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Underwater Still Camera Works in the Habitat of *Nautilus* off the Southeast Coast of Koror, Palau

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Abstract

Photographing *Nautilus* and other organism gathering around bait, and analysis of species composition and their searching and feeding behavior were carried out. *Nautilus* appeared on almost every occasion and showed active feeding behavior. Nine species of Crustacea, two of Echinodermata and six of Pisces also appeared, and showed active food search and feeding behavior.

Introduction

From mid-August to the beginning of September 1988, the writers performed the photographic studies with a baited underwater camera at twelve stations, 150-300 meters deep off the Southwest coast of Koror, Palau (Fig.1). Good 187 pictures showing bottom sediments and organisms were obtained, and based on them, combination of species and their food searching and feeding behavior were analyzed

The writers used a small-sized handy underwater camera system, which is described in, previous papers (Hattori et al., 1985; Shinomiya et al., 1988). Camera and strobe were fixed to an iron frame, and a bait-stand covered with wire netting was attached to the front part of the frame.

Field operation

Slices of skipjack and reef fish kept inside the wire netting cage were used as bait for *Nautilus* and associated organisms. Photographing time interval were ten to thirty minutes. The timing for a series of photographs was altered to be able to cumulate the record of organisms over a twenty four hour period. The time range and data on photography are shown in Table 1.

Results and Discussion

Based on photographic information and data from the samples obtained by trapping, the organisms seen in photographs were identified. The time of appearance of each organism, and the number of individuals of each species identified in each picture are recorded. Twelve photographic series were attempted, although the

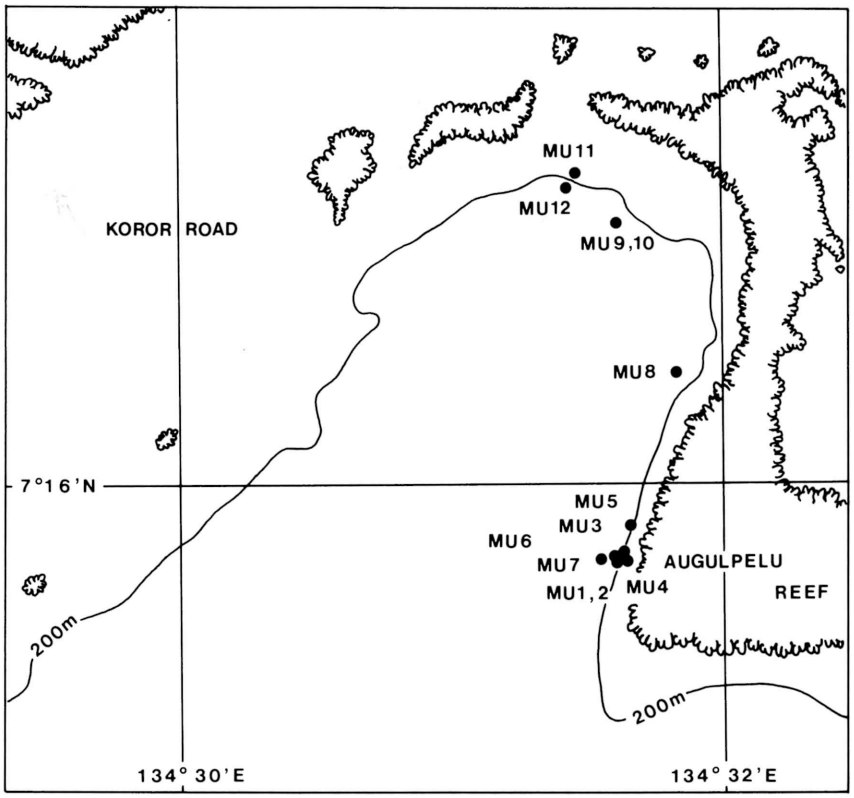

Fig. 1 The stations of underwater still camera (solid circle)

strobe only worked the 2nd, 5th, 9th, and 10th times. Based on these data, the maximum number of individuals of observed species for each hour is summarized in Table 2.

Times when the first *Nautilus* appeared in the vicinity of the camera, represented in seven cases., ie. MU2, MU4, MU5, MU8, MU9, MU10, and MU12 ranged from 19 minutes to 129 minutes. The average time was 67 minutes. In areas MU2, MU5, MU9, MU10, the number of *Nautilus* that appeared were between 1-10. They always appeared, except between 11:00 and 12:00, and were also abundant from 17:00 to 09:00. Many different species were seen around the bait, but *Nautilus* was the dominant species and spent longer times in getting to the bait.

Color pattern of the *Nautilus* shell were used for identification. Using the color pattern it was possible to record that the time of the individual that spent the longest time around the bait at MU10 was 14.5 hours (18:49-09:19). At station MU5 the longest time spent was 11.5 hours (19:59-07:29). Among the pictures taken at MU2, MU5, MU9, MU10, the maximum number of *Nautilus* that appeared were 3, 7, 6, and 13 respectively. In the present survey the shell color pattern was used to count the number of Nautilii that appeared in the vicinity, those which left the bait stand and the total number of Nautili that approached were, 6,

Table 1. Time range of pictures and data of photographic stations off the Southeast coast of Koror, Palau. S and F indicate start and finish of photographing, respectively.

Operation number	Date and Time (Time range of pictures)	Time interval (minutes)	Station number	Depth (m)	Hours 0	2	4	6	8	10	12	14	16	18	20	22	24
1	Aug. 17 (14 : 20 - 14 : 50)	10	MU1	200								S	F				
2	Aug. 17 - 18 (17 : 59 - 10 : 59)	30	MU2	200							F			S			
3	Aug. 24 (10 : 00 - 16 : 00)	30	MU3	200						S							
4	Aug. 24 - 25 (17 : 59 - 10 : 59)	30	MU4	200							F			S			
5	Aug. 25 - 26 (14 : 29 - 7 : 59)	30	MU5	220					F			S					
6	Aug. 29 - 30 (14 : 59 - 8 : 29)	30	MU6	190					F			S					
7	Aug. 30 (10 : 39 - 15 : 49)	10	MU7	300						S			F				
8	Aug. 30 - 31 (16 : 29 - 9 : 29)	30	MU8	300						F			S				
9	Aug. 31 (11 : 19 - 15 : 19)	10	MU9	295							S		F				
10	Aug. 31 - Sep. 1 (16 : 19 - 9 : 19)	30	MU10	310						F			S				
11	Sep. 1 (11 : 29 - 17 : 59)	10	MU11	150							S			F			
12	Sep. 1 - 2 (18 : 59 - 10 : 19)	30	MU12	150							F			S			

Table 2. List of species and hourly maximum number of occurrence off the Southeast coast of Koror, Palau.

Species	Hours 6	8	10	12	14	16	18	20	22	24	2	4	6
GASTROPODA													
1. *Distorsia* (*Rhysema*) sp.	4	4										1	2
CEPHALOPODA													
2. *Nautilus belauensis*	8	10 10	7 1	2	1 6	5 5	10 9	13 9	8 7	12 9	9 8	9 6	7
CRUSTACEA													
3. *Aega* sp.				2 1									
4. *Heterocarpus sibogae*	5	7 5	4	2 7	9 5	2	6 13	8 12	9 18	17 18	18 17	27 20	9
5. *Plesionika ensis*	7	1	2			1	1		2				
6. *Trizopagrus tenebrarum*	1	2 2	2 2								1		
7. *Paromola* sp.	1	1			1	1		1	1 1				
8. *Randallia* sp.		1	1 1	1	1					2 1		1	
9. *Cyrtomaia curviceros*					1 1	1 1	1 2	1 1	1 1		1	1 1	
10. *Cyrtomaia* sp.				1 1								1	
11. *Leptomithrax* sp.	1					1	1		2	1	3	2 3	2
ASTEROIDAE													
12. *Craspidaster* sp.	1												
ECHINOIDAE													
13. Temnopleurid sea urchin							1		1	1			
ODONTASPIDAE													
14. *Odontaspis ferox*	1		1					1					
OSTEICHTHYES													
15. *Synaphobranchus* sp.			1	4 1	2 1		5 1						
16. *Conger japonicus*									1	1	1		
17. *Physiculus yoshidae*							1	2 2	2 1	1 3		1 1	2
18. *Plectranthias kamii*	2	1		1									
19. *Etelis curbunculus*		1											

11, 9, and 25 respectively. The actual number of *Nautilus* was nearly twice as many as the maximum number of *Nautilus* observed in any givin picture, because the *Nautilus* were always changing their positions.

Comparisons of the number of *Nautilus* present and the time spent near the bait stand in Palau, were made with previous studies in Fiji (Shinomiya *et al.*, 1988), Papua New Guinea (Shinomiya *et al.*, 1991), *Nautilus* appearing time in Palau differed from that noted Papua New Guinea. The number of *Nautilus* present in Palau was greater than Fiji and was less than that of Papua New Guinea.

In the four surveys undertaken, 9 species of crustaceans were identified. Some of the common species were *Heterocarpus sibogae, Plesionika ensis, Trizopagrus tenebrarum, Paromola sp. Randallia sp., Cyrtomaia curviceros, Leptomithrax sp.* With the variation in time *Hetrocarpus sibogae* and *Leptomithrax sp.* appeared between 18:00 to 06:00 and *Plesionika ensis, Trizopagrus tenebraum* appeared between 06:00 to 18:00. Time variation in Palau was similar to that observed in Fiji (Shinomiya et al., 1988)

In the four surveys undertaken, 6 species of fish were identified. Species that were most abundant were *Synaphobranchus sp.* and *Physiculus yoshidae*. It was clearly distinguished that the *Synanhobranchus sp.* were present between 09:00 to 18:00 hrs and *Physiculus yoshidae* were present between 18:00 to 06:00. In Palau, *Gnathophis xenica*, family Congridae, appeared at MU7, MU8 between 11:00 to 18:00, and *Gymnothorax sp.*, family Muraenidae, appeared at MU12, between 20:49 to 22:19.

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Plates 1-2

Explanation of Plate I

Station MU2 (Depth 200m)

Fig.1. 19:59 A majid crab (*Cyrtomaia curviceros*) on the bait-stand, two morid cods (*Physiculus yoshidae*) at the right and left side, two *Nautilus belauensis* in the foreground and right side.

Fig.2. 6:59 A diogenid crab (*Trizopagurus tenebrarum*) and a majid crab on the bait- stand, a grouper (*Plectranthias kamii*) in the foreground, a *Nautilus* at the right side.

Fig.3. 9:29 A *Nautilus* at the left side and a leucosiid crab (*Randallia* sp.) on the left ground.

Station MU5 (Depth 220 m)

Fig.4. 1:29 Three *Nautilus* clinging to the bait-stand, 15 pandalid shrimps (*Hetrocarpus sibogae*) feeding at the inside of the stand, and a conger eel (*Conger japonicas*) at the right side.

Station MU8 (Depth 300 m)

Fig.5. 17:59 About 16 *Hetrocarpus sibogae* aggregating to the stand, two conger eels (*Gnathophis xenica*) at the left side.

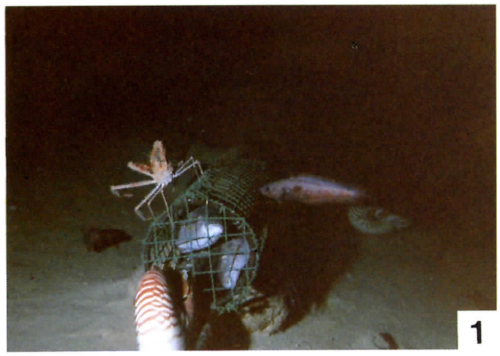
Station MU9 (Depth 295 m)

Fig.6. 11:49 Three cutthroat eels (*Synaphobanchus* sp.) feeding or approaching to the bait.

Fig.7. 14:09 Four *Nautilus*, about five shrimps, a majid crab and a cutthroat eel at the left side or on the bait-stand.

Fig.8. 15:09 A *Nautilus* attaching to another individual in the foreground.

Underwater Still Camera Works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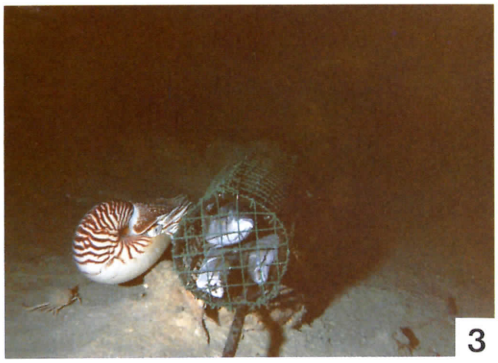
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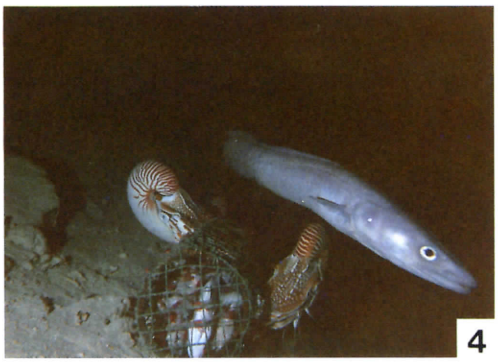
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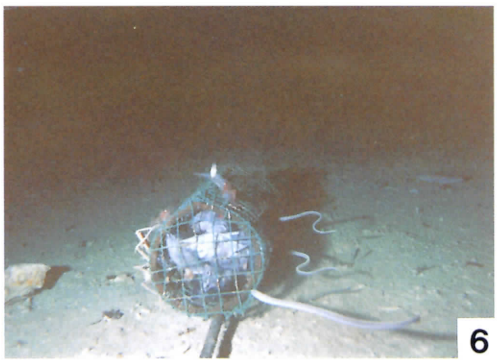
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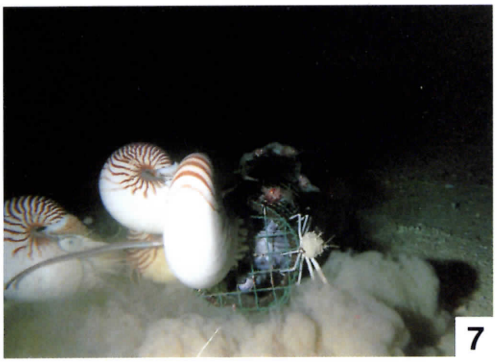
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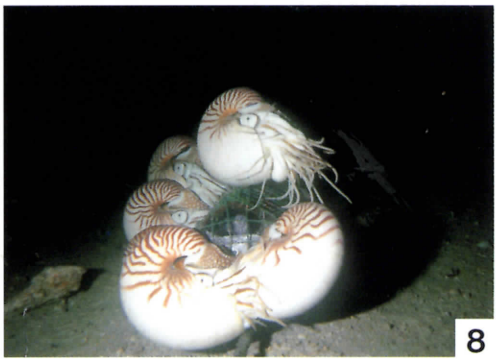
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Explanation of Plate 2

Station MU10 (Depth 310)

Fig.1. 16:49 Fifty minutes after landing of the camera system on the bottom, five *Nautilus* and two majid crabs were seen aggregating around the bait-stand. In this picture series, Nautili are numbered individually based on the color patterns of their shells.

Fig.2. 17:49 Eight *Nautilus* sticking to the bait-stand , a majid crab on the left, three *Synaphobranchus* on the right.

Fig.3. 19:19 Thirteen *Nautilus*, some swimming with protruded tentacles; *H. sibogae* aggregating to the stand.

Fig.4. 21:19
Fig.5. 0:49
Fig.6. 3:39
} *Nautilus* individuals sticking to the bait-stand; different individuals appeared with time lapse.

Fig.7. 6:19 A odontaspid shark (*Odontaspis ferox*) approaching the bait stand; most of the *Nautilus* disappeared, except one.

Fig.8. 9:19 More than 25 individuals of *Nautilus* are captured in this picture series. Individual No.8 continued to appear for 14 hours 30 minutes (18:49-9:19).

Underwater Still Camera Works