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目　　錄

醫　學

中國醫學

藥　學

CONTENTS

MEDICINE

CHINESE MEDICINE

PHARMACY

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China Medical College
Annual Bulletin
Vol. 2 (1971)

Biology and Control of the Taiwan Oyster Drill *(Thais tumulosa)* *1

by

Yin-woo Hwang *2 Sun-chi Huang *3

(Received March 20, 1971)

Abstract

Oyster drill (thais tumulosa)is a sort of oyster ectoparasite. Which can bore oyster shells and suck the oyster mest, thus, causing oyster mortality. In non-spawning season, this parasites are wide spread in oyster bed, consequently to control is difficult. When spawning season comes, the spawning aggregation of the spawners occurs, resulting in the production of egg-capsule masses attached on limited numbers of oysters or bamboo sticks, Failure to remove the egg-capsule masses, result in production of new generation, this study suggests a new method of control by removal of the egg-capsule masses in addition to the conventional method of control by eliminating only the adult parasites.

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*1 Dr. Takeo Imai of the Tohoku University identified it as Drupa marginaba (Blainville), while Mr. C. E. Lindsay of the Department of Fisheries, State of Washington, identified it as Thais tumulosa.

*2 Lecturer of Parasitology.

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INTRODUCTION

There are now some 8,000 hectares of oyster beds in Taiwan, on 99% of which the stake method of culture is employed. Among the enemies of the oyster, the oyster drill is the most serious. Despite the daily efforts of the oyster-growers in hand-picking the oyster drills, they still remain as the worst enemy in causing mass mortality and checking the growth of the oysters. The biology of the oyster drill were therefore studied and the general procedure of oyster culture described in order to form a basis for developing an efficient control method.

MATERIAL AND METHOD

All the oyster drills for this study were collected from the oyster beds in the Lukang area. The experiment on caged oyster drills of 2.5-3.5 cm in body height, which cause oyster mortality, was conducted in bamboo baskets of 0.04 m^3 in volume. Each of the baskets contained 0-171 oyster drills and 33 - 605 oysters. The bamboo baskets were hung in a canal leading to the sea.

The fecundity of the oyster drills was observed by keeping the oyster drills in a cage of 0.0056 m^3 in volume. made of asphalt painted wire. The cage contained two groups of spawners. One groups of seven females spawned in March 1967, and the other group of 12 females spawned in April 1967.

The former were held for further observation for 60 more days after cessation of spawning, while the latter were under observation for only seven days. Both groups were dissected. The March group showed that their gonads were already spent, while the April group showed that their gonads had not been spent yet.

All of the mesurements in height were made by vernier caliper. The death of the oyster drills was recognized by the odor of the decaying meat and the response of the foot. In order to facilitate the study of oyster mortality, the abundance of oyster drills and their egg-capsule masses, the oyster beds were divided into three zones: the outer zone, 4.0-5.0 km. away from the shoreline; the middle zone, 3.5-4.0 km. away from the shoreline; and the inner zone. 3.0-3.5 km. away from the shoreline.

In order to determine oyster motality in the field, 1004, 1534 and 786 oysters were sampled in October through November 1965, from the outer zone, the middle zone and the inner zone respectively; while 394, 469 and 398 oysters were sampled in the corresponding period and from the corresponding zones in 1966. At the time of mortality investigation, all the oysters were one year old except those in the inner zone which were two years old In order to find out the direct cause of death, the dead oysters with both of the valves (right and left) still present were examined in November and December 1966 from the outer, middle and inner zones. Altogether 127,83 and 58 dead oysters were examined from the respective zones. The specimens were washed clean to see if there were any holes bored by the oyster drill.

The percentage of the dead oysters bored was expressed as "boring rats". The abundance of the oyster drills was determined by employing 2-8 persons to hand-pick them on the oyster ground

once a month. The results were expressed as the number of drills picked per man per hour, or the number of drills found on 20 bamboo sticks, or the weight (in gram) of the drills picked per man per hour. The frequency of the egg-capsule masses found in the spawning season was expressed as the number of capsule masses found per man per hour, or the number of capsule masses found on 1000 sticks. In order to find out the correlation of the oysters to the abundance of oyster drills present in the field, or to the frequency of egg-capsule masses found, correlation coefficients "r" were calculated.

MORPHOLOGY

The external body features of the oyster drill and its egg-capsules are shown in Fig. 1. The shell is grey in color with no hair and the apex is sharply pointed. The egg-capsule is vast-sharped.

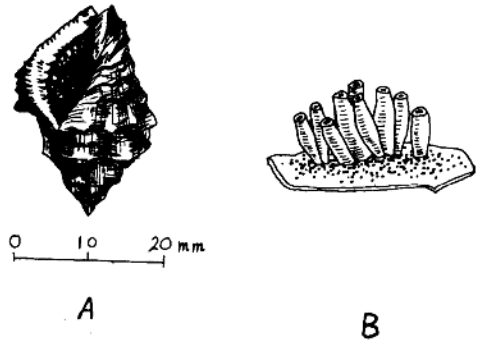

Fig. 1. The external feature of the oyster drill (A).
The egg-capsule mass attached on oyster shell (B).

"Condition": The ratio of wet meat weight to the body weight of the oyster drill (2.5-4.5 cm in height) was measured in August 1967. It ranged from 20.9 % to 23.3 %. The meat is of commercial value in some parts of Taiwan and is sold at NT$ 11.00 per kilogram.

Epiphylum: When the oyster drill is exposed to fresh water or desication the epiphylum seals off the aperture, thus enabling it to survire for a week or more in the air or fresh water.

Proboscis: The proboscis is protractile and the anterior part is pink.

Crystalline style: In the stomach there is a gelatinous, rod-like body known as the crystalline style.

Penis: In the male oyster drill, a long tapering "c-shaped" penis 1.13 cm long for a 3.15 cm drill, lies on the right side of the right tentacle.

Gonad: The size of the egg in the gonad before the formation of capsule is normally smaller (30-35u) than that after the formation of the capsule (68-210u)

Rectal gland: A blue thread-like gland known as the rectal gland is attached to the side of the rectum.

Violet color: The juice of the drill meat when dried or left standing for several hours becomes violet in color.

LIFE HISTORY AND ECOLOGY

Description of the environment and the method of oyster culture.

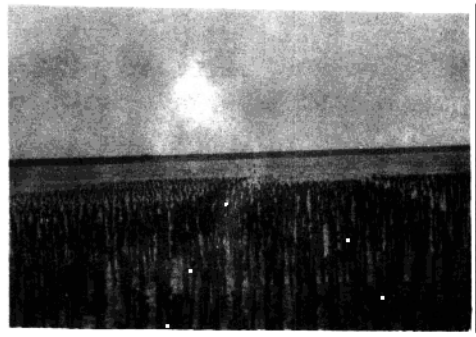

Plate 1. Showing the method of oyster culture.

There are two tide cycles a day. The mean tide range is 3.5 meters. All of the oyster ground has intertidal exposure. The daily exposure time was three hours, six hours and ten hours in the outer, middle and inner zones respectively. The atmospheric temperature, the water temperature and the specific gravity in the outer zone were taken, at least, twice a month over five years, as shown in figure 2. & 3. The atmospheric temperature ranged from 12.5°C to 33°C, the water temperature from 15° to 32°C, and the specific gravity from 1.017 to 1.025. In the spring and summer the wind is slight except when there is typhoon which normally occurs between June and October. In the fall and winter the north-east seasonal wind frequently blows at intensity of 8-15 m/sec. The typhoon and the strong seasonal winds cause the habitat change of oyster ground, resulting in the burial or sweeping away of the bamboo sticks and oysters.

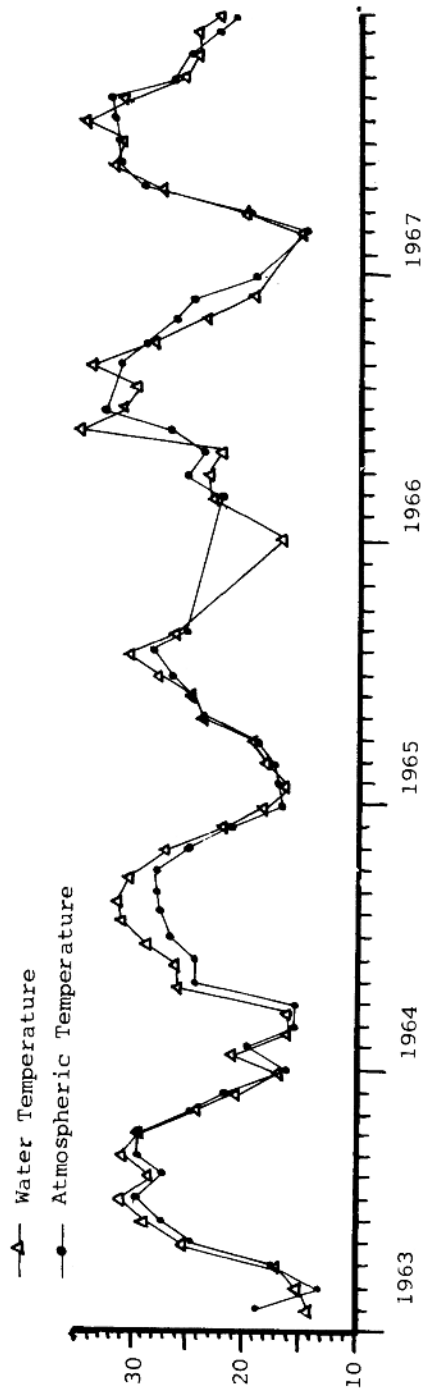

Fig 2 The observation of water temperature and atmospheric temperature in oyster bed over five years.

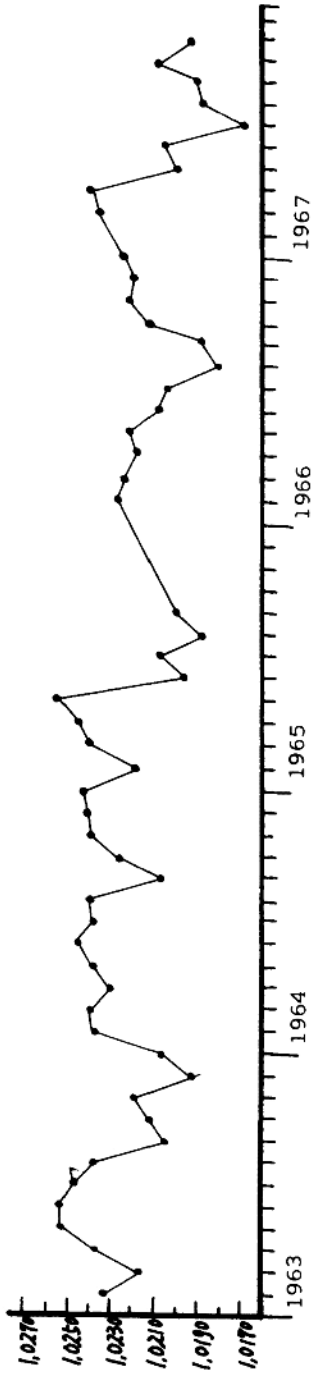

Fig 3 The observation of the specific gravity of sea water in oyster bed over five years.

The other enemies of the oyster beside oyster drills are Linetella cingulata (Camark), Cymatium pileare (Linnaeus) and Scylla serrata (Forskal).

Culture method(plate 1): Bamboo sticks of 90 cm long and 2-4 cm wide were planted between October and February.Normally 50,000 sticks per heatare were plated depending upon production potential. Spat collection, rearing and fattening took place at the same location.

Harvest - Every day the oyster men have to harvest the oyster which have fallen off the bamboo sticks lest they become buried by the changeable bottom soil or are swept away by the current. The falling down takes place every day, especially in the quick growing season in the spring and summer. Besides,the oystermen have to walk around the oyster ground to thin out all the over-crowded oysters and take them back for sale. The most important daily routine is to repair or raise the sticks which are about to be bruied by the elevation of the bottom soil, and to handpick the oyster drills.

Feeding and drilling:

The oyster drill bores a hole on the shell of the living oyster by means of its proboscis, and then eats the meat. The diameter of the hole on the surface of the oyster shell is bigger than that inside because of the tapering from of the proboscis. The outer diameter of the holes bored by the oyster drill with body height of 4.3 ± 0.1 cm was 0.23 ± 0.02 cm, and the inner diameter was 0.14 ± 0.01 cm, So far no oyster drill has been found to drill the shell of dead oysters.

Tolerance and general habits:

Plate 2. Showing oyster drills attaching on oysters.

Because the foot has become an effective sucker for attachment, the oyster drills are seasile and attach themselve firmly to the shells of the living oysters(plate 2)or the bamboo sticks on which the oysters set.While not immovably fixed, they travel about very little. The sucking force enabling them to attach themselves to any hard substrata. Prevents them from being dropped or swept away by the strong waves.

Oyster drills are a sort of epifauna and they have to live above the surface of the bottom soil. Otherwise, they will be smothered. Oyster drills seem to have a sense of direction. In the pond the hungry oyster drills managed to leave a cage without oysters for another cage with oysters. In the laboratory the hungry oyster drills crawled on the glass 75 cm within 25 minutes toward the oysters.

The body color of the oyster drill is almost the same as that of the oyster, consequently the finding of the oyster drills requires technique, namely to search all of the sticks on which oyster mortality occurs, because most of oyster mortality is due to oyster drill predation. In the aquarium the oyster drill stopped boring the oyster and became inactive when the water temperature dropped below 13°C. However, when the water temperature was raised to 16-20°C, it slowly bored the oyster at the rats of 1.2 oyster per month. In the field when the water temperature was 30-33°C, the oyster drills were found drilling the oysters fiercely. It is apparent that this oyster drill is a warm-water species. The protoconch(plate 3)is so well protected by its capsule that freezing the egg-capsule containing the moving stage protoconch, under -20°C for 10 minutes causes no death of the protoconch, and that immersing the egg-capsule containing moving protoconch in Polystream Poly chlorobenzene mixed with water for 30 minutes also caused no death.

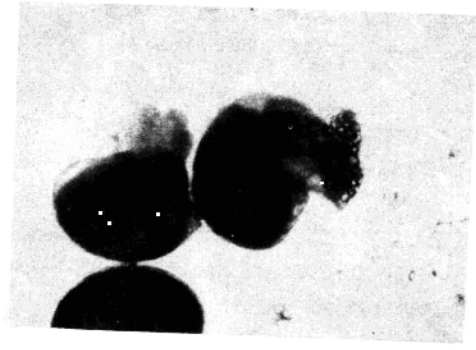

Plate 3. The protoconch 100X.

Regarding its resistance to fresh water, the protoconch suffers no mortality by being immersed in fresh water for 12 minutes, but it died after being immersed for 15 minutes. Oyster drills collected from the field with salinity of 30-34‰ were tested to see their resistance against low salinity.

Table 1. The tolerance of the oyster drill to low salinity

Salinity ‰	14.0	8.4	5.2	3.4	Fresh water
TLm (days)	Behaved normally	17	16	13	10
Remark	Oyster drill size 2.5 -3.5 cm. Water temperature 12.0 - 14.5°C.				

When the salinity was 3.4-8.4‰ and the water temperature 12 - 14.5°C, 50% of tested oyster drills died within 13 - 17 days. In fresh water, 50% of the tested drills died within 10 days. When the salinity was 12.5 ‰ and the water temperature 18 - 22°C, the tested drills died within one week. But, when the salinity was 14 ‰ the tested oyster drills behaved normally and there was no mortality. Normally the oyster drill was found to lose its sucking force critically when the salinity dropped to or below 12.5 ‰ (Table 2).

Table 2. The loss of sucking force of oyster drill inrelation to salinity:

Salinity	16.0	15.5	14.0	13.5	13.0	12.55	8.4	5.2	3.4
Sucking force	+	+	+	+	+	-	-	-	-

Based upon this relationship we may wash the spat collectors to be exported, in water with salinity less than 12.5 ‰. In so doing the oyster drills attaching themselves firmly to the spat collectors will automatically fall down due to the loss of sucking force. The preliminaty experiment showed that this method was feasible and not harmful to the oyster spats. Air

exposure tolerance of oyster drills was tested. The drills from the inner zone lasted longer than those from the outer zone, because they had acclimatized themselves to the long exposure time. Fifty per cent of the oyster drills in the laboratory could survice in the air at 22° - 24°C temperature and 88 - 91 % humidity for 5-6 days.

Reproduction:

Sexual dimorphism and the sex radio:(Table 3)
The oyster drill is dioecious with the sexual dimorphism not found externally.

Table 3. The monthly average body height of the male and female oyster drills in 1967

Date	Jan.	Feb.	Apr.	May	June	July	Aug.	Sept.	Mean	Total no. of oyster drills observed
Average body height	3.15	3.03	2.74	3.56	3.52	4.03	2.88	3.31	3.28	239
	3.29	3.07	2.83	3.28	3.36	4.04	2.81	3.61	3.29	301

Examination of the average male and female body height over eight months revealed that there was no significant difference between the body height of the male and female, because the test of significance was:

$$t = 0.044 < t\ (^{v\ =\ 14}_{p\ =\ 0.05}) = 2.145$$

Internally the sexual dimorphism is obvious. The male has a penis. Besides, when mature the gonad of the male is golden yellow in color as compared to the pure yellow of the female gonad, this characteristic colors lasts from November to May. In other words, the brown gonad indicated that the oyster drill is spent, while the golden yellow or the yellow gonad shows that the drill is mature and ready to spawn. As shown in Table 4. the dissection of 1,033 oyster drills collected over 12 months showed that there were slightly more females than males. The females were 54.8 % of the total oyster drills dissected, and the female percentage varied from 43.6 % in June 1966 to 76.2 % in December 1966 for unknown reasons.

Table 4. Sex ratio of the oyster drills in 1966 and 1967

Date	1966 June	July	Aug.	Nov.	Dec.	1967 Jan.	Feb.	Mar.	Apr.	May	June	July	Total
No. of drills	287	57	56	39	42	115	78	98	104	125	42	40	1,033
No. of females	125	36	32	20	32	71	47	42	57	64	22	18	566
females %	43.6	63.2	57.1	51.3	76.2	61.7	60.3	42.9	54.8	51.2	52.4	45.0	54.8

The spawning season:

Although the spawning season in some years may start as early as December and end as late as July, the main spawning season is from February to May, strictly speaking from February to April. But, in a very cold year, such as 1968, the spawning season did not start until March. The number of egg-capsule masses found per 1000 bamboo sticks was 2.7-14.5. The number of egg-capsule masses found per man per hour was