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氨對黃錫鯛魚苗（*Sparus sarba*）之急毒性研究

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Acute toxicity of Ammonia to the various larval stages of Goldline sea bream, *Sparus sarba*

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Median lethal concentrations (LC50) of ammonia were determined for Goldline sea bream (*Sparus sarba* Fosskal 1775) in static test. Ammonia toxicity to 1-day-old larvae, 5-day-old larvae, 10-day-old larvae, 20-day-old larvae & 1-month-old juveniles was studied. The 1-month-old juveniles showed the highest tolerance level to un-ionized ammonia while the 5-day-old larvae were the most sensitive stage to un-ionized Ammonia. The 24-h LC50 of un-ionized ammonia for 1-day-old larvae was 0.69 mg/l NH3-N, 5-day-old larvae were 0.48 mg/l Nh3-N, 10-day-old larvae was 0.54 mg/l NH3-N, 20-day-old larvae was 0.65 mg/l NH3-N and 1-month-old juveniles was 0.70 mg/l NH3-N.

Key words: Median lethal concentration, Ammonia, Goldline sea bream, Larvae, Juvenile.

前　　言

養殖系統中無機態氮的主要來源爲水產動物蛋白質代謝的最終產物一氨。氨在密集式養殖池或循環系統中很容易累積，常是引起水產動物死亡的原因之一[1][2]，而在水產種苗生產過程中，由於考慮到控溫及防止餌料生物的流失，在仔魚時期，飼育用水之換水量非常少，因此在這種飼育環境下，種苗之代謝生成物和餌料殘渣經由細菌分解，致使飼育水中氨濃度之累積，而氨對水產動物的毒性早已被證實[3][4]，同時也是造成種苗死亡的原因之一[5]，所以在育苗的過程水質管理是非常重要的。

氨在水中分爲離子態銨（NH_4^+）及非離子態氨（NH_3）二種型態，二者之比例在淡水中受溫度和PH值的影響，而在海水中則受溫度、PH值及鹽度之影響[6]，雖然氨對淡水魚的毒性已研究的非常多，但在海水魚方面，特別是氨對海水仔稚魚毒性的報告卻很少。

因此在種苗飼育期間，無法提供充分的資料作爲飼育用水之水質管理的依據，所以本實驗以黃錫鯛（Sparus sarba）之不同時期仔魚分別進行氨之毒性實驗瞭解仔魚對氨的忍受力，以作爲種苗飼育過程中水質管理之參考。

材料與方法

本實驗爲止水式毒性試驗（Static method），以黃錫鯛受精卵於實驗室孵化和馴養，在受精卵孵化後的第一天，五天，十天，二十天和三十天（以H_1，H_5，H_{10}，H_{20}及H_{30}代表）仔魚全長分別爲3.05±0.29mm，3.22±0.29mm，3.80±0.44mm，6.91±1.01mm及9.28±0.69mm進行24hr之毒性試驗。實驗用海水抽自台西養殖中心附近之海水溝渠，經砂過濾及添加次氯酸鈉50ppm消毒後，儲於一噸的FRP桶中曝氣備用。海水的鹽度爲35‰，PH8.2，氨一氮爲0.09～0.10mg/ l，亞硝酸爲0.04mg/ l，DO爲5.5mg/ l。

氨一氮（Ammonia-N）的配製以3.82mg的氯化銨（NH_4Cl，Merck公司出品，G. R.級試藥）溶於 1 升之實驗海水中，此相當於 1 mg/ l 的氨一氮，而非離子氨（NH_3-N）濃度的換算則以Carol（1987）發表之非離子氨在海水中的百分比表中查得爲4.65%[6]，實驗之氨一氮濃度爲 0 ，5，10，20，25及30，mg/ l，換算爲非離子氨的濃度則爲 0 ，0.233，0.466，0.699，0.932，1.165及1.398mg/ l 兩重複共計14組，每組以 2 升的三角錐瓶加入 1 升的試驗海水和20尾仔魚。再放置於德牌控溫器中，將溫度控制在20±0.5°C並於實驗開始及結束時測定氨一氮濃度。仔魚死亡的判別以萬能投影機檢視心臟跳動與否。半致死濃度（LC_{50}）的計算及95%信賴區間以Probit 分析法計算[7]。

結　　果

氨對黃錫鯛魚苗之急毒性試驗，各期魚苗死亡率顯示於Table.1而24-hr之LC_{50}及95%信賴區顯示於Table.2。H_1，H_2，H_5，H_{10}，H_{20}及H_{30}之24hr之死亡率的對機數（Probit of mortility，死亡率轉換爲Y值可由附表 1 查得）與氨濃度之對數值的關係表示於Fig1，Fig2，Fig3，Fig4及Fig5。

表 1　試驗之總氨濃度和各期黃錫鯛苗對應之死亡率

Table 1 The mortality rate of Various larval stages of Sparus sarba in difference concentration.

Stage	Total length (mm)	NO.	Mortality (%) 0	5	10	15	20	25	30
			(mg/l NH_3-N)						
H_1	3.05±0.29*	20	0	10	30	45	60	75	85
H_5	3.22±0.29*	20	0	15	30	65	95	100	100
H_{10}	3.80±0.44*	20	0	10	30	55	85	95	100
H_{20}	6.91±1.01*	20	0	15	25	40	60	90	100
H_{30}	9.28±0.69*	20	0	5	20	50	55	75-	95

* : standart diviation

表 2　總氨及非離子氨對黃錫鯛各期仔魚之24小時半致死濃度和百分之九十五之信賴區間

Table 2 The Value of 24-hr LC_{50} and 95% confidence limits of LC_{50} in ammonia for larvae of Sparus sarba.

Chemical	Stage	Ammonia－N (mg/l) 24-hr LC_{50}	Ammonia－N (mg/l) 95% confidence limits	NH_3－N (mg/l) 24-hr LC_{50}	NH_3－N (mg/l) 95% confidence limit
NH_4Cl	H_1	14.90	12.23～18.17	0.69	0.57～0.84
	H_5	10.37	8.67～12.40	0.48	0.40～0.58
	H_{10}	11.65	9.86～13.77	0.54	0.46～0.64
	H_{20}	13.92	11.24～17.25	0.65	0.52～0.80
	H_{30}	15.03	12.81～17.63	0.70	0.60～0.82

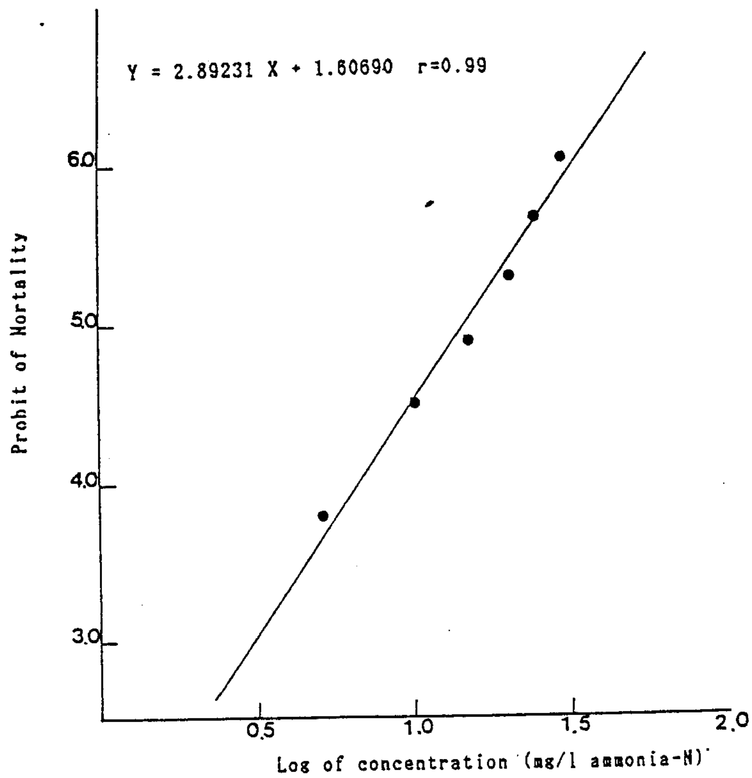

圖 1　孵化 1 天之黃錫鯛仔魚24小時死亡率對機數與氨濃度之關係

Fig.1 relationship between probit of mortality and log of concentration of ammonia-N in the 24-hr acute toxicity test on the first day after hatching of Sparus sarba larvae.

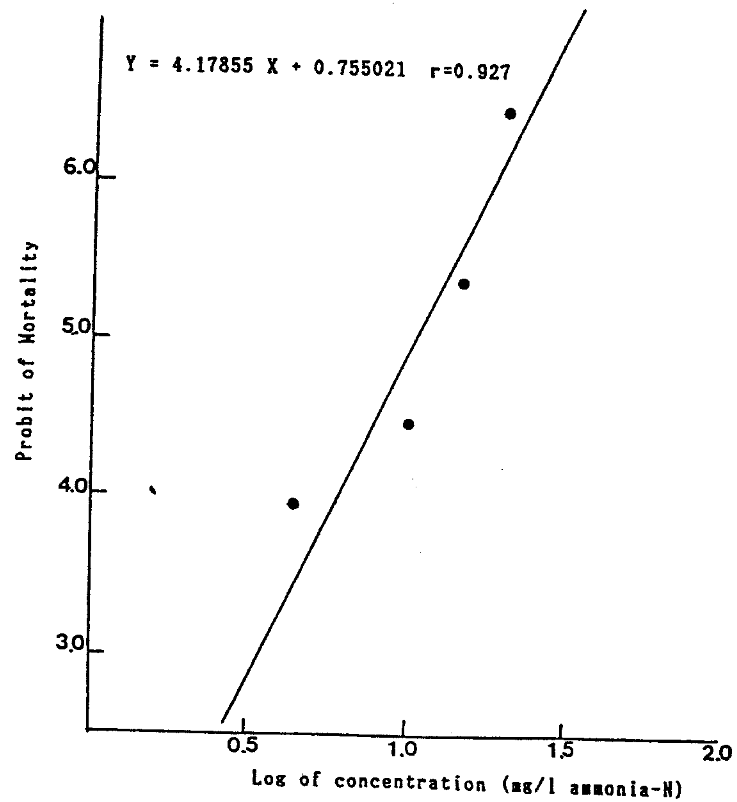

圖 2 孵化5天之黃鰭鯛仔魚24小時死亡率對機數與氨濃度之關係
Fig.2 relationship between probit of mortality and log of concentration of ammonia-N in the 24-hr acute toxicity test on the fifth day after hatching of Sparus sarba larvae.

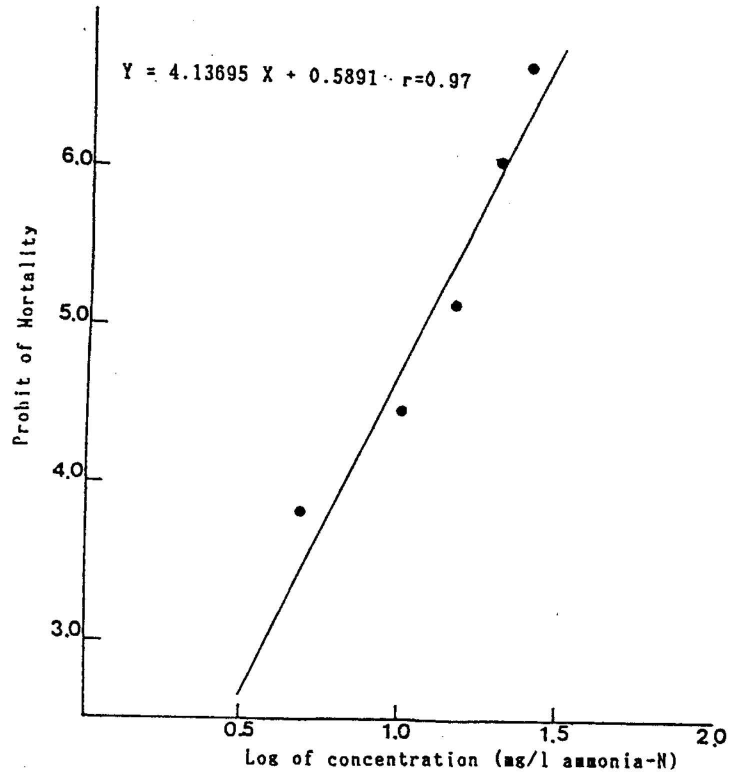

圖 3 孵化10天之黃鰭鯛仔魚24小時死亡率對機數與氨濃度之關係
Fig.3 relationship between probit of mortality and log of concentration of ammonia-N in the 24-hr acute toxicity test on the 10th day after hatching of Sparus sarba larvae.

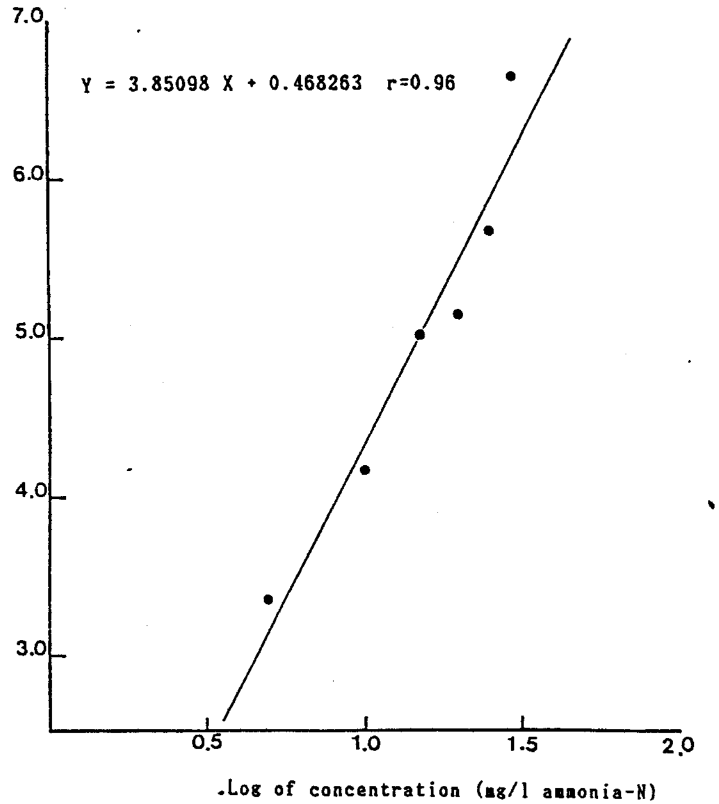

圖5 孵化30天之黃鰭鯛仔魚24小時死亡率對機數與氨濃度之關係
Fig.5 relationship between probit of mortality and log of concentration of ammonia-N in the 24-hr acute toxicity test on the 30th day after hatching of Sparus sarba larvae.

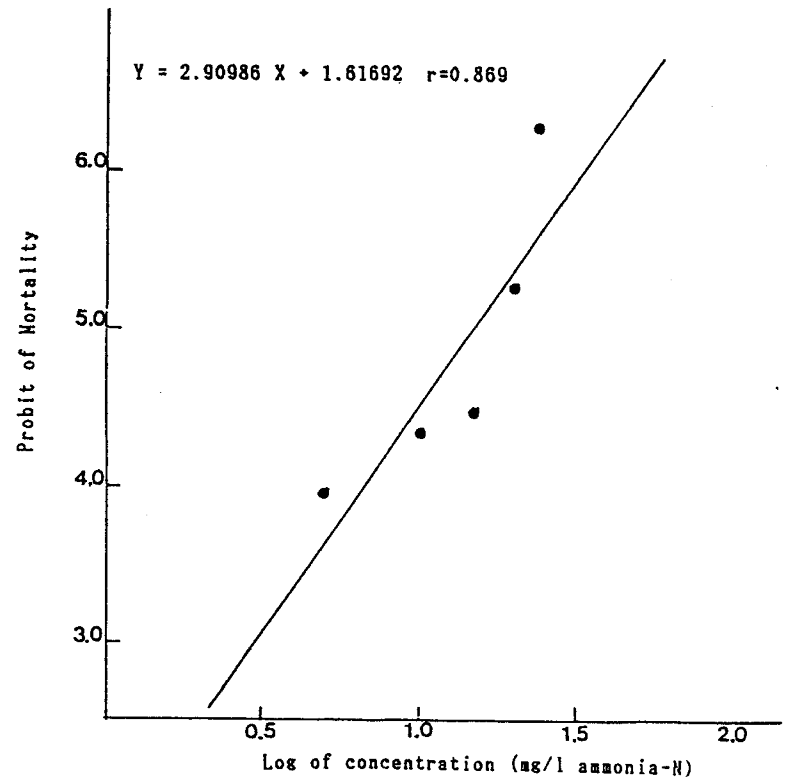

圖4 孵化20天之黃鰭鯛仔魚24小時死亡率對機數與氨濃度之關係
Fig.4 relationship between probit of mortality and log of concentration of ammonia-N in the 24-hr acute toxicity test on the 20th day after hatching of Sparus sarba larvae.

附表 1　實驗之死亡率轉換爲對機數值（Y）

Appendix 1 Transformation of mortality percentages to probit. (m%→Y)

%	0	1	2	3	4	5	6	7	8	9
0	—	2.67	2.95	3.12	3.25	3.36	3.45	3.52	3.59	3.66
10	3.72	3.77	3.82	3.87	3.92	3.96	4.01	4.05	4.08	4.12
20	4.16	4.19	4.23	4.26	4.29	4.33	4.36	4.39	4.42	4.45
30	4.48	4.50	4.53	4.56	4.59	4.61	4.64	4.67	4.69	4.72
40	4.75	4.77	4.80	4.82	4.85	4.87	4.90	4.92	4.95	4.97
50	5.00	5.03	5.05	5.08	5.10	5.13	5.15	5.18	5.20	5.23
60	5.25	5.28	5.31	5.33	5.36	5.39	5.41	5.44	5.47	5.50
70	5.52	5.55	5.58	5.61	5.64	5.67	5.71	5.74	5.77	5.81
80	5.84	5.88	5.92	5.95	5.99	6.04	6.08	6.13	6.18	6.23
90	6.28	6.34	6.41	6.48	6.55	6.64	6.75	6.88	7.05	7.33
—	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
99	7.33	7.37	7.41	7.46	7.51	7.58	7.65	7.75	7.88	8.09

討　　論

黃錫鯛魚苗對氨的抵抗力以24-hr LC_{50}比較，以H_{30}之0.70mg/1 NH_3-N最強，其次爲H_1之0.69mg/1 NH_3-N，H_{20}之0.65mg/1 NH_3-N及H_{10}之0.54mg/1 NH_3，以H_5之0.48mg/1 NH_3-N最弱（Fig6）。孵化後5天的仔魚對氨抵抗力較差的原因，可能是仔魚由內部營養（卵黃吸收）轉爲外部營養（攝食），體內消化系統正處於生理上的變化，故對周圍環境的刺激較爲敏感[9]，此結果與Mawateri & Hirayama (1975) 發表的氨對嘉臘魚苗的毒性試驗之結果相同[9]，但孵化後1天、5天及14天的嘉臘魚苗的24-hr之LC_{50}分別爲2.2mg/1，1.8mg/1及2.3mg/1 NH_3-N，比黃錫鯛魚苗對氨的忍受力強，由上述資料顯示鯛類魚苗對氨之抵抗力隨著發育時期之成長而增加。

氨對南非四種海水魚*Gaidroparus apensis*, *Diplodus savgus*, *Lithognathus mormyrus*及*Pachynetopan blochi*孵化後5-7天的魚苗的24-hr之LC_{50}在0.36～0.42mg/1 NH_3-N之間[10]，而Harry & Claude (1987) 發表氨對斑點海鱒（*Lynoscion nesulosus*）孵化後4天的魚苗24-hr之LC_{50}爲0.28mg/1 NH_3-N[6]，上述五種海水魚苗對氨的忍受力略低於黃錫鯛魚苗。但虱目魚魚苗（*Chanos chanos*）則比黃錫鯛強，氨對虱目魚24-hr之LC_{50}爲1.89mg/1 NH_3-N[11]與嘉臘魚苗相似，由上述的資料顯示海水魚魚苗對氨的抵抗力較弱，因此在大量生產種苗的高密度養殖狀況下，對於氨之蓄積毒性的問題是不可忽視的。

Lloyd & Orr (1969) 發現以致死濃度之12%的氨濃度對虹鱒不會有毒性的影響[12]，而歐洲內陸漁業咨詢委員會 (EIFAC,1973) 更以氨對虹鱒魚苗最低之LC_{50}的12%的氨濃度，當作歐洲淡水的水質基準[13]，因此根據上述資料，以黃錫鯛魚苗對氨之抵抗力最差的H_5之LC_{50}的12%的氨濃度，即0.058mg/1 NH_3-N可視爲安全濃度，作爲黃錫鯛種苗培育之水質管理的依據。

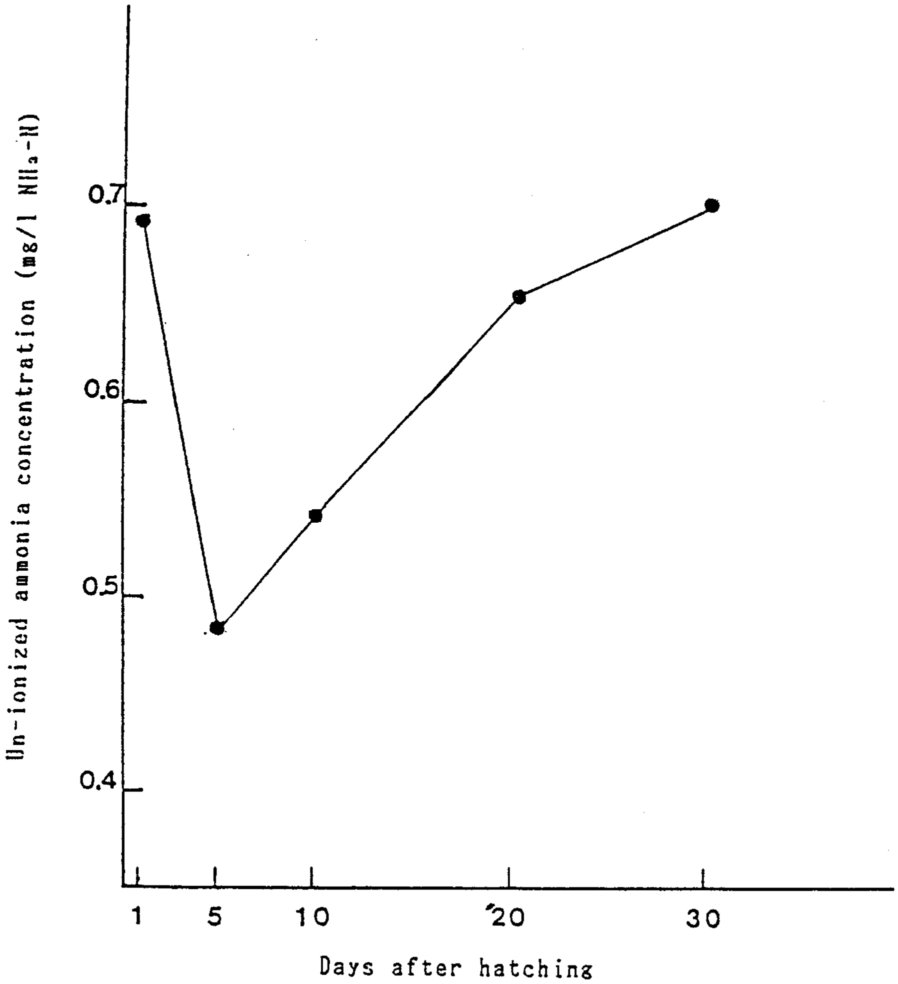

圖 6　不同時期之黃錫鯛仔魚24小時半致死濃度

Fig.6 24-hr LC_{50} of the different larval stages of Sparus sarba.

由上述可以得到下列兩點之結論：

1. 氨對黃錫鯛魚苗24-hr之LC_{50}，孵化後 1 天的仔魚爲0.69mg/ 1　NH_3-N，孵化後 5 天的仔魚爲0.48mg/ 1　NH_3-N，孵化後30天的仔魚爲0.70mg/ 1 NH_3-N。
2. 黃錫鯛育苗的水質管理上氨的安全濃度爲0.058mg/ 1　NH_3-N。

摘　　要

本實驗爲止水式的毒性試驗，在海水鹽度35°/oo、PH8.2及水溫20°C，將孵化後 1 天、 5 天、10天、20天及30天的黃錫鯛曝露在不同的氨濃度下，以決定氨對黃錫鯛魚苗24小時的半致死濃度。黃錫鯛魚苗對氨的抵抗力以孵化後30天的仔魚最強，孵化後 5 天的仔魚最弱。孵化後 1 天的仔魚24-hr的LC_{50}爲0.69mg/ 1　NH_3-N孵化後 5 天的仔魚24-hm的LC_{50}爲0.48mg/ 1　NH_3-N，孵化後10天的仔魚24-hr的LC_{50}爲0.54mg/ 1　NH_3-N，孵化後20天的仔魚24-hr的LC_{50}爲0.65mg/ 1　NH_3-N，孵化後30天的仔魚24-hr的LC_{50}爲0.70mg/ 1　NH_3-N。

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