紅尾蝦養殖池排放水中懸浮固體物的含量及其對水質之影響研究初報

謝介士*・廖一久**

摘　　要

建立養殖池池水的循環使用,是解決地層下陷及水資源不足等問題的方法之一,而要建立該等系統,則必須事先瞭解養殖池排放水的水量與水質。

本報告即調查紅尾蝦池排放水中懸浮固體物的含量及其對水質的影響,並嘗試探討分別由生物排泄物或飼料殘餌所造成的懸浮固體物,其對水質的影響,所得結果如下：

1. 紅尾蝦池排放水中,其懸浮固體物的含量是 4～145mg/ℓ,其中顆粒大小爲 0.1～0.2μm 者佔 27%,0.2～0.45μm 者佔 18%,0.45～0.65μm 者佔 15%,0.65～0.8μm 者佔 20%,0.8μm 以上者則佔 20%。
2. 排放水中懸浮固體物未除去者,其水中氨氮在 20 天內的增加量,比去除者高出 2～3 倍。
3. 飼料殘餌愈多者,其水中的氨氮及亞硝酸鹽氮亦愈高。而紅尾蝦所排出的體液或排泄物則似乎能促進硝化細菌的硝化作用。

關鍵詞：紅尾蝦、懸浮固體物。

前　　言

養蝦事業的蓬勃發展,導致地下水被大量地抽取,因而造成了嚴重的地層下陷,爲了避免情況的繼續惡化,必須有效且適量地利用地下水資源。因此如何循環使用養蝦用水,實爲迫在眉睫之重要課題。

養蝦池池水的循環系統,必須有效且經濟可行,因此設計之前,一定得先瞭解養蝦池排放水的水質及水量。但目前養蝦池排放水的水質資料仍顯不足,尤其有關懸浮固體物之排放量的資料更是缺乏,對養蝦池循環水系統之建立影響甚大。

所謂懸浮固體物係指水中呈浮游或懸濁狀的固形顆粒之總稱,包括浮游生物及其殘骸、水中動物的排泄物、有機碎片及無機微粒子等。其在養蝦池排放水中的含量及成份,對整個循環水系統的運作影響相當大,因它在水中會繼續分解,而影響水質；此外,若其在未分解前,進入循環系統中的硝化過濾設備,則會使過濾床堵塞,而使其過濾或硝化作用的效果降低,因此在建立循環水系統時,應設有去除懸浮固體物之設備。而要探討去除懸浮固體物的方法之前,則必須先瞭解養蝦池排放水中懸浮固體物之含量成份以及其對水質之影響,以作爲設計去除設備之參考。因此,本文即以

* 台灣省水產試驗所東港分所
** 台灣省水產試驗所

紅尾蝦（*Penaeus penicillatus*）爲對象,探討其飼養在泥土底養殖池的排放水中,懸浮固體物之含量、成份及其腐敗分解後對水質的影響；另外,亦探討飼料及紅尾蝦的排泄物對水質之影響,以作爲設計循環系統之參考。

材料與方法

紅尾蝦養殖池排放水中懸浮固體物含量的測定：

在東港分所 10m×20m 的泥土底養蝦池中,放養 4000尾的紅尾蝦幼苗,每天的換水率約 1/3～1/2,從放養於養成池之日開始,每隔十天定期採集其排放水一次,以 Whatman GFC 玻璃纖維濾紙過濾,測定其懸浮固體物含量[1],並以 Advantec 牌之不同孔徑的薄膜濾紙測定不同顆粒大小的懸浮固體物所佔的比率,同時測定池水的透明度[2]及葉綠素[3]含量。

紅尾蝦養殖池排放水中懸浮固體物對水質的影響：

採取紅尾蝦養殖池的排放水 8 ℓ 於 10 ℓ 的透明塑膠桶內,分別試驗在以 Advantec 牌 0.45μm 薄膜濾紙過濾與否,以及打氣與否等不同條件下,其排放水水質變化的情形,並定時測定其 pH 値、總鹼度、硝酸鹽氮、亞硝酸鹽氮及氨氮[4]。

草蝦飼料和紅尾蝦的排泄物對水質的影響試驗：

在 10 ℓ 的透明塑膠桶內,裝入 8 ℓ 以 Advantec 牌 0.45μm 薄膜濾紙過濾的海水,鹽度爲 32ppt,分別放入 0、1、2、4g 的市售中型草蝦用飼料,每天定時測定其pH値、總鹼度、硝酸鹽氮、亞硝酸鹽氮及氨氮；另一組試驗,則是重複上述的處理,而於每一桶子內,多放入兩尾平均體重爲 8g 的紅尾蝦,24小時後取出,然後繼續在打氣的條件下,每天定時測定其水質變動情形,以瞭解紅尾蝦的排泄物對水質的影響。

結果與討論

懸浮固體物的含量：

懸浮固體物的含量經測定結果爲 4～145mg/ℓ 之間,其中有兩次測定値超過環保署所訂定的放流水標準（100mg/ℓ）,分別爲 127mg/ℓ 和 145mg/ℓ；而其變化與同時間所測得之透明度及葉綠素 A 的含量,在統計學上均不顯著（$P>0.05$）（Fig.1,2）,但若採樣次數增加,則似乎可尋出排放水中懸浮固體物含量與池水透明度之關係（Fig.2）。因此在紅尾蝦養殖池的排放水中,其懸浮固體物最主要成份應該是由有機與無機顆粒所組成,而藻類所佔的比率較低,但仍須再詳加探討。另外,排放水中懸浮固體物的顆粒大小爲0.1～0.2μm 者佔 27%,0.2～0.45μm 者佔 18%,0.45～0.65μm 者佔 15%,0.65～0.8μm 者佔 20%,0.8μm 以上者則佔 20%。

懸浮固體物對水質的影響：

由 Fig.3 可知,紅尾蝦養殖池的排放水之 pH 値在 20 天內均在8.00～8.25 之間,變動不大,故可知排放水的 pH 値相當穩定。由 Fig.4 可知,其總鹼度亦維持在 125～150mg/ℓ as $CaCO_3$ 之間,變化不大,亦即排放水中的 CO_2,HCO_3^- 及 CO_3^{2-} 濃度並沒有顯著的變化。而由 Fig.5,6,7 可知,在無機氮化合物之變化方面,未經濾紙過濾的排放水之氨氮濃度,在 20 天內明顯地高出已過濾的試驗組很多,其懸浮固體物在第九天時已有大部份開始分解而產生氨氮,尤其在打氣的條件下,其變化

更快；至於經過濾處理的排放水,雖亦有氨氮產生,但濃度則低得多,而與未過濾組相同的是,在打氣的條件下,變化亦較大。因此排放水中打氣與否,對水質有顯著的影響。由 Fig.6 可知,未過濾組之亞硝酸鹽氮濃度高出已過濾組很多,而打氣者比未打氣者爲高,這可能是因爲在打氣的條件下,硝化作用較易進行。

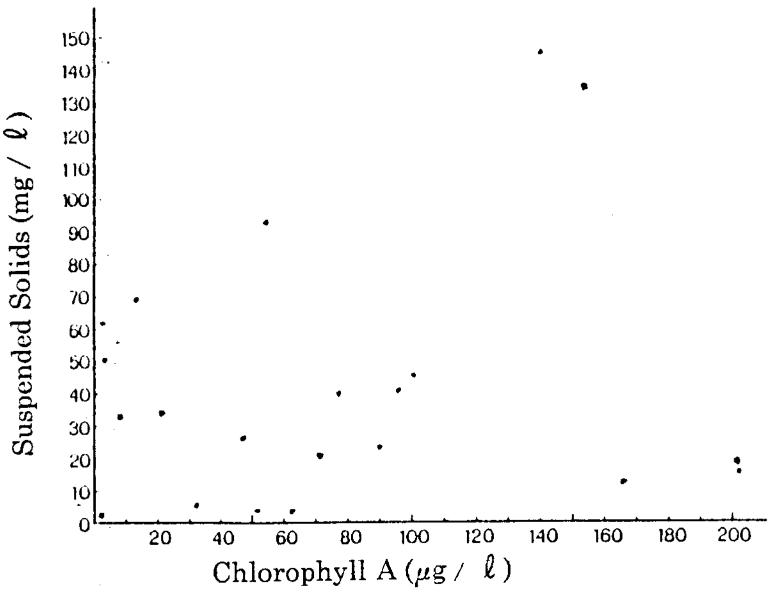

Fig.1. The relationship between suspended solid and chlorophyll A in *Penaeus penicillatus* ponds.

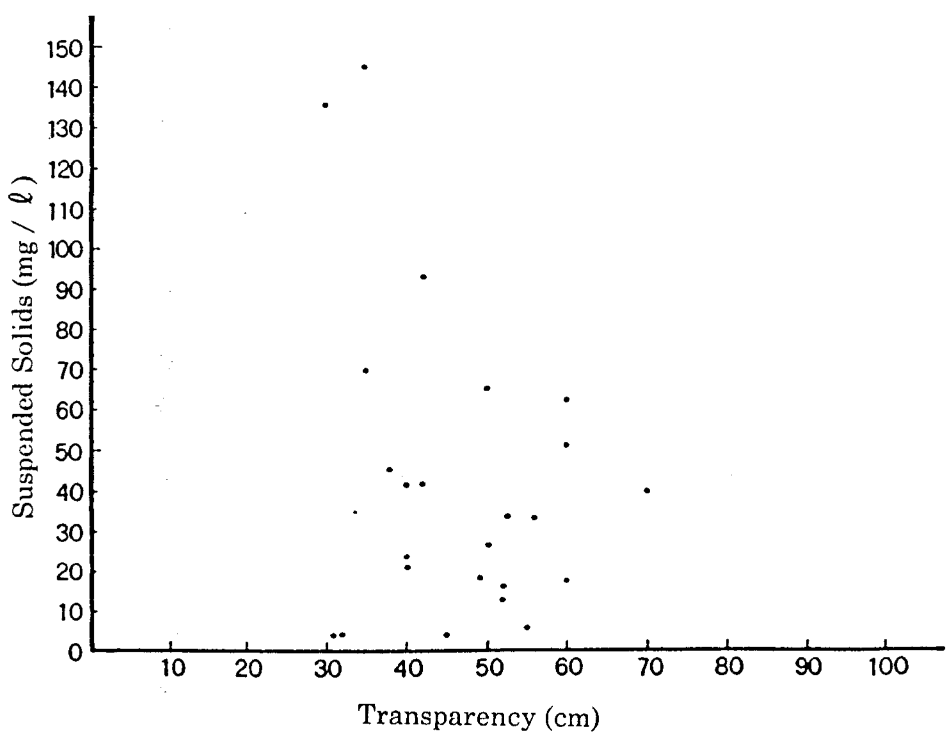

Fig.2. The relationship between suspended solid and transparency in *P. penicillatus* ponds.

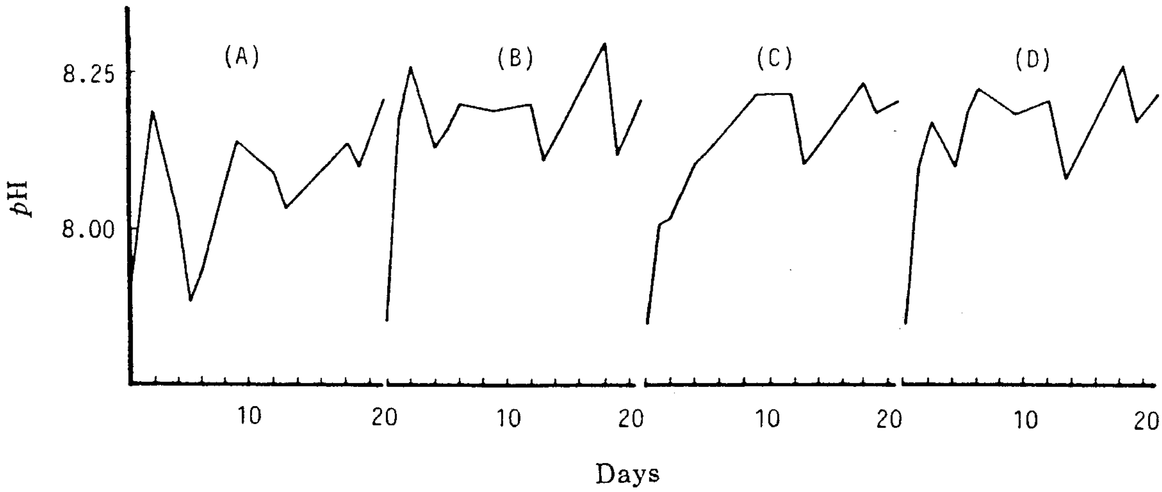

Fig.3. Variation in pH of *P. penicillatus* pond effluence by using defferent treatments:(A) no filter and no aeration, (B) no filter and aeration, (C) filter and no aeration, and (D) filter and aeration.

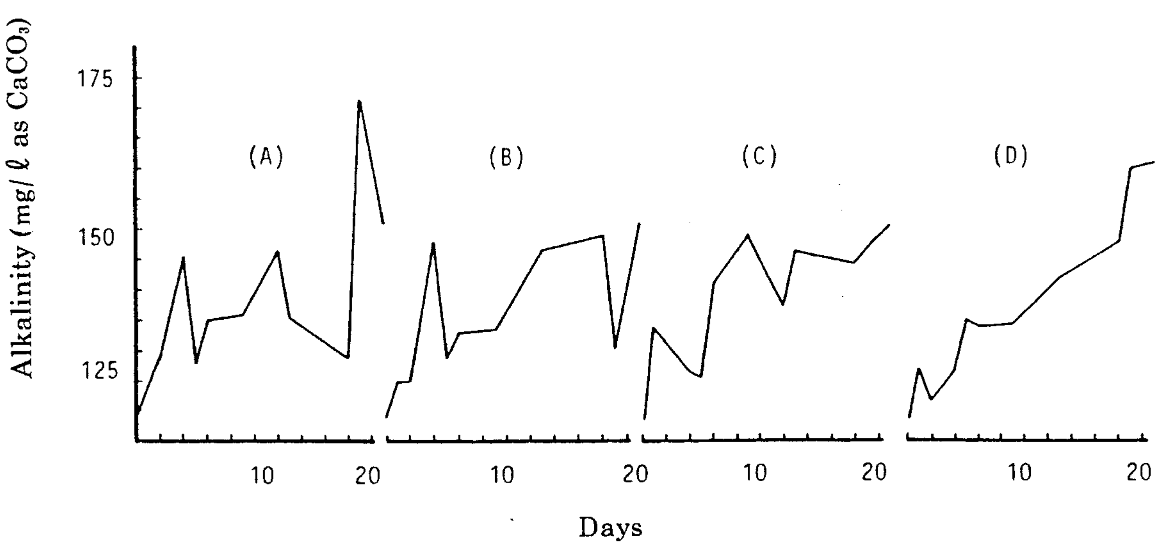

Fig.4. Variation in alkalinity of *P. penicillatus* pond effluence by using different treatments:(A) no filter and no aeration, (B) no filter and aeration, (C) filter and no aeration, and (D) filter and aeration.

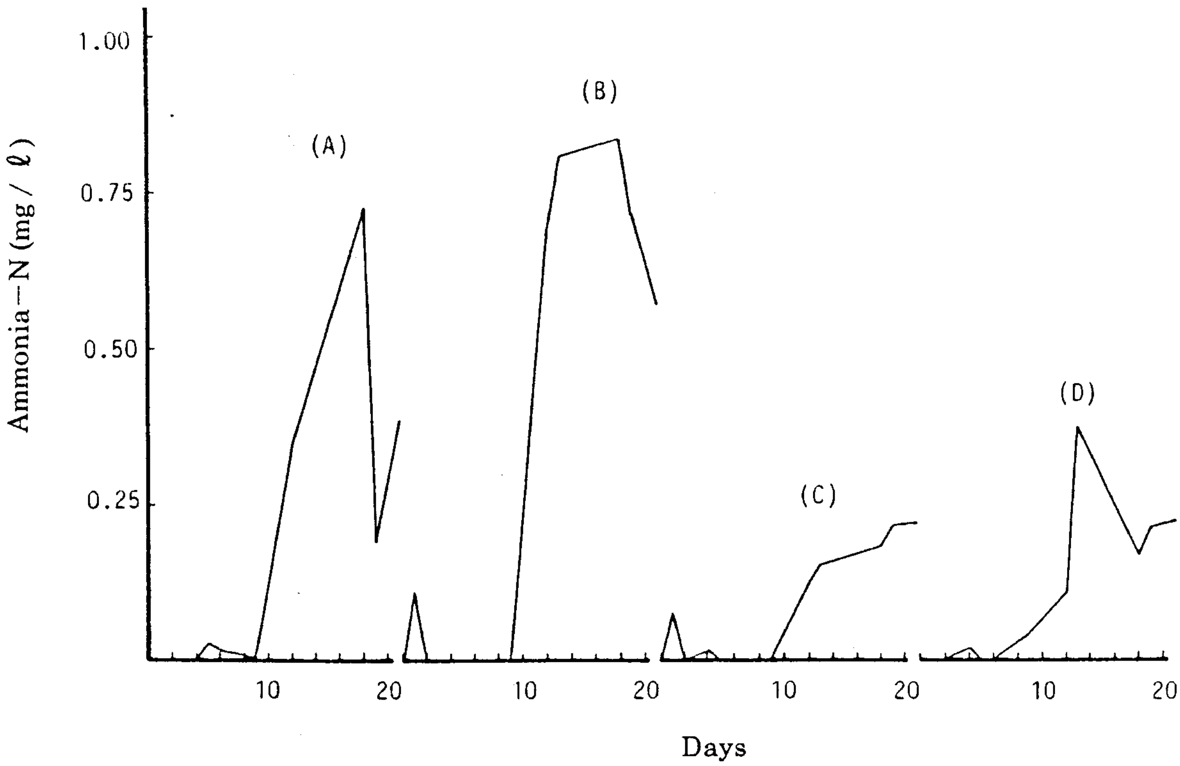

Fig.5. Variation in total ammonia-N of *P. penicillatus* pond effluence by suing different treatments: (A) no filter and no aeration, (B) no filter and aeration, (C) filter and no aeration, and (D) filter and aeration.

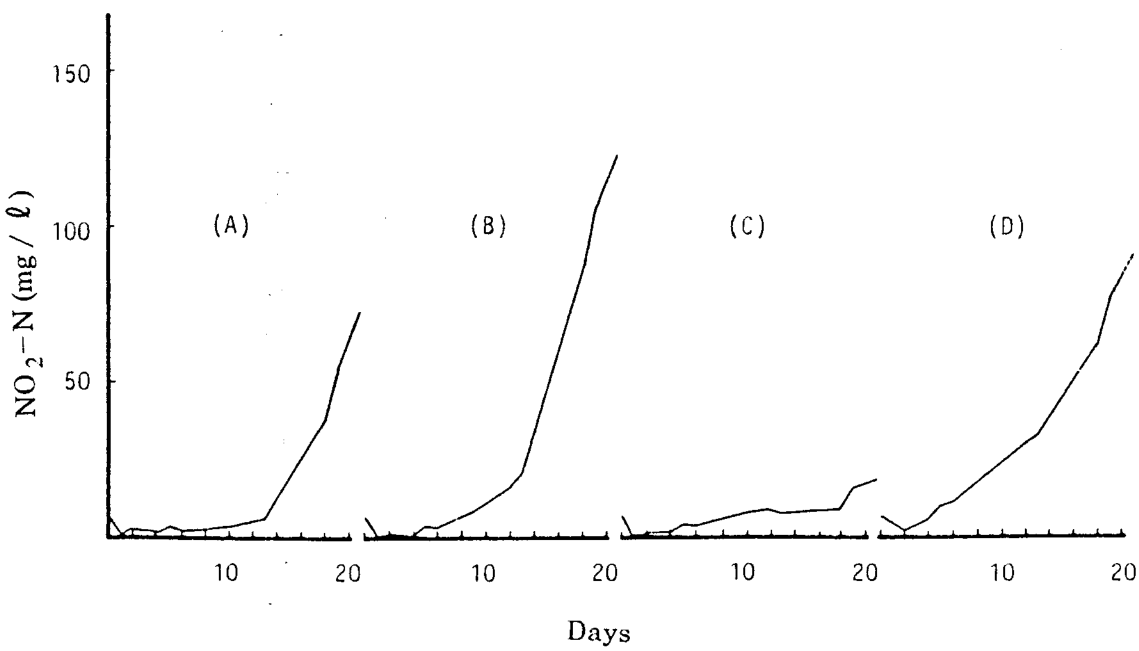

Fig.6. Variation in nitrite-N of *P. penicillatus* pond effluence by suing different treatments: (A) no filter and no aeration, (A) no filter and no aeration, (B) no filter and aeration, (C) filter and no aeration, and (D) filter and aeration.

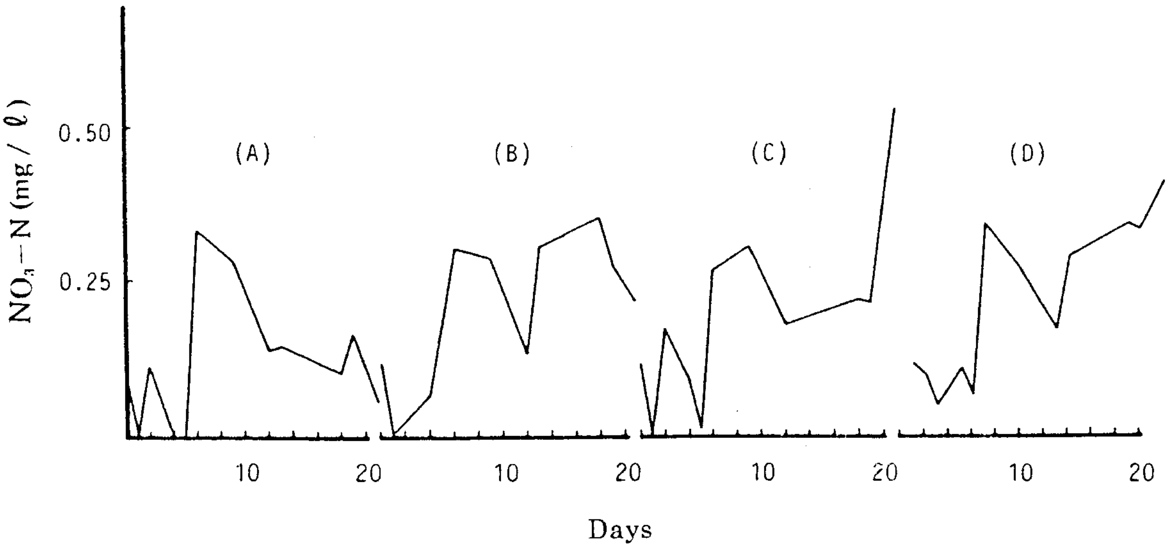

Fig.7. Variation in nitrite-N of *P. penicillatus* pond effluence by using different treatments: (A) no filter and no aeration, (B) no filter and aeration, (C) filter and no aeration, and (D) filter and aeration.

草蝦飼料和紅尾蝦的排泄物對水質的影響：

Fig.8 顯示,海水中未加入飼料時,在 10 天內,其水質均非常的穩定；但加入飼料之後,水質就發生很大的變化,尤其無機氮化合物,隨試驗時間的延長,其濃度亦逐漸上升,且加入的飼料量愈多,其變化愈大（ Fig.9、10、11 ）。由此可見,養殖過程中,必須控制適當的給餌量,否則投飼過多的飼料,造成殘餌,將嚴重地敗壞水質。由 Fig.12 可知,在海水中雖未投飼料,但放入二尾紅尾蝦 24 小時後,可能由於其分泌的體液或排泄物的影響,水質亦發生明顯的變化。由 Fig.13,14,15 發現,在放有不同份量的草蝦飼料及二尾紅尾蝦的試驗桶中,其水質有明顯的變化,氨氮均是先增高後下降,亞硝酸鹽氮和硝酸鹽氮則逐漸上升,總鹼度則有下降的趨勢。由此可知,試驗桶中雖有飼料和蝦的排泄物存在,但因硝化細菌進行硝化作用的結果,使得亞硝酸鹽氮和硝酸鹽氮濃度逐漸增加。 Boyd[2] 曾提出硝化作用進行時,所釋放出的 H^-,可降低總鹼度；Morel[5] 亦曾提出密閉系統中,硝化細菌進行硝化作用,將銨離子轉變成亞硝酸鹽時,總鹼度會明顯下降；這些可能都是因爲硝化細菌作用的結果,亦即紅尾蝦所分泌的體液或排泄物似乎能促進硝化細菌的硝化作用,值得再詳加探討。

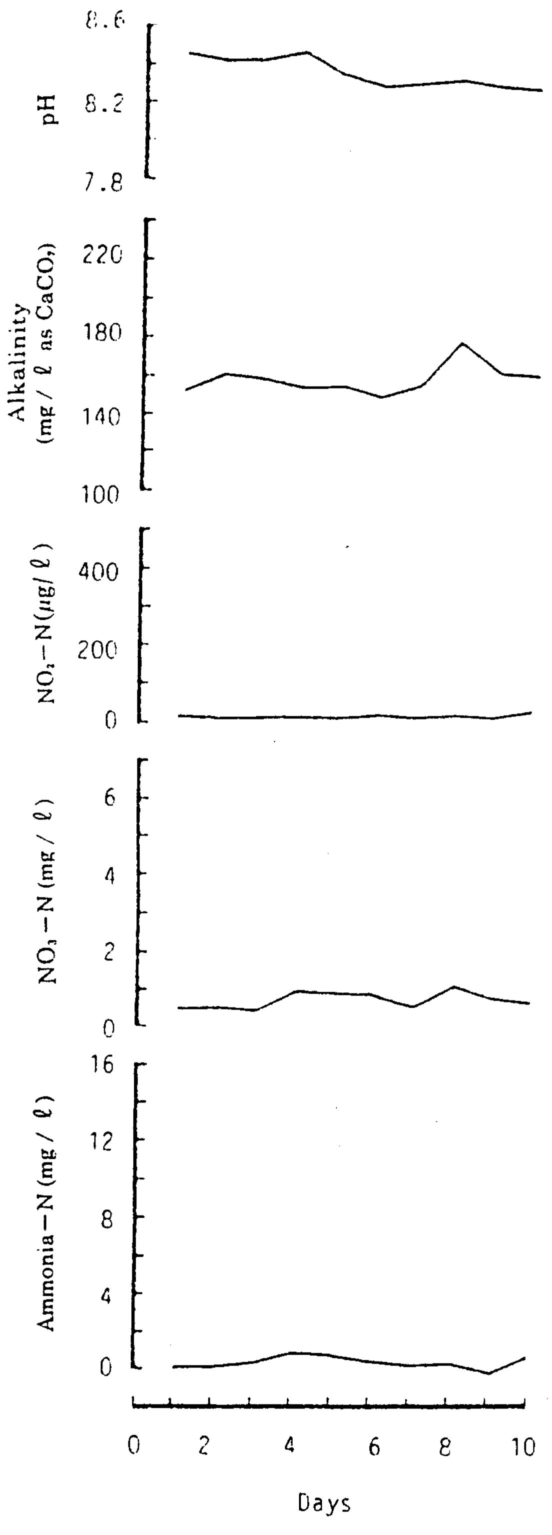

Fig.8. Variation in water quality of 8 ℓ filter seawater in 10 ℓ transparent plastic tank under aerated condition.

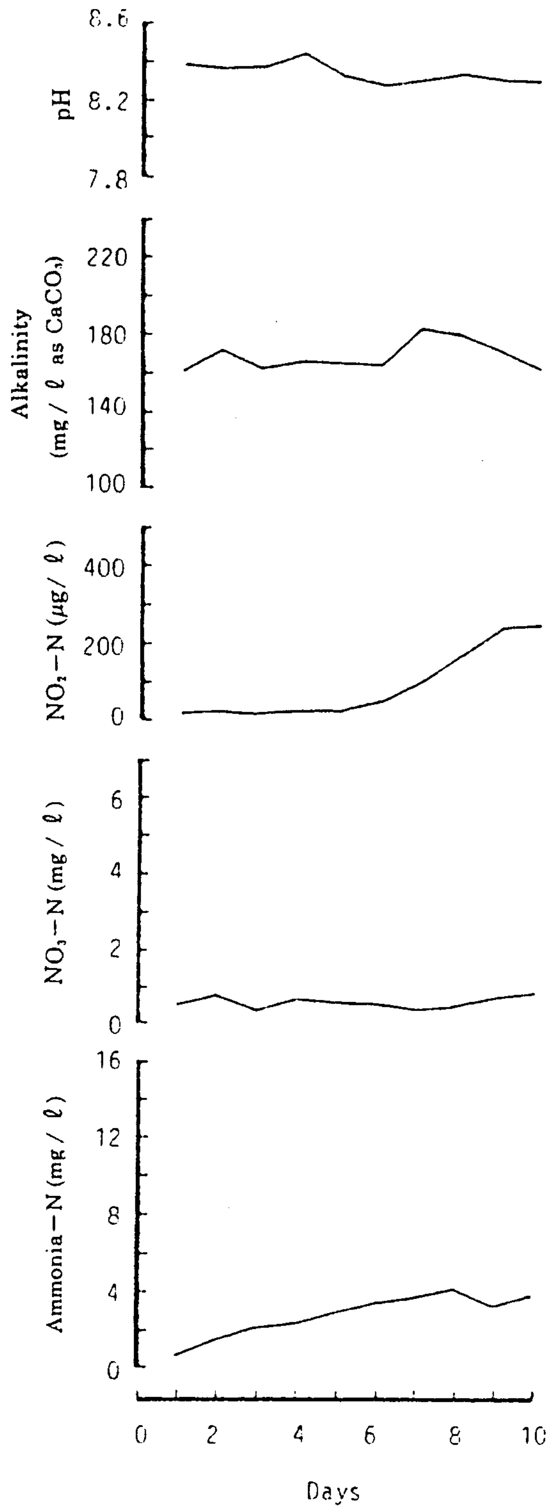

Fig.9. Variation in water quality of 8 ℓ filter seawater containing 1g feed in 10 ℓ transparent plastic tank under aerated condition.

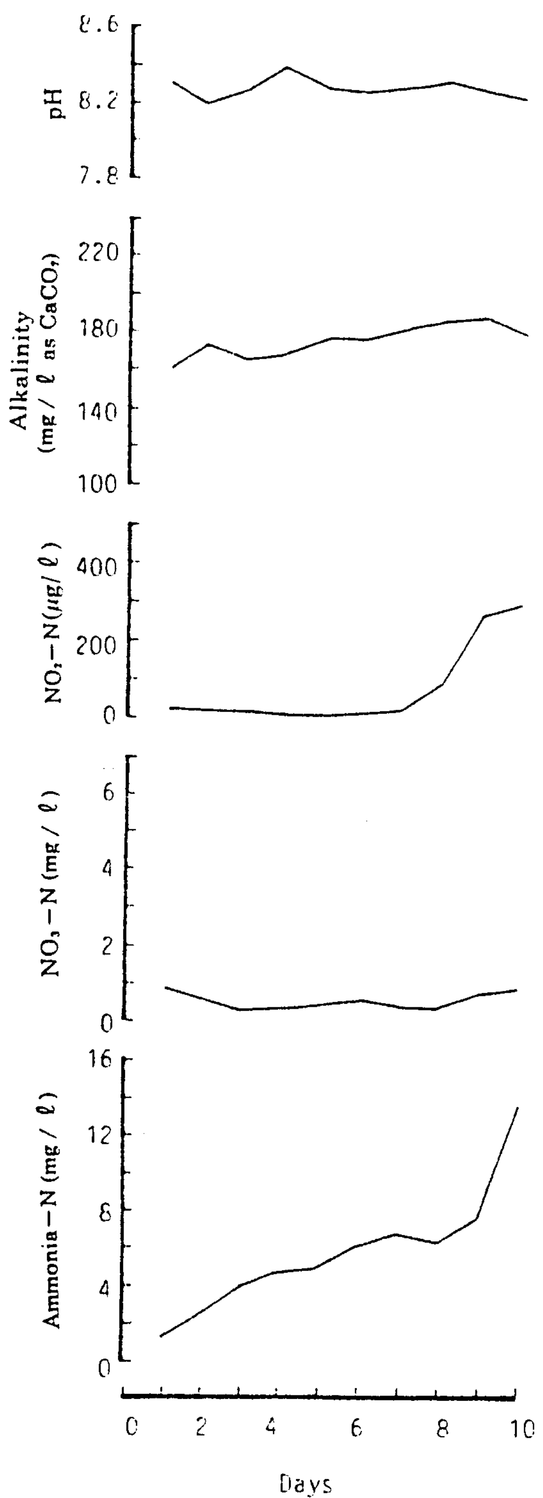

Fig.10. Variation in water quality of 8 ℓ filter seawater containing 2g feed in 10 ℓ transparent plastic tank under aerated condition.

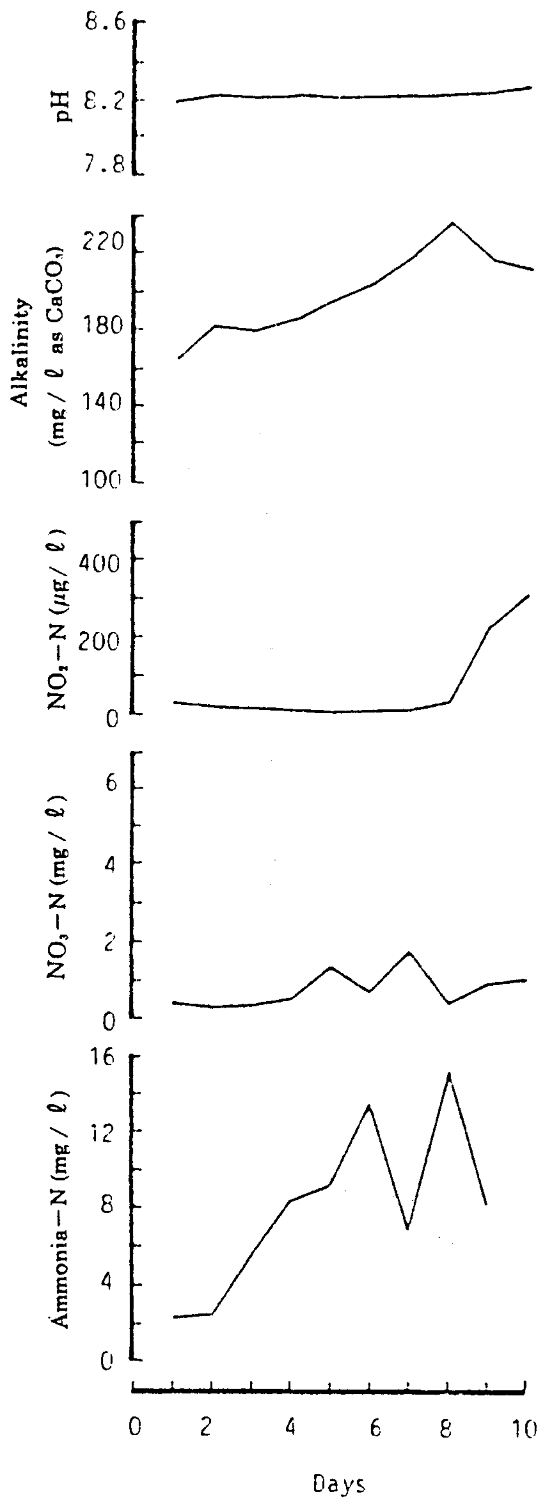

Fig.11. Variation in water quality of 8 ℓ filter seawater containing 4g feed in 10 ℓ transparent plastic tank under aerated condition.

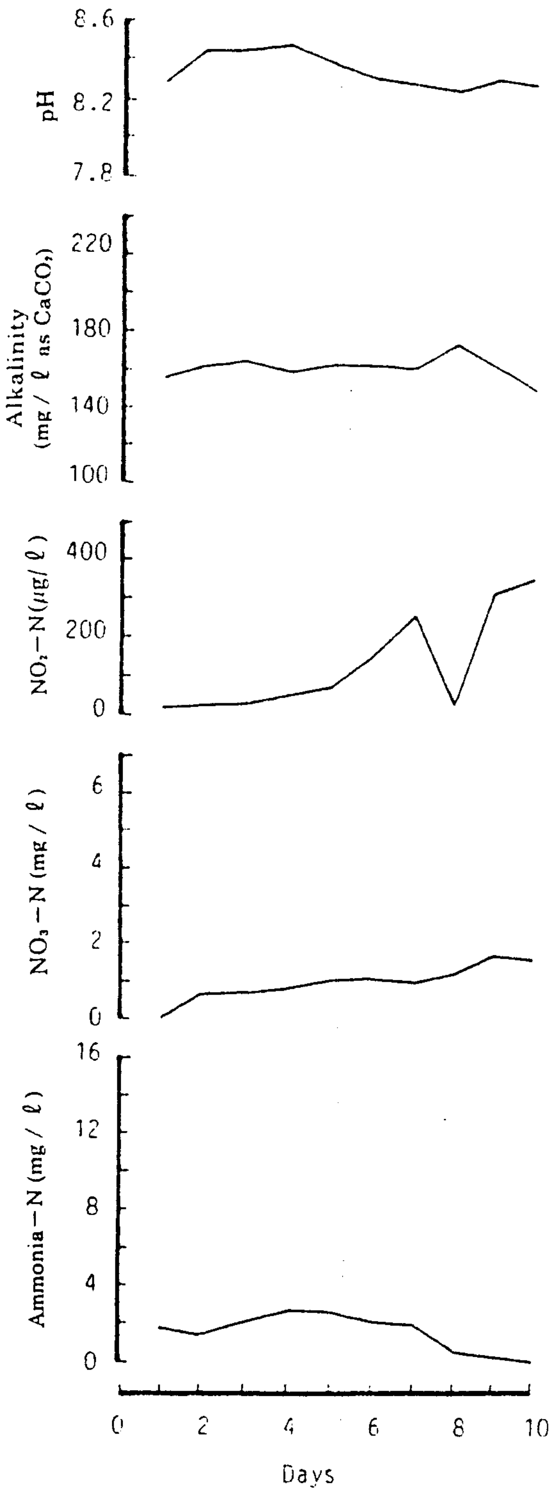

Fig.12. Variation in water quality of 8 ℓ filter seawater containing 2 shrimp in 10 ℓ transparent plastic tank under aerated condition.

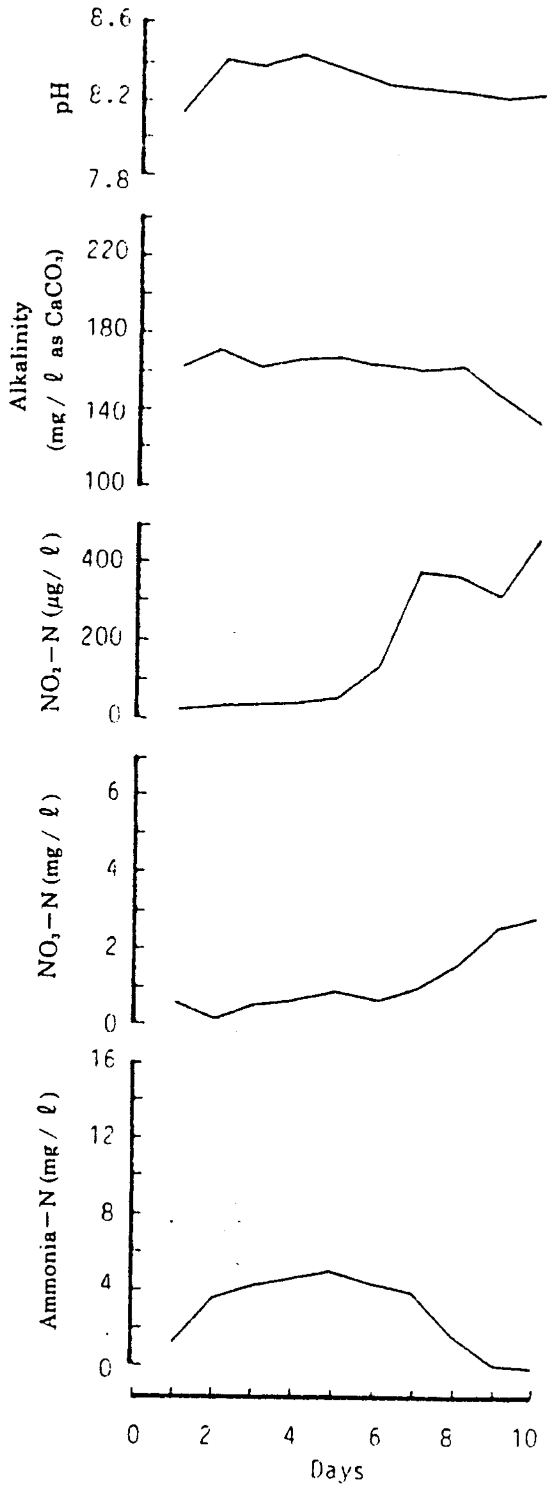

Fig.13. Variation in water quality of 8 ℓ filter seawater containing 1g feed and 2 shrimp in 10 ℓ transparent plastic tank under aerated condition.

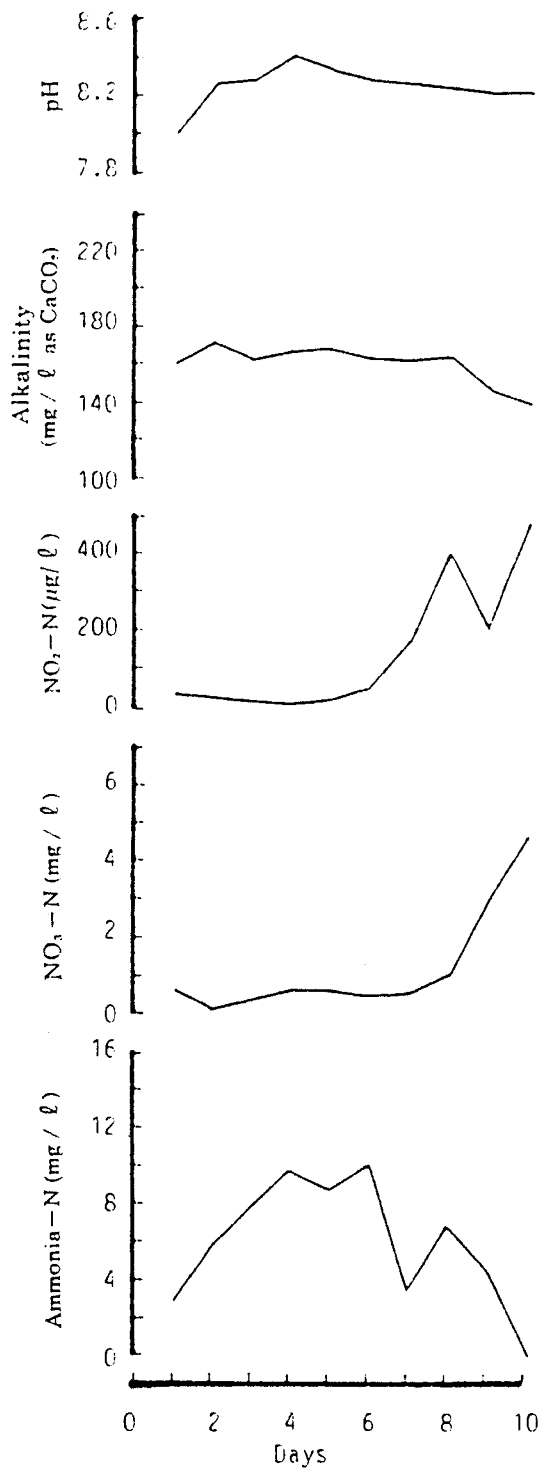

Fig.14. Variation in water quality of 8 ℓ filter seawater containing 2g feed and 2 shrimp in 10 ℓ transparent plastic tank under aerated condition.

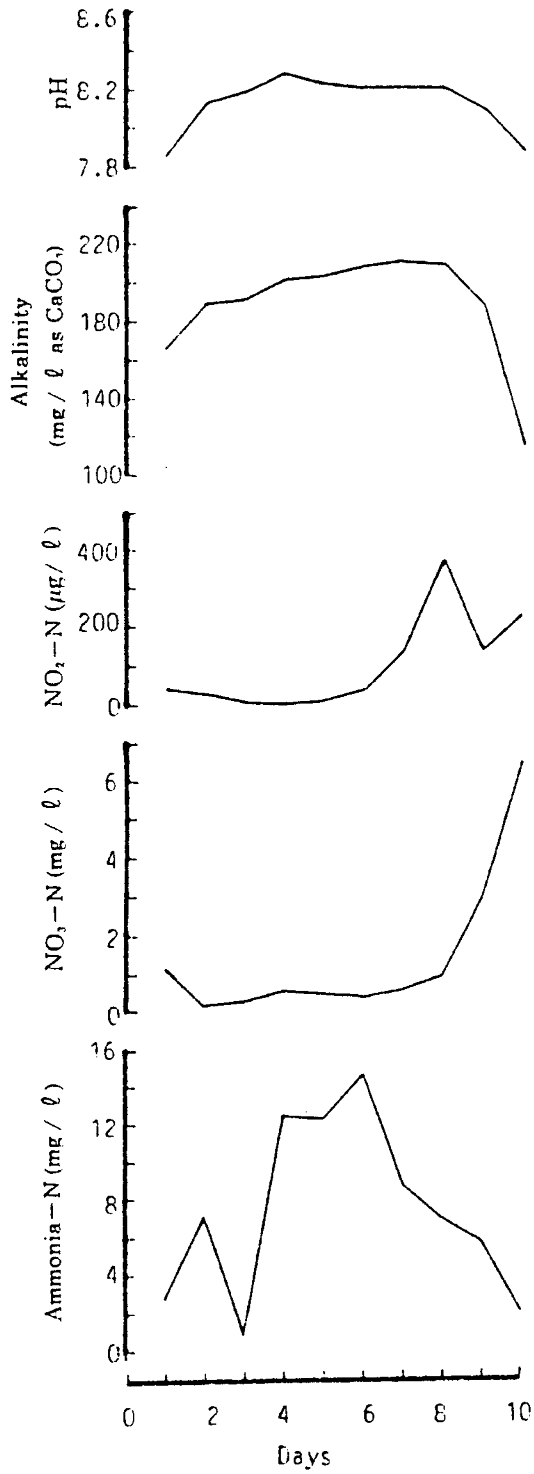

Fig.15. Variation in water quality of 8 ℓ filter seawater containing 4g feed and 2 shrimp in 10 ℓ transparent plastic tank under aerated condition.

參考文獻

1. APHA(American Public Health Assocation) (1985). Standard method for examination of water and wastewater. Published by American Public Health Association, Washington, D.C., p.92 – 100.
2. Boyd, C.E. (1979). Water quality in warmwater fish ponds. Auburn Univ. Agricul. Exp. Stat. Auburn, Alabama, U.S.A., p.276 – 279.
3. Parsons, T.R., Y. Maita and C.M. Lalli (1984). A manual of chemical and biological methods for seawater analysis. Pergamon Press, New York, U.S.A., p.3 – 8.
4. Nimura, Y. (1973). A direct estimation of microgram amounts of ammonia in water without salt – error. Bull. Japan. Soc. Sci. Fish., 39 (12) : 1315 – 1324.
5. Morel F.M.M., J. Wiley and S. Chichester (1983). Principles of aquatic chemistry. Wiley – Interscience Press, U.S.A., p.127 – 177.

PRELIMINARY REPORT ON THE SUSPENDED SOLIDS FROM THE EFFLUENT OF *PENAEUS PENICILLATUS* CULTURED POND AND ITS EFFECT ON THE WATER QUALITY

Chieh-Shih Hsieh[1] *and I-Chiu Liao*[2]

[1]*Tungkang Marine Laboratory, Taiwan Fisheries Research Institute, Tungkang, Pingtung, Taiwan*
[2]*Taiwan Fisheries Research Institute, Keelung, Taiwan*

ABSTRACT

A recirculating water system is probably the best alternative to solve and correct the aquaculture drawbacks of water shortage and overuse of groundwater. The latter, especially, has caused significant land sinkings in different regions of Taiwan. To establish an efficient recirculation system for aquaculture, biological, chemical and physical characteristics of the pond effluent must be understood.

This study focused on the suspended solids of the effluent of a *Penaeus penicillatus* culture pond. Prawn feces and uneaten food were found to affect water quality. The following results were obtained :

1. Concentration of suspended solids in pond effluent ranged from 4 to 145mg/ℓ ; particle sizes of 0.1~0.2μm, 0.2~0.45μm, 0.45~0.65μm, 0.65~0.8μm and over 0.8μm were present in 27%, 18%, 15%, 20% and 20%, respectively, of the effluent.
2. After 20 days, the ammonia-N concentration in the effluent water which contained suspended solids was 2 to 3 times higher than in the effluent which was free from suspended solids.
3. Ammonia-N and nitrite-N concentrations showed a positive relationship with the amount of uneaten food in water. Prawn humor or feces may accelerate the nitrification process of nitrifying bacteria.