍是 0.942-3.98 μg/g)，但 C_{20:1} alkenol 並未檢測到。四種主要固醇在總固醇所佔百分比平均值為 49% (範圍是 44-56%)，顯示浮游生物貢獻較少，最重要的是膽固醇其平均濃度為 167 μg/g (範圍是 30.1-375 μg/g)。

關鍵詞：脂質、懸浮物、台灣東部

Abstract

In this proposal, twelve samples of total suspended matter (5 m below sea surface) were collected from the sea between latitude 24°40' and 23°30' off eastern Taiwan. They were analyzed for aliphatic hydrocarbons, fatty alcohols and sterols. The percentages of the 7 planktonically-derived hydrocarbons (PDHC) in TSM ranged from 33% to 79% with an average of 63%. Major components in the aliphatic hydrocarbons fraction were C_{21:6} and squalene; their average concentrations were respectively 27.2 μg/g (range 2.28-82.0 μg/g) and 24.5 μg/g (range 2.99-94.6 μg/g) with higher concentrations found at north stations. However, relatively higher concentrations of *n*-C₁₇ and *n*-C₁₈ were found at south stations. Carbon preference indices for *n*-C₂₅-*n*-C₃₃ ranged from 0.64 to 1.78 with a mean of 1.25, higher than that (1.01) of the Okinawa Trough. Of special interest is that *n*-C₃₅ exhibited a relatively high content; the ratio of *n*-C₃₅/*n*-C₃₃ varied from 1.48 to 4.91. C₁₆, C₁₈, and C₂₂ *n*-alkanols along with phytol were the

four predominant alcohols. The most important component was phytol, which averaged 91.5 $\mu\text{g/g}$ (range 19.9-264 $\mu\text{g/g}$). The $\text{C}_{22:1}$ alkenol was present in every sample, averaging 2.06 $\mu\text{g/g}$ (range 0.942-3.98 $\mu\text{g/g}$), but no $\text{C}_{20:1}$ alkenol was detected. Four major sterols in TSM off eastern Taiwan averaged 49% of the total sterols (range 44-56%), suggesting relatively less contribution from plankton. The most important sterol was cholesterol with a mean of 167 $\mu\text{g/g}$ (range 30.1-375 $\mu\text{g/g}$).

Keywords: lipid, suspended matter, eastern Taiwan

二、緣由與目的

The lipid inputs by suspended matter/sediment transport to the seas off northeastern Taiwan (i.e. southernmost Okinawa Trough) can be from three sources. From the northwest, a small alongshore flow just off north Taiwan along with the eddy flow may carry materials from the southern East China Sea and Taiwan Strait (west of Taiwan) to this area. The Lanyang River discharges its sediment (ca. 8.0 Mt/y, Water Resources Bureau, 1998) directly to this area, and the contribution of lipids from this river run-off is clearly direct and significant. Another source from south is other river runoffs from eastern Taiwan carried by the Kuroshio Current to the Okinawa Trough. The respective contributions of lipids from

these three major sources to this area are not yet known.

One important and useful parameter for identifying lipid sources is the carbon preference index (CPI) of *n*-alkanes ($\text{C}_{25}\sim\text{C}_{33}$). Terrestrial higher plant wax contribution to sediment or soil is generally expressed by CPI of *n*-alkanes. Higher CPI values indicate greater contribution from vascular plants (Rieley et al., 1991); ancient sediments and fossil fuels tend to have CPI values of around 1 (Bray and Evans, 1961). The southernmost Okinawa Trough off northern Taiwan has the highest plant wax *n*-alkane contribution (average CPI 3.9 ± 1.2) among the coastal marine areas surrounding Taiwan (Jeng et al., 2003); lateral particle transport from the southern East China Sea shelf might be an important source as most researchers thought. However, the average CPI of the immediate shelf (off northeast Taiwan) sediments is 1.9 ± 0.5 (Jeng and Huh, 2001) and that of the East China Sea shelf is 2.0 ± 0.5 (Jeng, 2001). These CPI values of the East China Sea shelf are relatively low. It is quite unlikely that the southern East China Sea shelf is a predominant source for sedimentary lipids in the Okinawa Trough. The Lanyang River is seemingly a direct lipid source of this area. However, radiocarbon dating gave very old apparent ages ($>10,000$ yr) to the total suspended matter (TSM) in the main channel (Kao and Liu, 1996), that is, the percentages of modern

carbon in the TSM from the main channel are <30%. Therefore, the CPI values of TSM from the Lanyang River are expected to be low. Nine TSM samples from the Lanyang River were analyzed, the CPI values ranged from 1.14 to 2.35 with an average of 1.62 (Jeng and Kao, 2002), suggesting that lipid contribution from the Lanyang River is relatively less important. Another lipid source from the south of the Okinawa Trough is totally unknown, that is, river runoffs from the east Taiwan coast are considered to be the major contributors. Among the 28 rivers on the eastern coast, three major rivers south of the Lanyang River--the Hualien River, the Hsiukuluan River and the Peinan River--account for one-quarter of the total sediment export from Taiwan. Their runoffs altogether carried by the Kuroshio can be a large contribution to the sediment in the southern Okinawa Trough.

A survey of lipid composition and distribution in the area south of the Okinawa Trough—upstream of the Kuroshio Current will provide us with further information about the terrigenous lipid contribution from eastern Taiwan. The areas near the estuaries of the Hualien River, the Hsiukuluan River and the Peinan River were investigated. Suspended matter is comparatively more dynamic than the bottom sediment and will eventually be deposited on the sea floor. In the present proposal, total suspended matter in upper water column

on the east shelf and slope was sampled and analyzed for its lipid composition--aliphatic hydrocarbons, fatty alcohols and sterols.

三、結果與討論

In the East China Sea, seven most predominant components of TSM were *n*-C₁₇, pristane, *n*-C₁₈, *n*-C_{19:1}, *n*-C₁₉, *n*-C_{21:6} and squalene; other *n*-alkanes up to C₃₅ were minor ones. The 7 hydrocarbons are produced chiefly from plankton (Winters et al., 1969; Blumer et al., 1971) and are termed planktonically derived hydrocarbons (PDHCs). High percentages (80-94%) of the seven PDHCs have been observed at 8 stations, but relatively low percentages (45-61%) have been found at 3 stations (Jeng and Huh, 2004). The percentages of the 7 PDHC in the southern Okinawa Trough ranged from 23% to 62% with an average of 39% (Jeng, 2003). These values were comparatively low, probably attributing to the low productivity in the Okinawa Trough because Kuroshio water is oligotrophic. The percentages of the 7 planktonically-derived hydrocarbon (PDHC) in TSM off eastern Taiwan ranged from 33% to 79% with an average of 63%. In general, *n*-C_{21:6} and squalene were markedly pronounced and showed extremely high concentrations at the three northernmost stations and decreased southwards. Also, elevated *n*-C₁₇ and *n*-C₁₈ were found at four stations in the south. Of

special interest is that $n\text{-C}_{35}$ exhibited a relatively high content; the ratio of $n\text{-C}_{35}/n\text{-C}_{33}$ varied from 1.48 to 4.91. This is rather unusual since the relative amounts of odd-carbon-numbered n -alkanes from higher plants generally exhibit a decreasing trend of $n\text{-C}_{31} > n\text{-C}_{33} > n\text{-C}_{35}$ in the marine environment surrounding Taiwan (Jeng and Huh, 2001). The present result could be a contribution of terrigenous matter from somewhere south of Taiwan carried by the Kuroshio. The average CPI in the range of $\text{C}_{25}\text{-C}_{35}$ for the 7 suspended matter in the Okinawa Trough is surprisingly low, 1.01. This is mainly because the Lanyang river exports relatively low CPI in its suspended matter to the adjacent seas (Jeng and Kao, 2002). Carbon preference indices of TSM south of the Okinawa Trough (i.e. off eastern Taiwan) ranged from 0.64 to 1.78 with a mean of 1.25. This value is a little higher than that of the Okinawa Trough, indicating an additional contribution from inputs of rivers on eastern Taiwan.

In the lower molecular weight region, C_{16} and C_{18} n -alkanols along with phytol were the major components; their relative proportions in TSM samples in general were higher at north stations than at south stations. However, C_{22} n -alkanol was the most abundant alkanol in the higher molecular weight region. This is consistent with those found in sediments from the Okinawa Trough and East China Sea

(Jeng and Huh, 2001; Jeng et al., 2003). Its source is considered from microorganisms (Cranwell, 1981). In addition, The $\text{C}_{22:1}$ alkenol was present in every sample, averaging 2.06 $\mu\text{g/g}$ (range 0.942-3.98 $\mu\text{g/g}$), but no $\text{C}_{20:1}$ alkenol was detected. This indicates relatively less contribution from zooplankton as compared with the results from the East China Sea (Jeng et al., 2003).

In the East China Sea, four major sterols in TSM are cholest-5-en- 3β -ol (cholesterol), 27-nor-24-methylcholesta-5,22E-dien- 3β -ol, cholesta-5,22E-dien- 3β -ol (22-dehydrocholesterol), 24-methylcholesta-5,22E-dien- 3β -ol (brassicasterol/diatomsterol); they account for 55% of the total sterols (range 39-69%). However, these four sterols in TSM off eastern Taiwan averaged 49% of the total sterols (range 44-56%), suggesting relatively less contribution from plankton.

四、計畫成果自評

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五、參考文獻

- Blumer, M., Guillard, R. R. L., Chase, T., 1971. Hydrocarbons of marine phytoplankton. Mar. Biol. 8, 183-189.
- Bray, E. E., Evans, E. D., 1961. Distribution of n -paraffins as a clue to recognition of source beds. Geochim.

- Cosmochim. Acta 22, 2-15.
- Cranwell, P. A., 1981. Diagenesis of free and bound lipids in terrestrial detritus deposited in a lacustrine sediment. *Org. Geochem.* 3, 79-89.
- Jeng, W. L., 2001. Lipids in the shelf sand and mud. Final report to NSC, grant no. NSC 89-2611-M-002-044 (89/8/1~90/7/31).
- Jeng, W. L., 2003. Lipids in suspended matter in the southern Okinawa Trough. Final report to NSC, grant no. NSC 91-2611-M-002-008. (91/8/1~92/7/31).
- Jeng, W. L., Huh, C. A. 2001. Comparative study of sterols in shelf and slope sediments off northeastern Taiwan. *Appl. Geochem.* 16: 95-108.
- Jeng, W. L., Kao, S. J. 2002. Lipids in suspended matter from the human-disturbed Lanyang River, northeastern Taiwan. *Environ. Geol.* 43, 138-144.
- Jeng, W. L., Lin, S., Kao, S. J., 2003. Distribution of terrigenous lipids in marine sediments off northeastern Taiwan. *Deep-Sea Res. II.* 50, 1179-1201.
- Jeng, W. L., Huh, C. A., 2004. Lipids in suspended matter and sediments from the East China Sea Shelf. *Organic Geochemistry* 35, 647-660.
- Kao, S. J., Liu, K. K., 1996. Particulate organic carbon export from a subtropical mountainous river (Lanyang Hsi) in Taiwan. *Limnol. Oceanogr.* 41: 1749-1757.
- Rieley, G., Collier, R. J., Jones, D. M., Eglinton, G., 1991. The biogeochemistry of Ellesmere Lake, U.K.—I: source correlation of leaf wax inputs to the sedimentary lipid record. *Org. Geochem.* 17, 901-912.
- Water Resources Bureau, 1998. Hydrological Year Book of Taiwan Republic of China 1997, Ministry of Economic Affairs, Taipei, Taiwan, Republic of China.
- Winters, K., Parker, P. L., Van Baalen, C., 1969. Hydrocarbons of blue-green algae: geochemical significance. *Science* 158, 467-468.