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Cephalopoda (Squid) 1971-1973, 1975-1979, 1981-1982 (2 of 3)

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I

Indexed for displays
" " copulation

(1)
(1)

Cephalopoda

May 18, 1971
Porvenir (San Blas).

Making a brief visit to the island. Ca. 1:00 - 1:30 p.m. Swimming near hotel (perhaps 50-75 ft. from hotel landing). Sky very overcast, but no rain (although there was rain both earlier and later during the day — and this has been a particularly rainy May). Extensive area of turtle grass. Water 5-12 ft. deep; moderately clear (visibility up to 30 ft. at times?)

Come across groups of 5 squid. Sepiotheuthis ? Quite large and cuttle-fish-like. 15" - 24" ?

Group divided 3-1-1.

All the animals were associating with one another. But some much more closely than others. A "nucleus" of 3 individuals. Plus 2 others which were more "peripheral", apparently not more interested in one another than in me (see below) or the nuclear group.

I think that the "nucleus" was a courting party. Always same 3 inds. swimming very close together (6" - 2' apart), in the same order. A very large individual (♀?) in the lead. Call this "1". Followed by a smaller individual, performing much more elaborate behavior. Call this "2". Followed by a third indivi

Ceph., May 18, 1971, II (2)

dual, of the same size as the second. Call this "3". I should think that 2 and 3 may have been ♂'s.

The nucleus followed a very irregular course, swimming rapidly, all mids. usually backward, within a fairly limited area (60 ft.?) most of the time. Circles, figures-of-eight, irregular zig-zags, etc.

No. 1 just swam rapidly. No signs of display. Generally rather dark and nondescript (with blue spots on mantle?!??). No. 2 swam in an extremely distinctive manner. Obviously wing funnel. But with exaggerated "fluttering" of fins. ~~~~~ No. 3 swam in the same "normal" manner as 1, usually not quite as close to 2 as 2 was to 1. No. 2 usually was generally pink, blue, lavender, in very tiny dots. Flushing a little bit, but all very delicate (except when in "Zebra" — see below). No. 3 was always or almost always in a pattern which might be called "Pheasant". Rather yellowish, with irregular, broken up, often broad, transverse brown stripes across back, and an irregular white stripe (or series of discontinuous stripes and spots), longitudinal, down the center of the back. Plus bright yellow (all-dgnd) spots above eyes.

Every now and again, 2 would stop and/or spurt forward, and give a "zebra" display to 3. Black and white transverse stripes on all or almost all arms, probably not tentacles, perhaps not hectocotylis (eyes?)? Very conspicuous. Arms spread. Longest outside? At the same time assuming (adopting) less

Ceph., May 18, 1971, III.

(3) (3)

mas o menos!

extreme (duller) version of same type of striping on back. I presume that this sort of display is threat. Perhaps in all colocoids?

No. 3 always stopped, or perhaps even retreated, momentarily, in response to the Zebra by 2. As far as I could tell, it did not display back.

The usual swimming of these three animals was also interrupted from time to time by brief bursts of forward movements. Perhaps accompanied by some smooth up and down "rocking". I can't guess at the significance of this.

When the animals were seen first, they fed occasionally, shooting out the tentacles with fast "stabbing" motions. But this stopped after a few minutes. None of the members of the nucleus did any more feeding during the rest of the period that they were observed (nearly continuously for approximately 45 mins.).

Apart from feeding, I don't think that I ever saw the tentacles of any of the animals at any time.

The two individuals which were not part of the nucleus were obviously fascinated by me. One of them, no. "4", spent most of the time just hovering, looking at me, from a distance of only a few feet or yards

Ceph., May 18, 1971, IV. (4) (4)

Only moved around very occasionally (although it did follow the nucleus around, once, for a couple of minutes). At least while watching me, it was generally rather dark, grayish, indistinctly mottled, with many moderately small but conspicuous, apparently iridescent, bright light blue spots, even scattered over back and perhaps fins (I think that I shall call this pattern "Ocellated").

The remaining individual, no. "5", stayed much less close to me. Usually in "Pheasant" pattern, without yellow above eyes. (Is "Pheasant" an alarm display, at least agonistic with escape relatively strong?). Sometimes hovered with many of its arms curled upward at the tips. Sometimes conspicuous because undersides of arms are whitish. Suckers revealed.

All the squid disappeared in a flash when a large barracuda appeared.

June 11, 1971
San Blas

Worked at three islands today: Yantupo (Carti) and Naranjo Chico in the morning, and Porvenir (same site as in May) in the afternoon. More or less cloudy all morning, sunny during the first part of the afternoon. Water dirty at Yantupo and Naranjo, clear at Porvenir.

Squid seen at all three areas. Apparently all

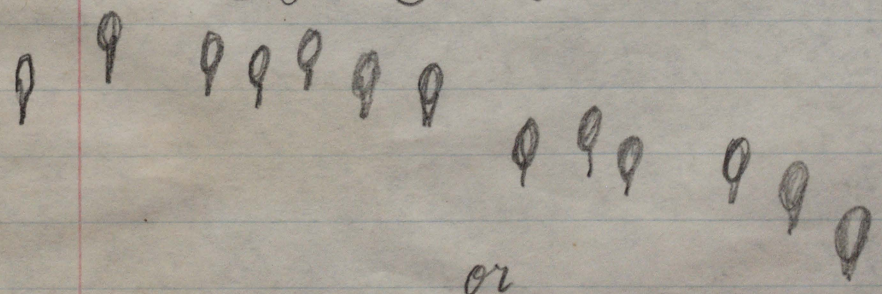
Ceph., June 11, 1971, II. (5) (9)

Lepidotenthis.

GENERAL NOTES. Perhaps the most interesting data obtained today were concerned with social organization. The species centaurch is highly gregarious. Both groups are organized in age classes. I could recognize three categories: large (ca. 12"?), medium (8-9"?), small (3-4"?). The individuals within each category may differ, but the gaps between them seem to be rather well marked on the whole. Are these annual classes??? If so, then the species must have a single definite breeding season.

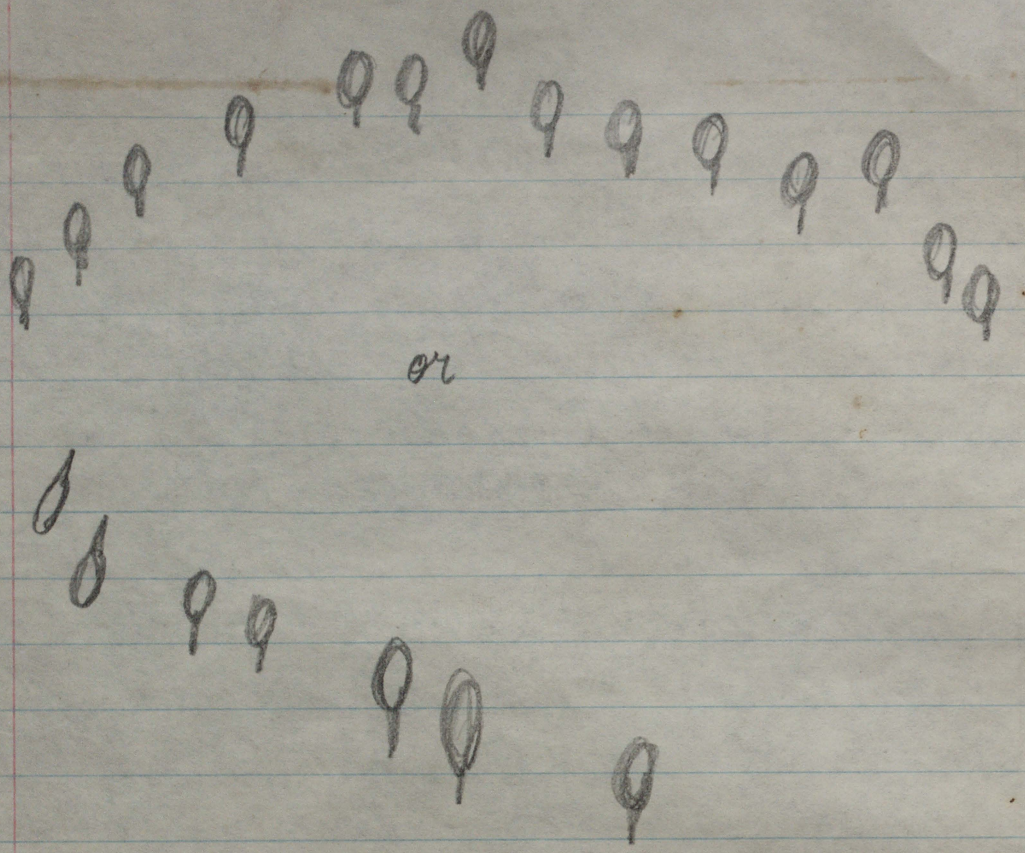
Inds. of different age classes may associate in the same school. But they do not mix completely. Inds. of the same age class stick together to form sub-groups within a school. And such sub-groups may separate from time to time.

The spatial organization of inds. is characteristic. Often in line or semi-circle; inds. usually (at least when swimming present) facing in same direction. Occasionally facing in opposite direction. Common:



or

Cepha., June 11, 1971, III.



or

They do not appear to be very active most of the time. Perhaps all the mids. seen today were simply fascinated by our appearance, and couldn't bear to tear themselves away. But they did not appear to be greatly upset most of the time.

This may suggest that they do not continuously search or hunt for prey over very long distances. But rather wait for the prey to approach them. And then advance to attack over short distances. See also below.

NARRATIVE:

Yantupo. Find groups of 24 squid. 3 large and 21 medium. The 3 large ones all together, at one end of the line of the group. All individuals more or less plain brown on back and sides, the top of the head and the

arms and tentacles, and the proximal part of the fins. (Notes. The fins extend to the front edge of the mantle, just as in cuttlefish. The tentacles are always visible, even when retracted.) The brown of the back, and probably the fins, is spotted with blue "ocelli". On the back, these are arranged in transverse rows. . . . . .

. . . . . .

All the individuals . . . . . .
show traces of a longit-
udinal whitish or yellowish stripe down the center of the back. This may be continuous or interrupted. It is not inconspicuous, but neither is it exaggerated, most of the time. The distal edge of the fins also is colorless, or whitish. This may give the impression of another longitudinal light stripe when viewed from the side.

I shall call this pattern "Ordinary" ("ORD").

Suddenly a 4th large ind. appears. Joins the other 3 large. Then suddenly swims forward, toward me changes color. Becomes yellowish with large irregular dark brown blotches. (This may be what I called "Pheasant" — "PH" — earlier.) Also curls up tips of arms. Then shoots out tentacles, grabs fish. A silvery anchovy type, probably 1/3-1/4 of its own (total) length. Fish is bitten immediately and does not struggle at all. The squid changes back to ORD immediately after the capture, and rejoins its group and sub-group. None of the other members of the school makes any attempt to steal the

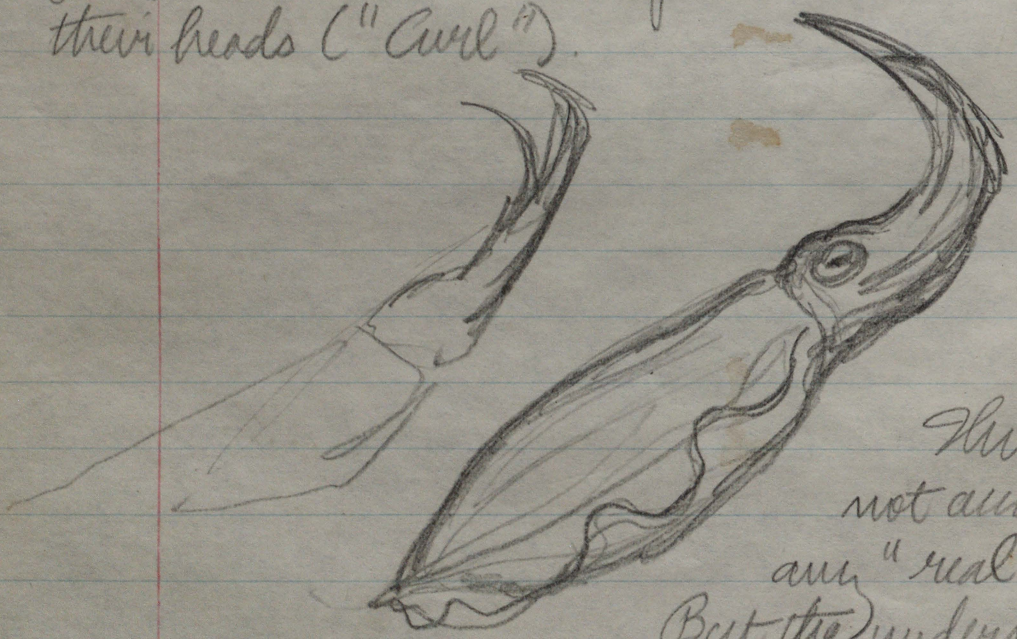
Cephs., June 11, 1971, V.

food! The fish is held in the arms, more or less dragonfly. Feeding is slow and/or begins late. Most of the fish is still visible 10 mins. after capture. When feeding does start, it begins with the head.

NOTE: Arcadio says that he has been watching 2 other large squid some distance away.

Now I see that some of the medium squid have yellow patches above the eyes. (These are really quite complex. Large, iridescent or "brassy", surrounded by iridescent blue and green which is not always conspicuous in the water. I shall call this pattern "Y".)

Then all the large squid disappear. A few minutes later the medium ones come closer to me. Most with rather exaggerated Y superimposed upon ORD. Several curl their arms upward and backward above their heads ("Curl").

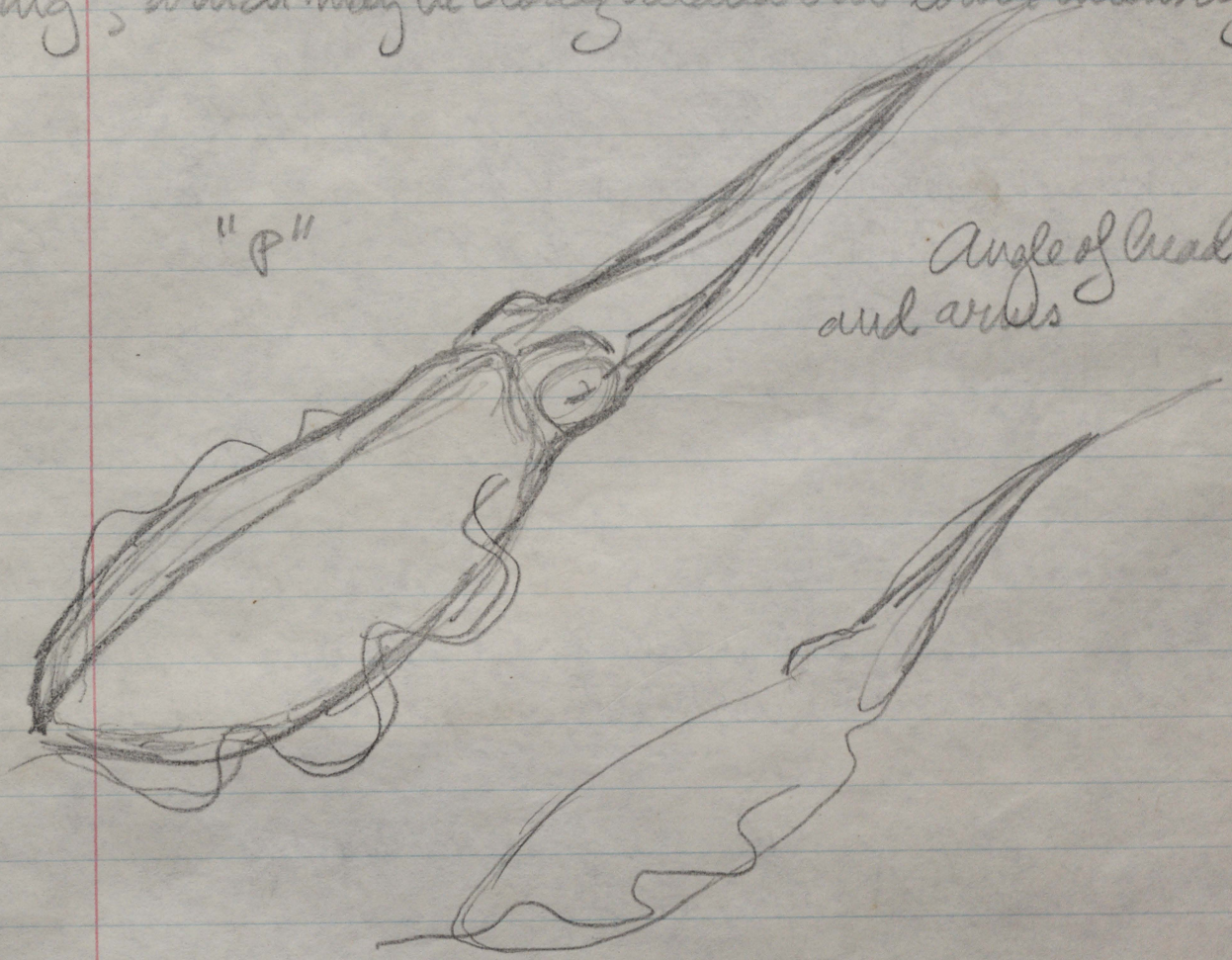


This probably is not accompanied by any "real" color change. But the underside of the arms is conspicuously lighter.

Cephs., June 11, 1971, VI.

(9) (9)

Several mids. also show another pattern, "Pointing", which may be closely related but lower intensity



One mid. suddenly shows a brief trace of PH when a fish comes close. See also below.

Now the animals seem to be relaxing, to have become quite blase' about my presence. And Y has gone!

Then a much smaller squid of the same species appear. Stay together on the outskirts of the school.

All these observations are made in an area of water 3'-9' deep. Bottom covered with Zwitte Grass.

Arcadio sees 3 large squid some distance away. The same 3 mids. seen with this school earlier ???

Ceph., June 11, 1971, VII. (10) (10)

The squid here seem to ignore both a cayuco and a (motor-driven) trading schooner passing near me. Further evidence that they cannot hear?

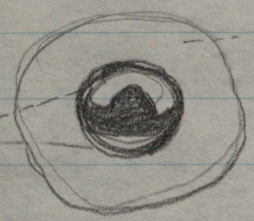
Naranjo Chico. Come across school of 10? more or less medium mids. (Some variation in size. Fairly graded from left to right.

. . . . . etc.

all in ORD. Some with Y.

Arcadio shoots one mid. It squirts ink when hit. The others retreat a few feet or yards without changing color. I.E. the sight of ink does not induce maximum panic.

The eye of the species is rather peculiar. In the dead specimen comme ça:



In live mids, the pupil is much less noticeable. Perhaps comme ça:

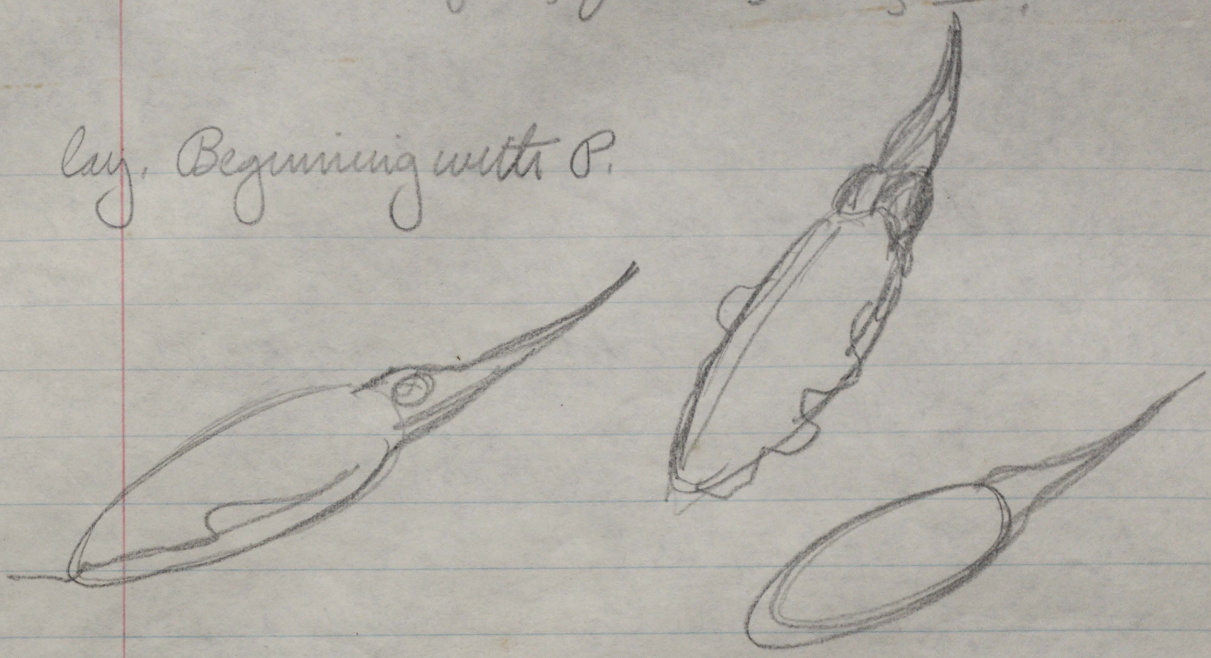
Porvenir. Find 3 medium size squid looking at me as usual, in ORD. Not much reaction at first.

Then 2 or perhaps all 3 of the mids. start to disp-

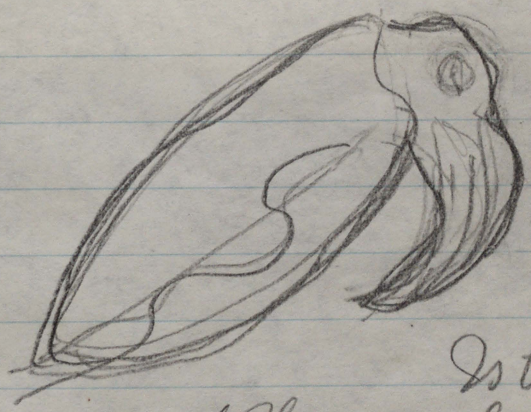
Ceph., June 11, 1971, VIII.

(11) (11)

Lay. Beginning with P.



Then switching to a remarkable "elephantine" ("E") posture. Apparently high intensity. Followed by rather extreme P's. And then by less extreme ones.



It is characteristic of all these P's and E's that the tail end is down. Is this a display in itself? (The normal, relaxed or semi-relaxed posture of the species may be with tail slightly up and head and arms slightly down.

Both the E's and P's were done most frequently by animals with their backs toward me and toward their companions. White median line particularly prominent ("WS") These animals seem to be consciously "showing off" their back patterns.

Cephr., June 11, 1971, IX.

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Then 2 small mids. appear. Coming from distance beyond the mediums. One approaches ass end to with P and lowering of the tail and WS. I should think that this display must be directed toward the mediums rather than to me.

Then I swim toward the mediums. They retreat, rather slowly, with Y and WS.

I notice that one of these mediums, the one who stays closest to me (the "dominant") has been badly injured but seems to have recovered. Scars on back. Missing at least 1 or 2 arms on left side.

Then the animals accelerate their retreat. At same time turn generally paler ("Pale") throughout.

Now the near small individual is in P almost all the time. Can P be submissive?

Then there is an E-P sequence by one of the mediums. Both postures with back shown to both me and other mids. in the school.

20 ft away we see a group of at least 17 small mids. One does lots of E. All with WS and

back toward both me and companions. Followed by P's with some color pattern.

P-E-P and E-P sequences may be typical.

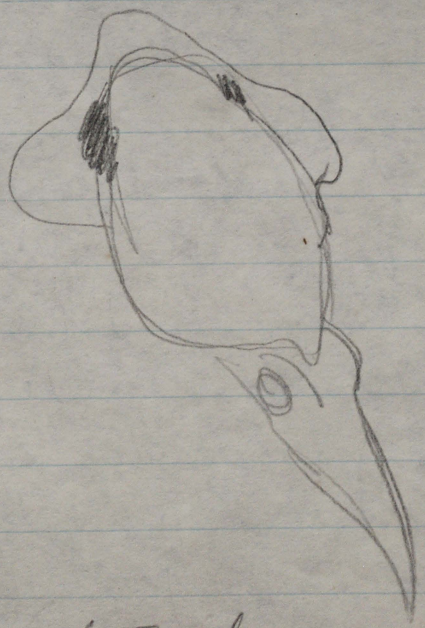
Then the group of 7 smalls joins the others.

Two mediums do P's back to back. One also does E. Very extreme WS's by both.

Smalls do P's to one another

Suddenly there is a general panic. Apparently triggered by fish movements. Escapes with both WS & 7.

A few minutes later, one of the mediums goes "dynamic" ("DM") Can't see what provokes this. Whole of fins becomes colorless or whitish, except for 2 large dark spots toward rear. (Possibly these spots are on sides of body rather than fins. But I don't think so.)



Perhaps with trace of E.

Some time during this general period one of the mediums assumes a "devilfish" posture after performing P.

Ceph., June 11, 1971, XI. (14) (14)

"DF"

(I know that I have seen this at least once earlier here today. Probably during the first burst of P's and E's.)

Then I start to chase the mediums again. One escapes rapidly, goes Pale, and also, finally, DM!

I repeat chases again & again & again. Almost all of them induce DM by one or more mids. DM is not always symmetrical. Spot can be much larger on one side than the other. Can be combined with ORD-Y-WS. Also seems to intergrade with PH!!! Other blotches appear on body at same time as DM spots!

NOTE: Some of the small mids. tend to be much yellower than others most of the time. Is this physical or motivational variance???

SUMMARY: What do I think about displays now? Y, WS, and Pale are large, escape. Pale presumably higher intensity than the other two. P may be submission. Curl and DF probably are related to P. "Zebra" ("Z") presumably is aggressive. Perhaps PH is also aggressive, although less so than Z. DM must be moderately high intensity — or perhaps more — with attack less minimal than in Y, WS, and Pale. E may be moderate intensity again with attack less minimal than in Y, WS, and Pale, but perhaps relati

Cephs. June 11, 1971, XII.

(15) (15)

very stronger than in DM. "Pastel flushing" must be sex
mat (courtship?).

COMMENT: These squid seem to ignore all fishes
even small ones, except for certain potential prey. And
most fishes ignore them reciprocally.

June 12, 1971
San Blas

Starting out work off island of Miatupo (Aven-
ado Island), one of the Lemon Cays. Weather is cloudy. The wat
er is remarkably clear. Get into water ca. 8:00 a.m. Cont
inue off and on until 10:00 a.m.

Come across group of 17 squid (usual Sepioteuthis
type) almost immediately. In 8-9 ft of water. Over turtle
grass. Near edge of coral reef. Group includes approxim
ately 6 large, 11 medium. Large inds. seem to be in pairs.
Pairs tend to be on outskirts of group slightly apart from
the main mass. Sometimes all the pairs are on one side
of the group. More often scattered along several sides.
The 2 inds. of a pair usually stick close to one another.

Inds. of the main mass tend to string out in
lines, just like the groups seen yesterday.

All the (medium) inds. of the main mass are in
ORD. So are some of the large inds, some of the time (see
also below). Some inds. in ORD have Y and/or WS. Some
also do brief P's from time to time. Can't tell if these are

by or directed toward me or toward other members of the school.

Then see a "sub-group" of 6 more large about 20 ft away.

Follow 2 pairs swimming on parallel course. All mds. swim normally most of the time. Then there are a few bursts of swimming with exaggerated fin waving ("Flutter"). Then one individual turns light, iridescent ("Pastel") along one longitudinal half of body! Comme ça:

The "eye ridge" of the Pastel side of the body is very conspicuously silvery iridescent.

This display lasts for only a few seconds. Then the 2 pairs gradually diverge.

A barracuda appears and everything darts away.

See what must be largely same group same area approximately 15 mins. later. But now it includes at least 36 mds.! At least 6 smalls as well as the mediums and large mds.

General organization more or less as before. Smalls

(17)

in their own sub-group. Large usually in pairs around outskirts. All smalls and mediums in ORD. Rather dark. Very little Y or WS. Some apparently hostile encounters within med-lrg and small sub-groups. See both P and E (not very extreme) preceding attack init. movs. (sudden forward dashes toward an opponent). None of the attack init. movs. leads to actual biting or striking.

Pairs of larges are swimming around rather calmly. Only occasional fluttering. The mids. are usually or generally rather pale — presumably as an init. mov. of Pastel. Swept by occasional, almost always partial, flushes of more exaggerated Pastel. The partial is extremely variable. Sometimes (as above) it is one side of the body, which turns light. Sometimes it is the arms and tentacles. Most frequently it is a localized area at the rear tip of the body, a sort of "rear light" ("RL"). RL is frequently assumed, and long continued by both members of a pair. Some mids. who have shown unilateral or weak general lightening of the body continue to have comparatively broad and conspicuous lateral median stripes after the rest of the body has returned to ORD. I do not think that I can distinguish this from "conventional" WS. But it may not have the same social significance.

In all pairs, one mid. usually leads while the other usually follows. In at least 2 pairs, the following mid. is larger than the followed. (Viz. contrast with May observation. What does this suggest about ♂-♀ roles?)

Some mids. of some pairs certainly stick together

for more than ½ hour. For all I know, pairs are "permanent".

But there certainly is some "fluidity". See a good example. One mid. of a pair gets separated from its partner. Drifts after another pair. One mid. of the latter repells this "intruder" by rapid forward darts after P. (No color change in the aggressor. It retains traces of Pastel throughout.) Then the isolated or abandoned individual transfers its attention to, drifts after, yet another pair. Throughout this process, the abandoned mid. remains darker, in "power" ORD, than any of the members of the 2 pairs it follows. Eventually it is joined (re-joined) by a single large in Pale or semi-Pastel.

There are some P and attack moves between members of one pair. Each time, the attacked shows traces of PH while retaining RL!!!

Observations interrupted temporarily. Resume approximately ½ hr later.

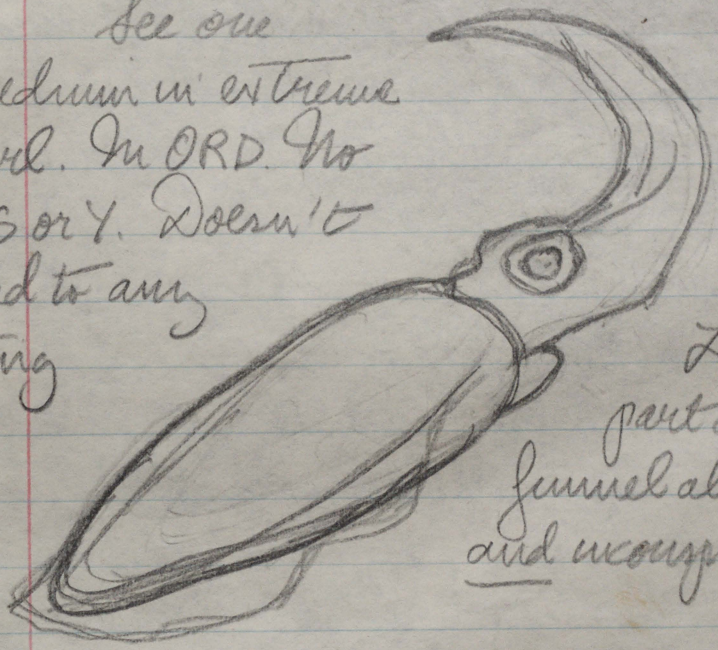
Follow a pair (large, of course). One member of pair turns completely Pastel. (I have not this morning been able to distinguish real flushes of different colors or tones in Pastels, although they may be occurring. I presume that Pastels are sexual or closely related. But they are low intensity on the average this morning. Easily inhibited by even slight degree of alarm. Inds. show this behavior only when relatively far away from me. Alarm seems to inhibit sexual behavior more easily or frequently than it does feeding. See below.) The Pastel mid. darts toward its partner. The latter leaps away with extreme RL. The first mid. goes back

Cephs., June 12, 1971, V.

(19) (19)

into ORD (more or less) and follows the second who is still in RL.

See one medium in extreme Cond. In ORD. No WS or Y. Doesn't lead to any thing



The part of the eyeball which is covered with skin is conspicuous Light colored. Looks like part of the exposed eyeball. The funnel also is quite large. But light and inconspicuous.

One large mid. behaves similarly with a similar absence of visible results.

Then one medium does P with WS. Again no results

Get a good view of feeding behavior. A moderately large school of very small minnows appears. Swimming near surface of water. Well above the squid which are 6-10 ft down. Squid tend to retreat in front of school of minnows as the latter advances. But every once in a while a small or medium squid will dart forward and upward and seize a minnow. Usually paling just as it shoots its tentacles. This behavior would seem to confirm the suggestion made yesterday that these squid tend to wait for their food to come to them rather than relentlessly hunting it down. And it also suggests that the PH with

feeding seen yesterday was a reaction to me rather than to the prey.

General panic. All mds. shoot away several yards. All Pale with Y and WS during retreat. Panic subsides very quickly.

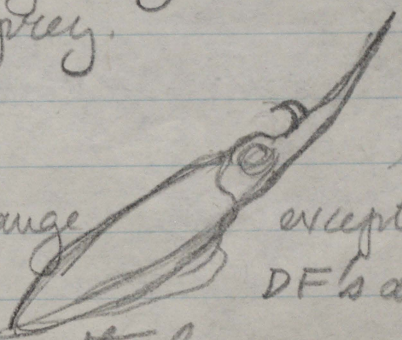
Then there is chaos. A series of reactions which I cannot catch. Turn around to see 2 large mds. almost in contact. One above the other. Facing same direction. Both with arms spread ("Spread"), sharply marked with black and white. The upper md. is generally darker than the lower. Spread is pure and "typical" Z. Lower md. has arms almost white with much more scattered black patches. Upper md. probably has modified Z or PH pattern (see below) on back. Lower md. probably has whiter, although perhaps equally motted, back. Once the upper darts down to the lower, apparently trying to bite it. Then the reverse occurs. Immediately the 2 mds separate with puffs of ink ("Ink").

This could have been a cop. attempt by the two members of a pair, or, perhaps more probably, a fight between members of different pairs.

A few seconds later, same area, see 2 pairs not far apart. Once an md. of one pair approaches another. The approached md. immediately does Spread with Z on arms and a PH type pattern on back. The approacher retreats. Approached goes back into more ORD lilac color and stops Spread. Then the whole process is repeated. Then the 2 pairs

separate

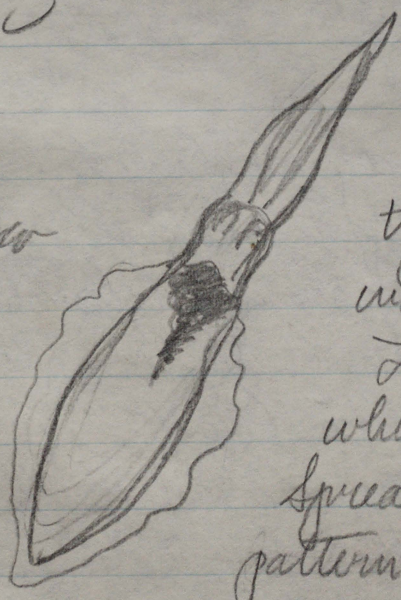
Observe more feeding. Twice, mediums do extreme DF before seizing prey.



Once a medium does Curl before seizing prey. With little or no color change except paling at moment of impact. Were there DF's and the Curl directed toward me? I rather think so.

(Note. DF may be an exaggeration of a normal "pre-seizure int. mov. Upper pair of arms sometimes lifted slightly above and apart from others before apparently ritualized attack upon prey.)

One large mid. turns almost completely white, retaining only a black blotch toward the front of the mantle.



"Pie" see below

Swims near other large in normal way. Apparently provokes Spread, with Z on arms and PH-type pattern on back, by one of the mids. it passes.

Later, one member of a pair turns whitish all over. Apparently provokes Spread, with Z on arms and PH-type pattern on back, by its partner.

COMMENT: Obviously I am having trouble in distinguishing some of the color patterns. Two major difficulties. (1) Pale-Pastel (2) Z-PH

Ceph., June 12, 1971, VIII. (22)

(22)

(1) I really don't know if Pale (and WS) and Pastel are closely related or not. Possibly all the high intensity patterns of the species involve lightening — simply to provide contrast with the generally rather dark ORB. Compare vocalization vs. silence in birds.

(2) I am no longer sure that these animals can show real Z on back. Perhaps they cannot become more mottled than PH on the back. If so, perhaps one should distinguish only 2 displays of this type: A. "True" PH. Mottling on back only, without spread or conspicuous change in color or pattern of arms and tentacles. B. "Complex" Z. Spread with Z on arms and tentacles, and PH-type mottling on back.

NOTE: Several times today, medium inds. swam directly below me in the course of our mutual maneuvering in ORB with Y and WS. And also, when they were closest, DM. DM usually symmetrical.

Starting observations again slightly before 1:00 pm. Weather now sunny. Go to same place as this morning. Group still there. Now includes at least 42 individuals. All categories. Small, medium, large. Plus a considerable no. of intermediates. (But intermediates are still less abundant than "typical" categories.)

When we first arrive, there are many "courting pairs" of large inds. One is started by a member of a pair suddenly turning Pastel while swimming after its partner. The latter responds by becoming "Jeid" ("Pie"). Largely silver with a few dark markings,

Ceph., June 12, 1971, IX.

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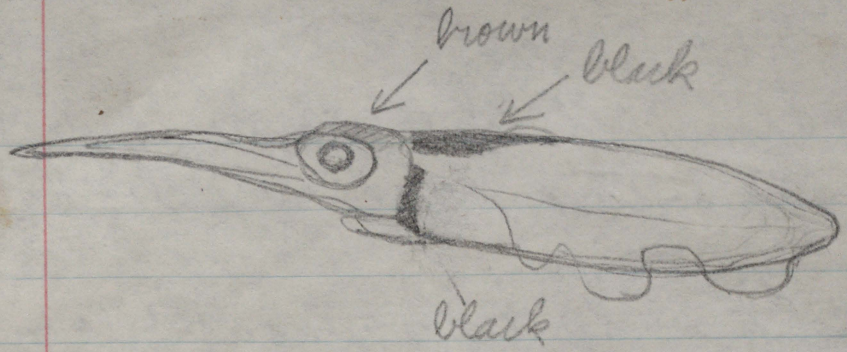
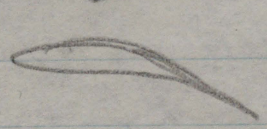
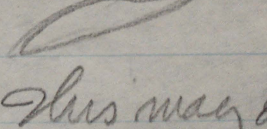


This Pie appeared to develop as an exaggeration of RL. The first individual reverts to ORD with WS (and probably Y) as soon as its partner goes Pie, while still continuing to follow.

During next 15 min. or so I see several other counting parties. One mid. (♀?) in Pie followed or attended by 1–4 others (♂'s?) in ORD with WS (and Y?) or in PH (PH of back, no sign of Z on arms or tentacles). The followers or attendants pass back and forth beside or around the Pie mid., the presumed ♀, perhaps trying to get under her. Sometimes there is considerable "rocking" by some or all members of the party. Brief alternations of forward swimming and backward swimming





This may or may not be ritualized per se.

One dispute (?) between 2 attendants. One mid suddenly spreads, with Z pattern on arms and tentacles and PH pattern on back. This seems to repell the other attendant.

None of the counting parties is seen to do anything more. My impression is that counting must be a lengthy process in this species.

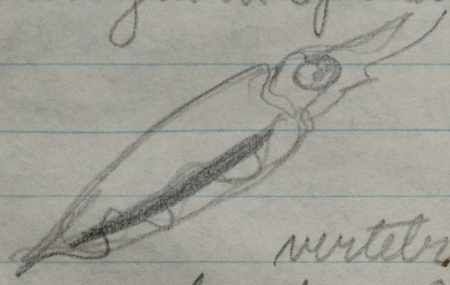
Cephs., June 12, 1971, X

(24)

(24)

The medium mids. of the main mass do low intensity E from time to time. One or more also does extreme Curls.

NOTE: There is a conspicuous dark longitudinal stripe below fin in Spread-Z-PH complex



Are cephalopods similar to vertebrates in using dark for threat and light for escape, appeasement and seduction? If so, why?

A half hour later, everything is very quiet. Counting is almost stopped.

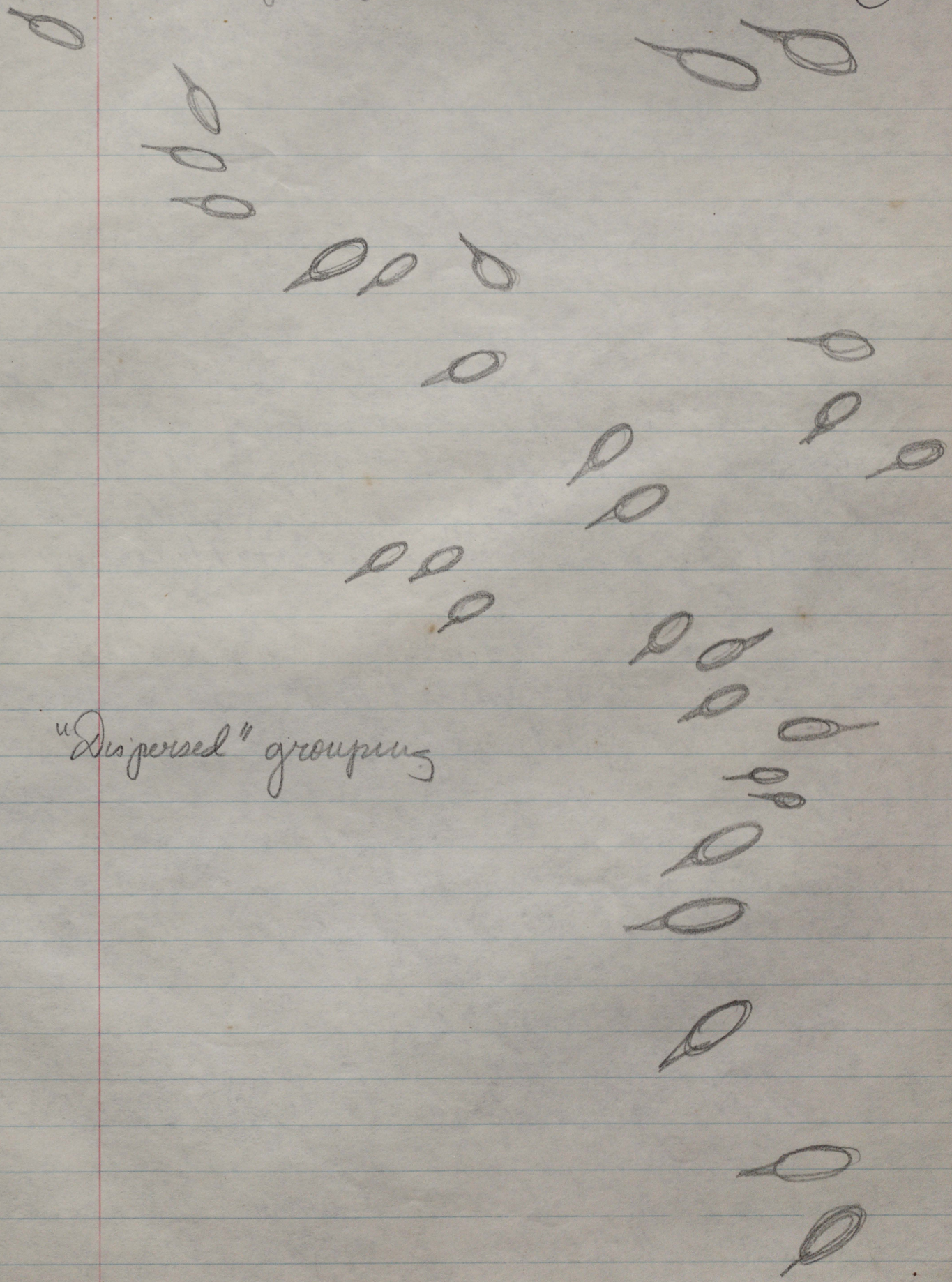
All the animals seem to be getting used to my presence. All are in ORD. Rather dark ORD. No trace of WS or Y. (Notice that ocelli on back may be more white than blue, at least in many lights.)

They also have begun to "scatter" a little. At least their lines are less regular than earlier. See next page

I eventually stop observing ca 2:30-3:00 pm. Simply because everything is too dull. We go off to look for more suitable areas. Without success.

Ceph., June 12, 1971, XL

(25) (25)



"Dispersed" groupings

June 13, 1971
San Blas

Going to work same place today as yesterday. Start a few minutes before 7:00 a.m. Cloudy, rather windy, wat er clear.

At first find nothing at all. Squid definitely not here. Why? This is the windy side of the island today. Yester day it was the lee. Do these squid prefer lees? (One might per haps expect so, considering their feeding habits.) So Arnaldo goes off to the other side to look. Without finding anything there either.

In the meantime, a single "pair" shows up here ca. 7:40 a.m. Most peculiar. One is very large, one is only medium (altho perhaps large for an ind. of this category). Greater difference in size than I have seen in any other pair. When first seen, both mids. are swimming around rather calmly. In and near coral reef. In a sort of pale (Pastel ?) ORD. The medium mid. does definite DM in this pale ORD when it first notices me. Then it does a long E, with a rather darker ORD and WS.

Continue swimming. Varying in color. All combinations of ORD & WS (never any Y) and Pastel. Little or no fluttering. The medium follows the large more frequently than the reverse. Once medium does another DM in ORD with WS. Occasional "pauses" with gentle rock ing by both mids. "Forward up phase" of rock may be

real P. Large is more often more Pastel than medium.

A peculiar "intermezzo". Large turns completely ORD with WS. Seems slowly backward toward medium. Which is also in ORD with WS, completely stationary, and with its back toward the approaching large. The medium goes into extreme E as the large approaches, and just stays in this posture. The large mid. finally passes over the medium. Immediately turns Pastel or semi-Pastel, swims off forward. Medium follows. Also going forward. The large turns back into ORD. The medium remains in ORD throughout. Maintains E for minutes while swimming forward after large!!!

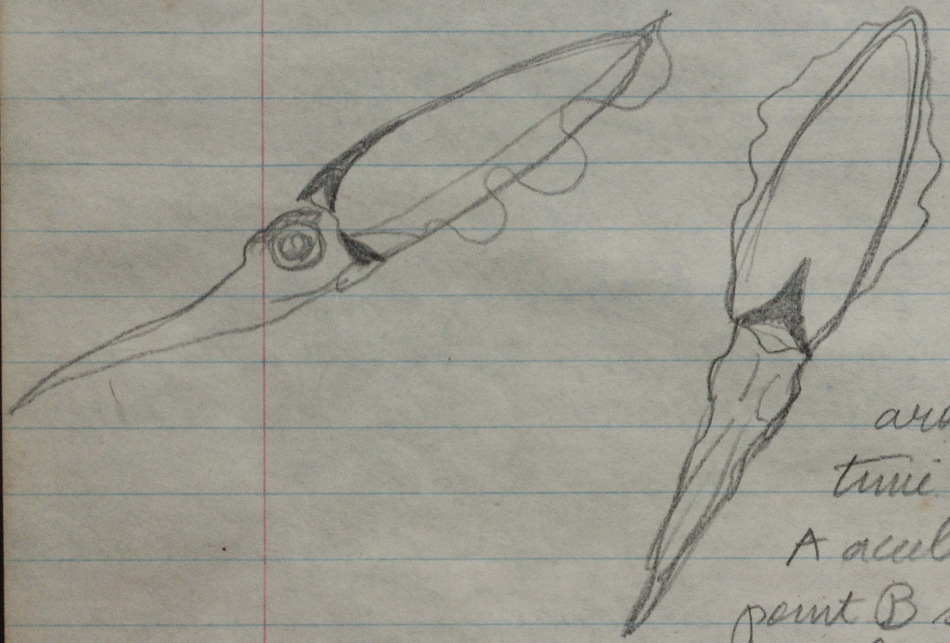
A few minutes later, Arcadio and boat come back. Both squid dart off backward. Large in Pale-Pastel. With DM. Medium in ORD with WS and DM.

8:00 a.m. Indians tell us that squid are now in very shallow water near shore of island. Is this where they sleep at night? We go in to see, but can't find any animals. (Possible explanation? Jose', our guide, says that the squid come into the shore when tide is high, not otherwise).

Go back to the deeper Turtle Grass-Reef area. Find group of 7 large squid about 20 yds away from where animals were seen yesterday and earlier today. Apparently 3 pairs and 2 "loners"

Watch one pair. One mid., B, is slightly larger than the other, A. I should suppose that B is ♀, A ♂? A suddenly turns real Pastel, starts to swim after B with extreme

Flutter. B turns Pie and swims away. Both animals going backward. B's Pie is extremely variable. Sometimes exaggerated. Sometimes little more than well developed RL (on ORD).



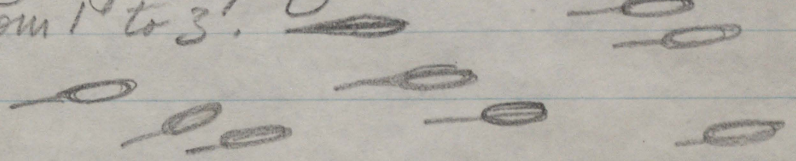
Extreme Pie

The 2 animals swim around like this for some time. Every once in a while A accelerates. At which point B shoots upward. A shoots after "her", underneath and behind (Both vids. still swimming backward)

NOTE: Background of Pie is brilliant silver, iridescent with pink and gold, perhaps other, reflections. General effect is quite different from extreme Partial and Pale, which are opaque, "powdery".

B eventually goes back to ORD or something similar. Then a 3rd vid., C, joins group. C gets between A and B. Approaches B in Partial with Flutter. B goes Pie again. Then there is a lot of rapid swimming. I get confused. A certainly approaches C and gives Lyreas with Z (Z certainly extends to back as well as arms and tentacles). Then I think that A and C exchange places. All

3 are now swimming more calmly. Around and around me (It looks as if the B may have chosen my legs as a small coral reef around which she can take shelter!) B always in lead, followed by A, followed by C, but the distance between ends varies from 1" to 3'.



B seems to be in very ambivalent colors. Some RL ⇌ Pie. Some ORD with WS. Some yellowish semi-PH. C usually in rather dark ORD with WS. A in a variety of colors. Often in semi-PH. Yellowish brown with only scattered or fine dark mottling. Often intergrading into a yellowish form of Pastel. (Yellowish Pastel more hostile than "pure" Pastel? A presumably is reacting to both B and C.) Very occasionally A "reverts" to ORD with WS.

Every once in a while A shoots backward toward B. In Pastel-Yellow-Pastel. As usual, "she" responds by shooting upward. "He" follows behind from below, sometimes tilting his back toward her when and if "he" catches up. A's swimming during accelerations may be fluttering. When "he" is in Yellow-Pastel, there may be a dark streak along "his" side, well below the fin. This dark streak ("Bottom Streak") may be an indication of ambivalence. It probably is absent in "pure" Pastel.

This sort of behavior continues for 5-10 mins. Then I have to interrupt observations.

20 mins. later, find same 9 larvae in same place.

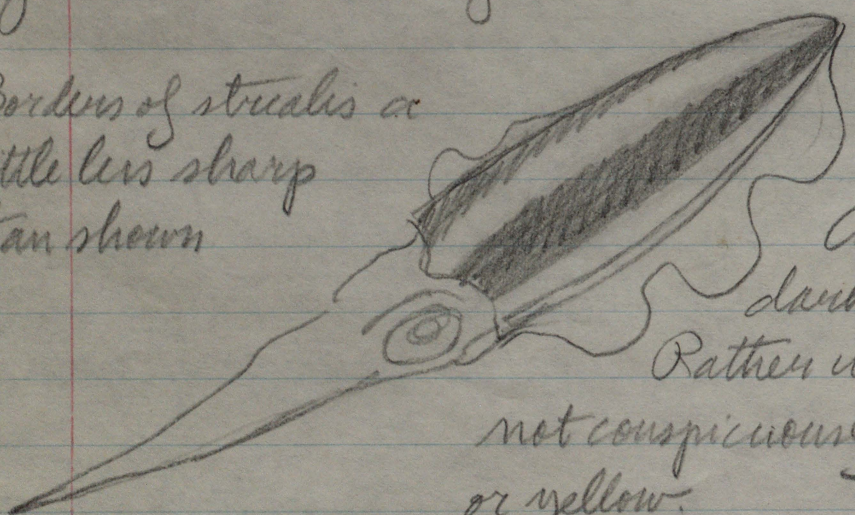
Ceph., June 13, 1971, V.

Some mds P in ORD to me.

Some RL by one or both members of several pairs. In ORD, with or without WS. Never any Y.

ABC trio apparently still around. Not doing much. All more or less ORD.

Then one md. of trio, presumably B, turns Pic. Shoots off. Followed by presumed A and C, and also 2-3 neighbors. Apparently an "expanded" counting party. All mds. move in same direction, quite close together, but P and some followers backward, other followers forward. All followers in PH and/or ORD-type patterns. One shoots forward, makes usual upward "pass" at B. Showing back (presumably by tilting). In a pattern which I have been describing as ORD with extreme WS, but which may have a slightly different significance. ORD-type brown concentrated in 2 broad streaks, on either side of median light streak and above fins.

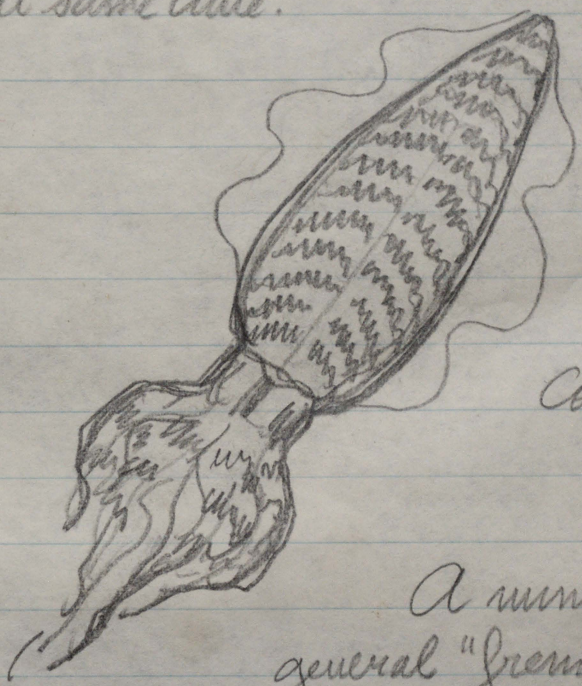


Borders of streaks a little less sharp than shown

Call this "Double Streak"

All areas below dark streaks are light. Rather undistinguished, not conspicuously white, silvery, or yellow.

At some time during this performance, there is a hostile encounter between two followers. Spread with complete (back) Z by one. Back probably tilted toward opponent at same time.



Lateral stripes blackish. Crowded quite close together. I am not sure if there is (are) median stripe (s) or not. Could be black and/or white.

A minute or so later, the general "frenzy" stops. Leaving A-B-C as before. Swimming slowly back and forth, backward and forward. B definitely controls movement of trio as a whole. B in ORD with frequent RL, occasionally developing into semi-Pie. A in relatively yellow or rich brown ORD (semi-PH?). C in dull dark ORD. (I notice that A and C have row of larger light spots on fins than does B. Is this significant?)

There has been no trace of E or P, much less curl, in the counting of A-B-C this morning.

Then A swims backward toward C, gets very close. The whole rear half of the body of A turns silver (!), as in Pie, but with a conspicuous, sharp, black line just at base of fins. I shall call this "Fin Stripe" ("FS").

(I know that I have seen FS before, but I can't remember where or when or in what circumstances or combinations.)

Then everyone relaxes. Everything goes on as before. A-B-C together as usual. B suddenly goes Pie. A makes a pass at "her" in Double Streak, after brief Pastel. Then all relax again.

We try to collect B, but miss. All the animals become nervous. Stop observations ca 10:15 a.m.

NOTE: Arcadio saw a group of 14 squid yesterday near Achutupo (Dog's Island) while I was observing group here at Matupo. Distance between two groups approximately 175 yards. Is this typical?

Start observation same place Matupo ca 1:00 p.m. Find group of at least 32 inds. Mostly medium. Also at least 2 pairs large. And apparently A-B-C.

We shoot at B. Miss (again). B squirts ink and darts away. Ink coagulates in water. In rather chiffon-like "veils". Remains intact for 5 mins. or more. Definitely a decoy.

Watch another semi-detached pair. One turns pale does extreme E, shoots off, disappears. Other follows.

Watch still another pair. Largest of the two leading the other. Largest presumably ♀. In PH, then ORD with WS. Partner always in ORD-WS at first. Then turns Pastel on longitudinal part of body away from presumed ♀.

During the next half hour, we shoot at least 3

times at presumed ♀'s. Missing every time. Usually provoking milk. By the end of this period, all the animals are very spooky indeed. But they are still hanging around same general area. This is a further indication that they are essentially sedentary.

Stop observations 2:00 p.m.

July 24, 1971
San Blas

Working at Mulatupo, the same area as last month. Start around 9:30, but I have a lot of trouble with equipment, and don't really get going until ca 10:00 a.m. Partly overcast. Some wind. Which increases steadily as the morning wears on.

First squids almost immediately. Over turtle grass near reef. In approx. 8 ft of water, 2-3 feet above bottom. (This is exactly the site favored last month.) Usual species. But not many individuals.

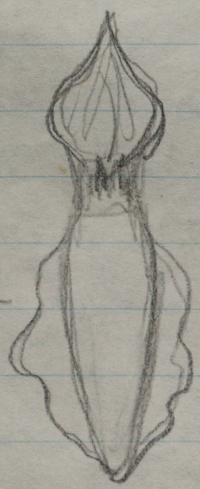
First see group of 3 large. One does extreme E, in Ord or DH when it first sees me. Relaxes almost immediately. Then see 2 more large a few yards away. (Note: There are a lot of fish around, some moderately large. They are ignored by the squids, and vice versa.)

The members of the group of 3 are "courting". Swimming back and forth. Perhaps some rocking. Occasional sudden "passes" by one or more of the males. Also,

one ind. (always the same?) sometimes leaves the party and approaches the other group of 2.

Inds. which are approached closely or suddenly, or are "passed" at — and there is at least one such ind. in each "sub-group", the sub-group of 2 and the sub-group of 3 — usually go Pie. Often extreme Pie. At least once, an ind. in extreme Pie also does exaggerated E.

Sometimes when an ind. of one sub-group approaches an ind. of the other, there is some PH. Sometimes with a "semi-spread" of arms.



Tips of arms kept nearly together
No trace real Z.

Many, perhaps all, of these PH's are accompanied by dark or black stripe along bar of fin. This "fin stripe" may be typical of PH.

Sometimes an ind. making a rapid pass (within its own sub-group?) starts out light colored (presumably Partel) and then turns PH at the climax.

Inds. which are not being active at the time are in Ord, with more or less WS. Also Y when close to me.

I think that there is considerable variation, from time to time, in the size and/or brilliance of the ocelli in ORD. Why?

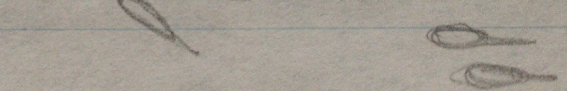
When the 3 inds. of the "counting" party disappear.

A few minutes later find group of 5. Again? Probably same inds. as before. Certainly divided into sub-groups of 2 and 3. All quite active. Lots of display. But all very rapid. Low intensity. Probably highly ambival-ent. (There are lots of fish nearby here too). Some P in ord, probably with WS. Some passes. Perhaps traces of Pastel and/or Pale. Certainly PH. Some Spreads, complete and incomplete. One Spread in Pale by an approached individual. One actual brief attack (between whom?) with little or no display!

Then I take a few minutes breather. Return, ca. 10:40 a.m. Come across group of 4 same general area. 2 pairs? All in ORD with WS. One ind. of one presumed pair approaches ind. of other in slight PH. Then goes back. 2 inds. approach me. In Ord with WS and extreme V. Occasional traces of P. Then drift off.

Nothing of interest happens for a long time. Only a few very low-intensity indications of P and E.

Then all the annuals shoot off when a school of large fishes approaches. Come back again, all at the same time. They certainly appear to be moving as a unit, but they still show traces of a 2-2 division within the group. Note: I am recognizing sub-groups simply by spatial arrangement. Thus, for instance, these annuals tend to arrange themselves comme ça:



All very calm now.

Then they close up and swim in a fairly tight bunch for a few minutes. Three in front swimming forward. In Ord with WS. The one in back swims backward in PH.

Then there are some passes among the mids. of one pair. Once an approached mid. does extreme Spread when all the arms are white but the rest of the body is Ord or PH !!!

Now a fifth mid. shows up. Immediately there is some Pie-ing in the group.

Is Pie hostile?

Now I see that there are 7 mids. around. Divided more or less 2-2-3-2. (Arcadio thinks that there may have been an eighth in the area, but I didn't count it.)

Watch one "pair". One repeatedly swims backward toward the other. Starts approach with RL, changing to Pie as distance between mids. decreases. Approached reacts by RL. Both approacher and approached show traces of B. Some "rocking". A third mid. seems to show interest, but doesn't join in the game.

COMMENTS:

It is possible that many of my earlier interpretations of social encounters were mistaken. Some or many of the encounters which I called "courting" may have been purely hostile. (Perhaps all the encounters without Pastel?!?)

Pie may be purely hostile and related to DM (my Octopus vulgaris). But I must state that I have not seen

real DM in my sense (i.e. 2 black spots) this morning.

The social structure of the animals here is certainly different now from what it was last month. Only large buds. Divided into pairs and what look like polygamous clusters. (Perhaps the large mids. were the same last month. But what has happened to all the smalls ??? ??)

NOTE: Not only are there more fish here now than last month, but there also are more pelicans. Is this related to the apparent disappearance of the small squid?

After lunch Arcadio goes to look around some adjacent areas, Achutupo and some other parts of Ailetupo Finds only 1 or 2 groups. First 8 large, and then 5-6 large, a hundred yards apart at an interval of ½ hour (i.e. more probably 1 group than 2). I go down to look at the 5-6. All in dark Ord-PH. 3 in extreme Curl. 2 in extreme E. All with some WS. Two of the mids in Curl have white stripes that are particularly broad but also interrupted. Sort of a series of blotches.

NOTE: Arcadio says that he saw some smalls yesterday near an island called Ailumiga. So they still exist after all.

ADDITION: The 5-6 larges here now are almost directly under the Tethys. Are they using it for protection?

Later this afternoon we go out to the Holandes Keys. Look around the island of Ogopukeyi ca. 4:00-4:30 pm. Without seeing any squid. Then Arcadio takes a look at several adjacent islands. Again no squid. And then

Ceph.; July 24, 1971, II.

Once again without interesting results.

Arcadio says that there's an awful lot of large predatory fish here, more than in the Lemon Cays. Barracuda in the turtle grass. Snappers and Nassau Groupers in the coral reefs. It occurs to me that Sepioidea may avoid reefs simply because they are preyed upon by snappers and groupers. (They may be particularly vulnerable because of their own hunting methods.)

July 25, 1971
San Blas

Looking around the same area and adjacent islands (Wisandes Cays) this morning. On both extensive areas of turtle grass and superb coral reefs. Masses of fish. But absolutely no signs of squid!

Of course, we may have overlooked some mids. But squid can be no more than relatively very rare here. Is this typical of the area? And/or of the time of year?

NOTE: Arcadio has never seen anything except Sepioteuthis on this coast. And only one other species (of another genus) on the Pacific coast. This fits in quite well with the opinions expressed in my recent paper.

But truly don't cephalopods diversify more in inshore habitats?!?!?

ADDITION: The weather this morning was comparatively cool, windy, overcast, with occasional rain.

The water was clear in some areas, murky in others. It is my impression that the water usually tends to be clearer in pure coral areas than over pure turtle grass. But there is much overlap.

This afternoon we began by taking a look at Icacos Island. Weather the same as this morning except for little or no rain. Swam around in large area of turtle grass in rather shallow water (5–2 ft). Also in adjacent coral areas, also rather shallow on the average. Water fairly murky. Didn't see a trace of a single cephalopod.

Then we went back to the Lemon Cays. Did some exploration ca. 4:15–5:30 p.m. Arcadio saw a single small Sepioteuthis over turtle grass near the "real" Achutupo. (Note: the island called "Achutupo" last month is something else again; our guide considers it to be just a separate part of Miatupo or "Miatupo pequeño"). We also found cephalopod ink in shallow and murky water off Anigalatupo.

Perhaps the typical habitat of Sepioteuthis here is calm water 2–8 ft deep, over turtle grass, near a reef (for protection from currents? And against predators?) Areas with comparatively few fish. (Cause or effect?) Can be either clear or murky.

July 26, 1971
San Blas

Cepl., July 26, 1971, I.

This morning we start out to look at site at Ixtapa where I worked last month and where we saw the squid the day before yesterday. 8:00 a.m. Cloudy and windy. Water murky. And rather rough, rougher than I have ever seen here (this is the windward side today). Lots of small to medium fish, including lots of the minnows which the squid seem to like. But absolutely no visible squid. (And Arcadio and I swim around extensively for 35-40 mins.)

So we go around to other sites. Finally find 4 large squid between the old wreck and Ixtapa Pequeño. This is the lee side now. This is an area of sand bottom with scattered patches of coral (sponge etc.). No trace of turtle grass. Water about 20 ft deep. Squid range 4-10 ft above bottom.

It is beginning to look as if these squid absolutely have to have moderately calm water. (Which might be expected in view of their feeding habits.) When water becomes rough, they move into areas of weaker currents and/or take "shelter" (retreat into nooks and crannies?)

The 4 large squid are obviously associating as a group but also divided into pairs. Members of a pair usually 1-4 ft apart from one another, 4-10 ft from the other pair.

Both mds. of first pair seen in Ord. Then one gets WS. This develops into extreme paling of whole side of the body, away from both me and the mate. I think that

this must be a version, variant, or relative of "real" Pale, rather than Pastel. Very silvery and shiny. I shall call it "LP." Doesn't last long. But same individual does same thing again a few minutes later. This time with Y (more conspicuous on dark side than on light side). This second performance occurred when I was quite close to the animals. The Y, at least, may have been released by, and directed toward, me.

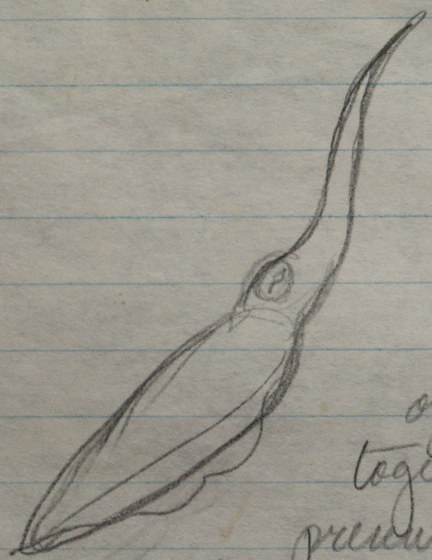
A few minutes later, same individual does another LP combined with extreme E? While swimming forward and after mate who is also swimming forward. Both swimming rather slowly. Box mids. Tolax. LP disappears. Then both swim slowly backward, maintaining relative positions. Then reverse again. Swim forward. Rear mid., the one who did E with LP before, now does E without LP. Then both relax.

As usual, it is difficult to determine whom this display is designed to impress. Of course, I am hanging in the neighborhood. There are fish around. And the other pair is not far off. (Actually, I suppose that the other pair is the most significant factor. See also below.)

Now there is a dull period. Only some traces of P by some or all of the 4 mids. Then one or more mids. does more LP from time to time, while just swimming around in an apparently aimless manner.

Then one of the pairs disappears from my sight. The remaining pair, which is almost certainly the one

that engaged in LP-E displays earlier, now starts again. 2 mds swimming 1½-2 ft apart, one in front and to the side of the other. Both swim forward. Rear md. in LP with E. (Note: all these E's have been very extreme.) Then drops E. LP continues. Then both mds. stop. Displaying md. relaxes. Both swim backward, maintaining relative positions. Then swim backward. Slowly at first. Then both shoot backward at an accelerated rate. Both P with LP! Then stop LP but continue P. At first both in Ord with WS. Then one goes into Double Streak. Most of the P is very extreme.



Then both mds. relax, drift apart.

Then I rather lose track of the mds. When I pull myself together again, both pairs are present. Not very close together. Mds of nearest pair are in Ord with WS. One md. of further pair is in extreme E, then extreme and then extreme E again. Dark (Ord and/or PH — WS?) throughout. Then relaxes. 2 pairs drift together again all in Ord with WS and Y (to me?).

All swim gently back and forth. Arms slanted upward while going forward, downward while going

backward. I don't think that either slant should be considered ritualized; they probably are not real indications of either P or E. But P and E might well have been derived from such patterns.

One ind. does PH when an ind. of the other pair gets too close.

Now I see that there are 5 inds. around. The new one is also large. All inds. more or less close together now.

One suddenly does E in Ord. Neighbor shows brief and slight PabE with DM. Then relaxes. First ind. continues E for some seconds longer, then relaxes also.

Now all inds. with Ord. Some with more or less conspicuous WS, some without. One or more assumes E from time to time.

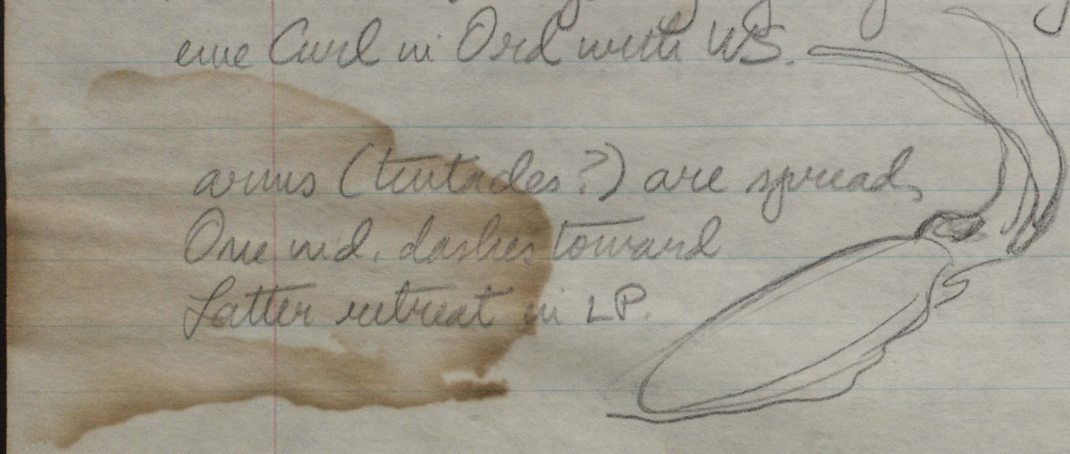
There are no minnows here, although plenty of other larger fish. The squid make no attempt to feed.

The previous social structure has dissolved to all outward view, although presumably not in real fact. I can't tell if the new arrival, the light ind., is associating with one or both pairs, or not discriminating between the two.

Some P by some or all inds. Not very excited or exciting. One ind. alternates E and extreme P (or P-Cwd). Joint in Ord. Then in Ord and/or PH with broken but broad WS.

Then I take a break. Come back 10 mins. later. No squid around. Obviously because there is a bar-

nacida a few yards away. When the barracuda disappears the squid come back almost immediately, 2 pairs again. Presumably same inds. as before. (Ponder, also same inds. seen before) Setting day before yesterday & One does extend one Card in Ord with US.



arms (tentacles?) are spread. One ind. dashes toward latter retreat in LP.

Notice that long in V, during Card: the other pair.

COMMENT: I think that the breeding season is quite over now. If so, all the displays seen today and the day before yesterday must be (purely) hostile. Or is there "friendly" motivation in this species???

Minor points:

Obviously LP, Pic, and DM are closely related. What is the difference among them? LP presumably is low intensity. But cannot be a simple low intensity version of Pic??? What is the qualitative difference? LP rather more aggressive??? (NOTE: My impression is that almost all the displays observed today were intraspecific. But it would be difficult to prove.)

NOTE: I am quite willing to believe that there was a lot of RL this morning. Probably often as preliminary as LP. But I was rather too far away to be able to see it.

ADDITION: Water here is moderately clear.

In the afternoon, we go to Malumega. (One of the more or less inner islands).

2:45 p.m. Come across group of 9 mids. 4 large, 2 medium, 3 intermediate between large and medium. In area of pure turtle grass, water about 12 ft deep. Animals more or less in line, 3 ft above bottom. Water calm (this is lee) but murky. Very few fish around. All the squid are in Ord with WS, except for one large in PH or semi-PH with WS. Several mids. assume Y when they get close to me.

Then, when I approach them, 2 of the large mids. assume extreme PH with Y. Their PH's include conspicuous stripes down the length of the back. The sort of thing that I have been calling "WS". But I notice that the stripes now are actually yellow.

When I approach again, one mid assumes PH with brief DM (in my sense, 2 large black spots) before shooting away. DM must contain or indicate relatively strong escape component.

None of the mids. is giving any obvious intra-specific display. So I don't watch them long.

Late in the afternoon, we go over to Pico Teo for a few minutes. Arcadio see 2 large squid in murky but calm water. In area of pure coconut shell bottom. But both mids. shoot over to turtle grass. And disappear.

ADDITION. We caught a medium sized octopus

at Mulanega this afternoon. It was hiding in large conch shell in area of turtle grass, 3 ft deep. When we urge it out of the conch, it sits in bottom of pail. All arms curled around body. Generally pale grayish-yellow all over head and body. Eyes reddish, without visible pupils). Some dark cross stripes on arms. This might be related to OH.

July 27 1971
San Blas

Working at Mulanega again this morning. Start out 9:00 a.m. Cloudy but not very windy.

Find squid immediately. Group of 11 mds. in 3 ft of water right beside dock. Water is calm and slightly murky. Bottom mixed rubbish, sand, and turtle grass. Large areas of turtle grass nearby. All the mds. are more or less large. 3 perhaps larger than the others. All in ORD with more or less WS.

One md. does Pie briefly as group starts to retreat before me. Then they pause. Again one md. does Pie as group starts to retreat again. Pie is obvious, an alarm pattern, probably quite low intensity. Group is not very frightened, retreating only slowly.

When the group approaches me. Add Y to Ord WS as they do so.

Then group gradually drifts off. I follow. Obvious

Ceph., July 27, 1971, II

& my following is accentuating or confirming the retreat, But the whole thing is still unmistakably low intensity. One ind. Pies repeatedly (3 or 4 times) at irregular intervals. Little or nothing else in the way of display. This group is certainly much less active in display than the group(s) at Achotines now.

All continue to retreat in line in front of me. Suddenly two inds (two of the largest in the group) do several extreme Pie. Several times. Not synchronous. I see that there is another group of 7 squids approaching from distance. All medium. Leading medium approaching in extreme Curl in Ord. Curl obviously threat. The group of 11 large shoots away. Leaving the group of 7 medium in possession of the field!!!

This was obviously a boundary dispute. And it proves that the groups are territorial in the strictest sense of the word.

Why are there particular groups segregated in size (age) classes?

The group of 7 mediums hangs around near me. Several do E (presumably to me). All in Ord, with no or slight US throughout.

Then I take a break. A half hour later find group of 11 large again. Almost same place as before, but in slightly deeper water over turtle grass. All very quiet and placid. Stop observations.

At 11:15 a.m., we can see, from the ship, that this

group of 11 has grown to include at least 17 inds. And at least 2 of the "new" members are medium. Does this mean that the original 11 and 17 groups have coalesced??? If so, is this typical? Do large groups form in the middle of the day and then break up into smaller groups in the late afternoon or evening? (Certainly some of my earlier observations could be reconciled with this hypothesis. And it would, or might, help to explain the age-size segregation observed earlier this morning. But, if so, the territorial dispute observed was rather remarkable. Quite unmistakable but not, perhaps, what one would have expected.)

Now we see that there is another (third) group of large squid only 15-20 yards away (on the side of the 11-17 group opposite the area of the 17 group). There are at least six inds. in this third group.

Group territories here would seem to be narrow. The territory of the 11-17 groups may be no more than 200 ft across near the beach.

Population density here is enormously high. Due to lots of food from outhouses? Or to heavy fishing of predators by the natives?

COMMENTS: There are no visible signs of pair or small family units in any of the groups around here. Why? In any case, it indicates that the animals seen under this hypothesis this trip, dull as they were, were (still) in partly reproductive mood (doubtless declining).

Presumably the species is a seasonal breeder.

NOTE: When there are many individuals in line, there is a tendency for the largest to occur at one or both ends. But it is only a tendency. Many exceptions.

ADDITION: Twice this morning, at a long interval, I saw a large suddenly spread and writhe its arms. Display? Cleaning? Reaction to fish? Once the writhing was accompanied by a very brief, momentary, flash of pale.

In the afternoon, after lunch, we go looking for squid near adjacent islands.

Forvener. Arcadio sees a single squid apparently feeding by dashing thru a school of sardines.

But then we can't find any more individuals here, nor in extensive turtle grass beds around a nearby sand bar, nor around Wichuvala. Rather surprising, as it is fairly calm.

2:30 p.m. Nalunega. Arcadio finds squid in area occupied by "third" group this morning. Now 12 large and medium ones in one cluster. Plus four small ones, 7-10 yards away.

July 28, 1971
San Blas

6:30 a.m. Squid already in "third group" area (seen from boat). At least 10 ind. 2 different sizes.

NOTE: There are quite a lot of needle fish around.

Capri, July 28, 1971, II

According to Arcadio they feed on the same kinds of minnows as these squids. I have yet to see any direct reaction between them and the squids.

Start out 8:10 a.m. Find "Group I" of large squids in exact same place as yesterday. But it now consists of 12 rather than 11 mds. Slowly retreat, in rather irregular small spurts. One does Pie before retreating. Then 2 do Pie with moderate E. Then there are more Pds with and without E's. Also several E's without Pie, in Ord with (not extreme) WS. At least 4 or 5 mds. involved.

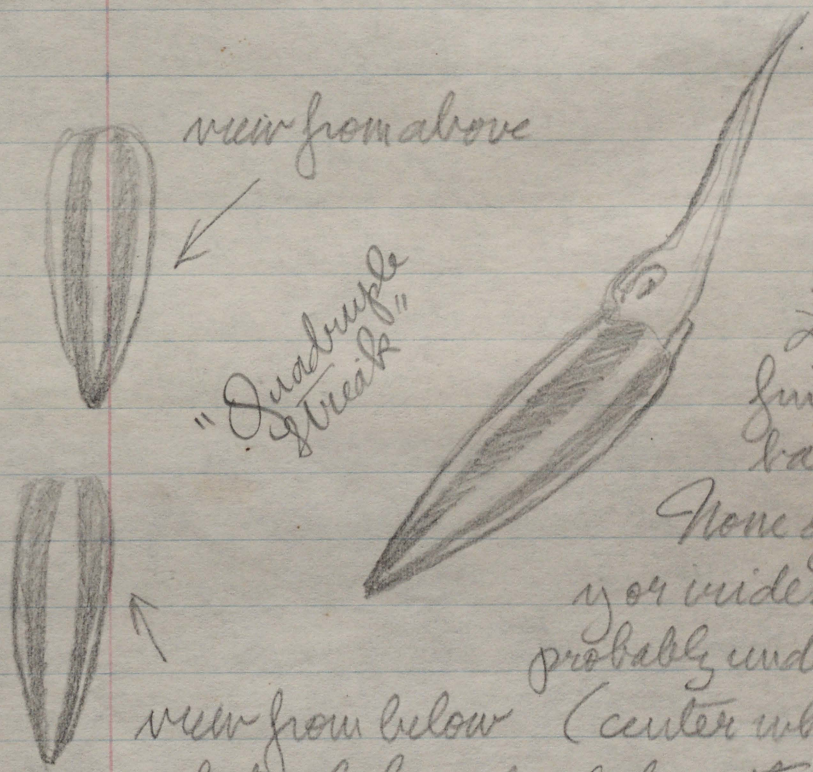
The Tethys motor starts out a few yards away. Squid apparently pay absolutely no attention at all. So then do seem to be small deaf (altho I must admit that most of the fish in the neighborhood appear to be equally unconcerned — this is a busy dock).

Go over to group III area. Find group of 5 mds. Four are medium — the fifth is small-medium. All quite close together. Probably about 40 ft away from Group I at the moment. Very placid. The whole place is loaded with jelly fish. So I get out post haste. (It is quite possible that there are more squid in this Group III area. But, if so, they are in separate groups or sub-groups.)

8:30 Back to Group I area. Group of 12 is still around. Behaving as before, with even less display. Then a group of sardines appears, swimming near surface. All the squid point at them (this pointing

appears to be "real" P). Then sardine swim away. Back again. And here the story gets complicated!

All the squid P. And many shoot up to catch the fish (as far as I can tell, always successful). And they all show a characteristic color change just before shooting. Surprisingly enough, a form of Double Streak!!

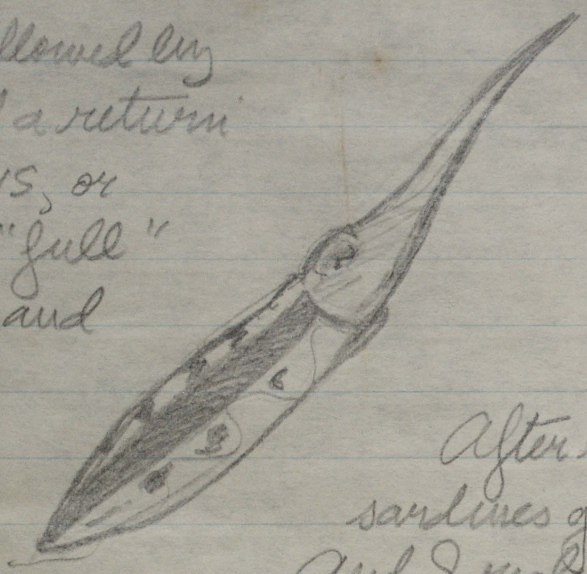


Compare with p. 30

Two streaks above and two streaks below
Light side streak is fin and area of body at base of fin. Almost white.
None of the light areas is silvery or iridescent. Head and arms probably undistinguished medium. (center white or light probably is relatively broader below than above)

After catching a fish, an ind. sulks back down lower in the water. Usually remains in P or semi-P for some seconds. Sometimes also remains in Double Streak as above. More often changes to another slightly different but obviously related patterned "Mottled Double Streak" Center white line of back interrupted by large blobs. Dark streaks below fins also disappear, also to be replaced by dark blobs on a light ground.

This may be followed by relaxation and a return to Ord with WS, or by a return to "full" Double Streak and another strike.



After some minutes, the sardines go away again. And I realize that there are more squid around than earlier. A lot of mediums. At first it is difficult to distinguish social groupings among the animals. All more or less in a continuous line. But they gradually sort themselves out into 2 groups or sub-groups about 10 ft apart. One cluster is composed of the 12 large mids. who have been in this area all morning. The other includes 7 mediums. This is obviously the group II of yesterday. Apparently they followed the sardines into the Group I area. And I suppose that all the Double Streak and Mottled Double Streak displays during feeding were actually indications of intra-specific hostility. Nothing to do with feeding per se. (Note: the various Streak displays certainly were performed by mids. of both groups or sub-groups. And I might add that the mediums of the 7 group are rather large as mediums go. There seem to be more intermediates between "typical" size classes everywhere here now than last month.)

Both I and II clusters remain fairly calm after

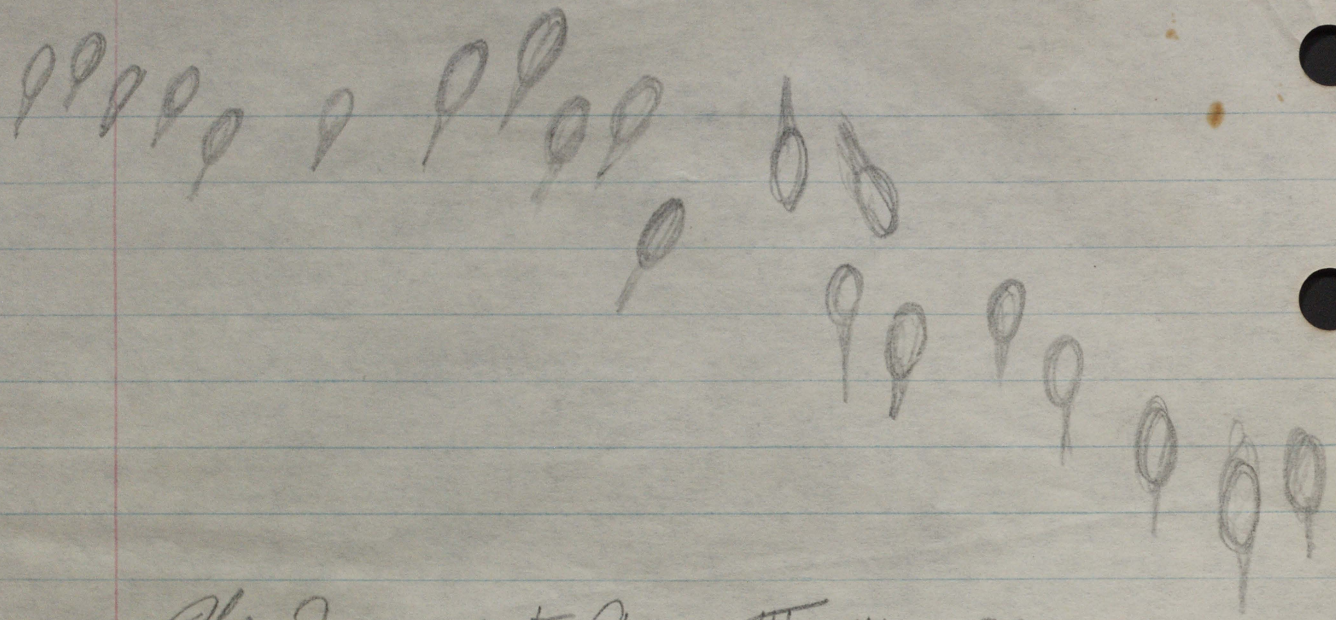
feeding. Some members of both groups, those which are nearest to the other group, do E's. All mds. in Ord now, even when E-ing, with some US in all or most cases. The groups gradually drift somewhat further apart, but are still only 20 ft apart when I break off observations to start writing.

NOTE: There have 6 or 7 needle fish at the surface of the water here for quite a long time. They and the squid are definitely ignoring one another.

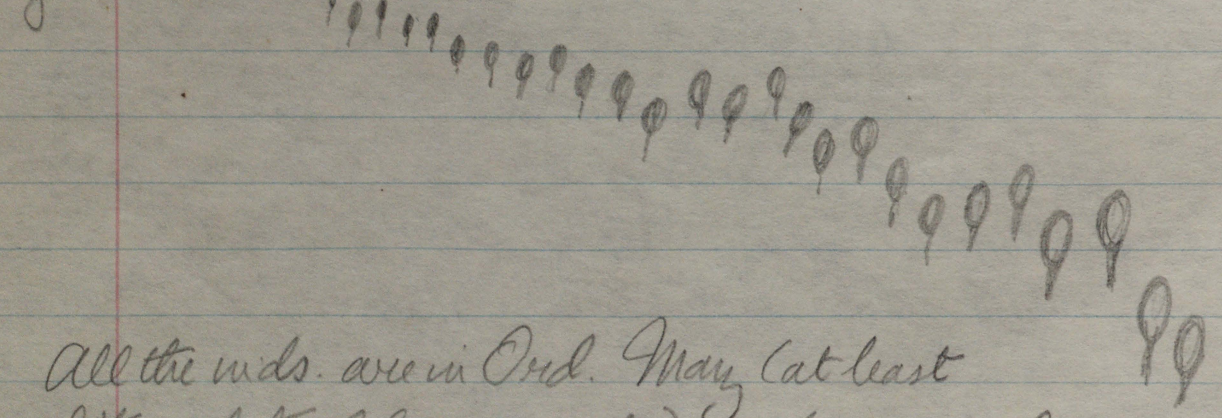
I suppose that Black Terns must also be important competitors of the squid.

10:00 a.m. Watching from ship. Three large or large medium squid in Group III area. Then Arkadio sees large group (22?) of small or medium small mds. coming into area (from other side of island?) Some of the newcomers Ord. Apparently without color change. Then all join up, apparently peacefully. This join would appear to have been entirely "voluntary", quite apart from feeding.

10:10. Go swimming in Group I area. Find squid in almost exactly same area as before. Group of mediums and group of large. Now more or less joined together in single line. Mediums still 7. Large have now increased to 14 mds. All very placid. No display. No feeding. Distribution more or less common:

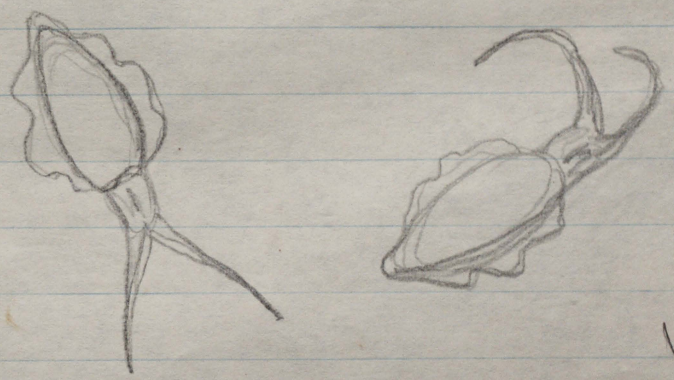


Then I go over to Group III area, 30 ft away. Group there seems to be about 26. Including 4 more or less medium, grading down quite nicely (and smoothly) to 2 or 3 mds. which are as thin as any squid I have ever seen. The presence of such small mds. now is evidence against a definite breeding season, or perhaps suggests that different populations have different breeding seasons. The group is storing out in a line, going from largest to smallest. (This is another rather common arrangement.)



All the mds. are in Ord. May (at least of the relatively larger mds.) with some mid. of WS and/or Y. No other display as long as I stay some considerable distance away. But then, as I come closer,

4 of the smallest mids. start to display to me, the closest displaying most frequently. Two forms of display. One is Curl. The other might be called V. In the latter, the arms and tentacles are separated into two diverging lines. This can be done alone, with the arms and tentacles pointing ahead or ahead and slightly downward. Or it can be combined with Curl.



V is obviously lower intensity than Curl. Done more frequently. Initial response frequency of Curl increases as I get closer. (Note: these very young mids. seem almost, although obviously not absolutely, fearless. The smallest actually forward, with V and Curl, as if it were about to attack me.) One of the smalls also did Curl without V once or twice, but "pure" Curls were certainly relatively very rare. All the V's and Curls were done in quite ordinary (Ord?) color patterns. (This may not be very significant. All smalls seem to have many fewer color changes, or perform them much less frequently, than larger mids. (Perhaps the real smalls have no color changes at all???)

V would seem to be an eventually, although not exclusively, infantile pattern.

Cephs., July 28, 1971, VIII

Possible correction. Talking to Arcadio again, I gather that some of the smalls did V without Curl, as well as Curls with V, when they first joined the mediums earlier this morning.

NOTE: Some of the Indians on this island tell us that they distinguish 2 kinds of "squid". One is the "kikire saburta". This is the common one around the shoreline, i.e. Lepioidea sepioteuthis. The other is just plain "kikire" It is supposed to be longer (the Indians do realize that the Sepioteuthis vary in size). This "kikire" has been caught around a sandbank and/or reef offshore. (Arcadio and Olga are looking for it now.) The name for the local octopus is "kikire Waliwali".

Arcadio and Olga are back. Area is sand and coral without turtle grass. All they saw was a single medium and a pair of two large, apparently the ordinary Sepioteuthis. Plus one octopus.

Go to group I area again 11:30 a.m. Swim around for a while, without seeing a thing. Squid quite definitely absent. Then come across a group of 9 small-medium mds. (i.e. definitely not Group I or II). But right in middle of Group I area. One md. in E. All the others in P. One darts up to grab a small fish. All in Ord, with or without WS, throughout. Then a nearby school of medium-sized fish dashes off in panic. Squid follow, apparently also in panic. And then all go into full Double Streak (dark streak below fins) as

they go !!!!

Have I seen Double streak as an alarm reaction of this type among the squid of other islands? Do the populations of different islands have rather different repertories??? Pic also the Pic-LB problem.

Then go over to Group III area. Find 17 very small to small medium inds. This is an indication that the 9 inds. just seen in the Group I area a "split off" from the group of 26 seen in III earlier. Presumably the 9 moved into the I area "because" the I and II groups have gone off somewhere else for the time being.

In other words, inds. of these species tend to "recur" in the same places and spatial arrangements, rather than maintaining their constants.

All the 17 display when I get close In more or less Ord with WS. Then change into a more peculiar coloration, rather difficult to describe or decipher. Broad WS on top. Fins and base of fins whitish. Thus 2 dark streaks on top. Color of top dark streaks is either Ord or (Ord-PH) There also are broad dark streaks just below fins. Bottom generally white or whitish. But with thin, sharp, dark streak down center in some (but probably not all) cases. These center belly streaks probably do not extend the whole length of the body. The whole thing, at its most elaborate, might be described as a "quintuple streak". (Obviously smalls can manage some color changes.) All inds. in P when this color change first

Cephs. July 28, 1941. X

38

occurs. Men several, including both the smaller and several a few cm. longer, adopt extreme V's. Some V's are forward. But most are upward, without curl. Comme ça:

Club-like tips to tentacles quite conspicuous. Suckers hardly noticeable (if at all)

II.

Index of for displays
" " copulation

November 20, 1971
San Blas

Working in new area today: "Salar" (Islands)
Beginning around island of Ucubuay (Ucubuag?)
12:15 p.m. Sunny. Moderately calm. Water moderately clear.

Swim around whole island. Great variety of habitats Patchy coral. Sand. Extensive beds of Turtle Grass. Continue until 1:30 p.m. Without seeing a single squid. Then return to boat anchored offshore.
Find 2 tiny (baby) squid right near boat. A few feet below surface in water approximately 20 ft deep. Appear with Sepioteuthis. One is Ord. One whitish with a couple of black blobs (Pie?). One does extrude V when swimmer approaches. Then squirts ink when we try to catch it in dip net.

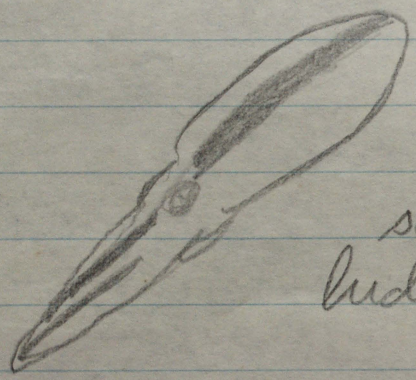
NOTE: Boat was anchored in exactly same place on October 18th (Peter Glynn trip). At that time, Lucho counted over 65 squid near the boat! Apparently all ages.

Later in the afternoon, we go exploring around three adjacent islands. Again a variety of habitats, including Turtle Grass. And again no squid visible!

There would appear to have been a major change here since October. Why???

ADDITION: We did see one Octopus late this

afternoon. Moderately large. Alone. In 20-25 ft of water, hiding under coral just above bottom. More or less unidentifiable mottled sandy in color. Being persecuted (attacked) by Black Damselfish. Finally dashes (swims) away to another patch of coral. In flight assumes pattern very reminiscent of Double Streak(s) of Sepioteuthis. (Roughly) commensal:



Goes back to sandy when in partial hiding again.

NOTES: Last night, the other people on the boat were trying to catch organisms at a light. They caught one Sepioteuthis with hook and line. Near surface. Ca 7:30-8:00 p.m. They also saw a small school of apparently narrower squid. Doryteuthis?

Tonight we tried lights again. Ca. 7:00 p.m. Immediately a large school of squids appears. Two types. Presumably Doryteuthis again. Group includes approximately 35 inds. Circling very rapidly. All inds. incredibly close together. (Apparently but presumably not actually frequently touching.) In what looks like equivalent of Oval with small but extreme

and tightly defined RL
(This may be what
Boycott calls "display
of testis".) Varying in depth from a couple of feet
below the surface to at least 20 feet below.

Continue like this for 5-10 minutes. Then
apparently grow blasé about lights. Tend to
remain deep. Then disappear. So we turn lights off.

COMMENT: As far as we could tell, these mds.
did not feed while visible. Only one possible exception.
One md. may have struck at an "anchoveta". All
mds. swam backward all or most of the time. But if
there was a strike, it was forward.

About 20 mins. later, we turned the lights on
again. A group of approx. 11 squids of similar type
appeared within a few seconds. These also circled.
Fairly deep in water. Then 4-5 "struck" almost sim
ultaneously. Dashing to fish swimming at surface.
And Wayne catches one in dip net!!! We put it in
a pail immediately.

Discharged lots of ink in repeated bursts.
Usual form ("dummy veils"). But dark red in
color.

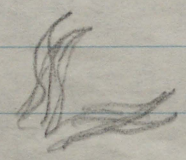
Taking a good look at the animal, it does
appear to be Dorytenthis - like in shape. Small triangular fins et al. Ca 6-8" in length.

Obviously very disturbed. Alternating perio

ds of resting on the bottom with forward rises to the top. And bursts of bumping rear against sides.

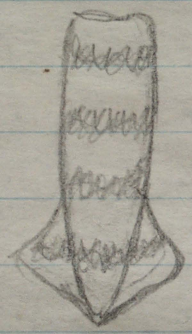
Rises may be accompanied by some sort of not very extreme "E". Perhaps only mechanical effect.

When resting on bottom, arms and tentacles sometimes spread in "semi-V".



At least once, "semi-V", accompanied by "Devil Fish", (by 1 or 2 pairs of arms!).

Resting on the bottom, the animal also adopts something like 84. Four transverse brownish bars across pale background.



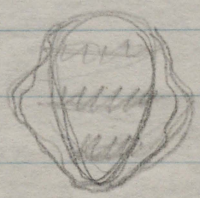
No trace WS.

Rising to the top, the animal becomes generally dark "granular" reddish, at least on the top of the head and mantle (perhaps all over). For all I know, this might be Ord.

The species also has iridescent ocelli. Golden, not blue-ish.

We turn out the lights while taking care of the captive. Put them on again after a few minutes. Large group comes back, but disappears after a few minutes. Lights out again.

Ca. 8:15 p.m., try lights for fourth time. A small Sepioteuthis appears. On surface. Mike catches it in dip net. Puts it in pail. It adopts extreme V. No Curl. Combined with definite PH. Two or three transverse stripes.



Ca. 9:30 p.m. A single Doryteuthis type appears near lights. I.E. this species would appear to have a flexible and/or variable social organization.

November 21, 1971
San Blas

Going to work at Malunega today. Start out at 8:15 a.m. Sky clear and sunny. Strong wind. Choppy waves. Water rather murky.

Explore areas occupied by groups I, II, and III last trip. Absolutely no signs of squid. In spite of the fact that there are lots of "anchovetas", of 2-4 species.

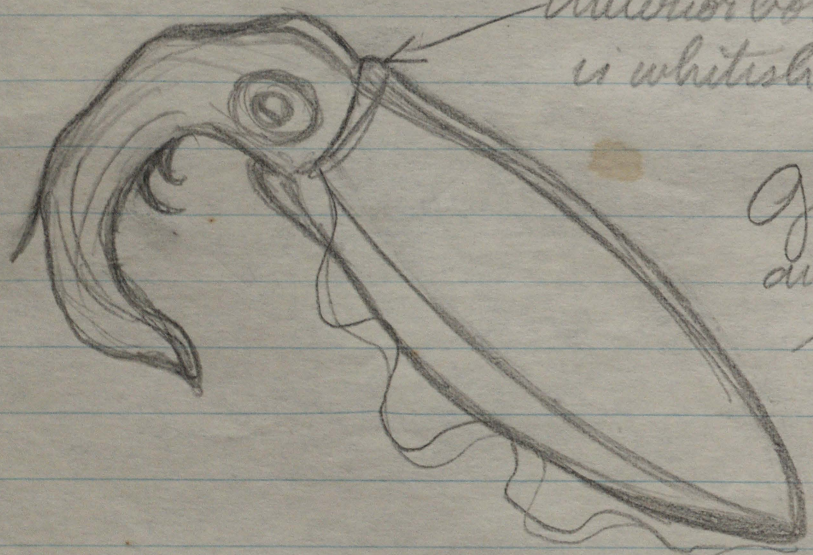
NOTE: This is the windward side at the moment.

Stop observations 8:30 a.m., when Arcadio arrives with the news that he has found squid on the leeward side a mids. Large. In a ft. water. Over coral. I go to see them. Arrive 9:00 a.m. Find three large. In area of low Turtle

Grass near border of patchy coral area. Water approximately 8 ft deep. Squid 2-2½ ft above bottom. All in ORD with WS and more or less trace Y.

They retreat, slowly, before me as I approach. One mid. does trace of E during retreat. No change in color. Then animals change direction. Come forward toward me. One mid. (same mid.?) does extreme Curl during approach. Again without change of color. (Note: Approach is all swimming head forward.) Then all three mids. do extreme E, still in same color, close to me. All three presenting back to me. Then one does P. Then resumes E. Still no change in color.

Good view of E.



9:08 a.m. All squid leave when school large fish appears. I find them again a few minutes later. Now swimming over almost pure Turtle Grass in water 6-20 ft

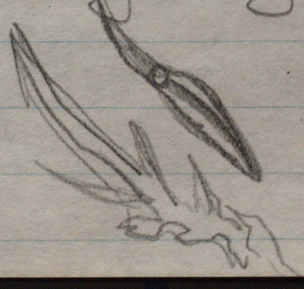
deep. Usually swimming 2-3 ft. above bottom. Still (?) in Ord & WS + Y. I see that the back stripe of the WS of the mantle is "semi-continued" by a light streak down the center of the arms. No Cottier's display, to me or to anything else.

Anchovetas are not nearly as common here as near the dock (Group I, II, III) region. But one large school finally shows up. One or more of the squid make occasional passes toward the fish. But do not attempt to strike.

Later in the morning, we go patrolling around several small islands between Fidalnega and Pico Teo. Still no squid.

COMMENT: The population of squids would appear to be greatly reduced. And in completely non-reproductive condition. Was there a major die off after breeding in the Spring - early Summer? Are newly-hatched young pelagic now? Quite probably, yes.

While we were patrolling, Wayne and Mike went "deep diving" on a reef a few hundred yards off Fidalnega. See one large Sepioteuthis 15 ft down. Hiding in Stag Horn coral. Apparently mimicking Stag Horn. Head up. In something like Double Streak. With tips of arms and tentacles lighter than most of rest of animal.



Julie chases annual. Flees in Pale to another clump of Stag Horn. Then returns to first. Does E during return shows a definite preference for first clump. But does not stick to particular branches I.E. probably not incubating.

NOTE: Arcadio says that the natives of the island say that the squid tend to come inshore ca. 4:00-5:00 p.m. Obviously something queer or garbled. The squid were here all day in July!

But certainly there have been no squid visible around dock 1:30-3:30 p.m. today.

One of the natives, Luis, swims around in the Group I-II-III area 3:30-4:00 p.m. I swim around in the same area 4:05-4:25 p.m. No squid at all.

This is all the more significant because: 1) the weather has been calm since around noon and 2) the whole area is lousy with small fishes, including tiny fry which could be caught by the smallest of the observed Sepioteuthis.

ADDITION: Wayne saw a large Sepioteuthis, definitely single, swimming around offshore reef, not far from where "Stag Horn mimic" was seen earlier. This occurred ca 4:15 p.m. Annual 10 ft down in 15 ft. of water.

November 22, 1971
San Blas

Working at Lemon Keys (Achutupo – Miatupo, usual area). Weather clear, sunny, calm. Water somewhat murky.

7:45 a.m. One squid is seen from boat (presumably medium or large). Boat is anchored in usual channel. Ca. 20 ft depth. Then Mike sees a single squid (same individual?) a hundred yards away 8:00 a.m. In deepish water (perhaps 5 ft above bottom in 20 ft of water), edge Turtle Grass area.

There do seem to be a lot of single squid around now!

Then I go to look at areas near Miatupo where we have seen squid before. 8:05 – 9:05 a.m. Definitely not a single squid present.

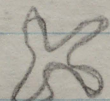
Later in the morning, we go prospecting around other sides of Miatupo.

11:00 a.m. Finally success. Find one squid. Definitely Sepioteuthis. In area of patchy coral of a great variety of species interspersed with expanses white sand. Water varying 20 - 30 ft deep. The first squid seen (and its companion seen later – see below) tend to stick close to the bottom, from a few inches to 5 ft above bottom.

Arcadio is the first of us to see the first squid. The squid is apparently alone at the time. In a patch of

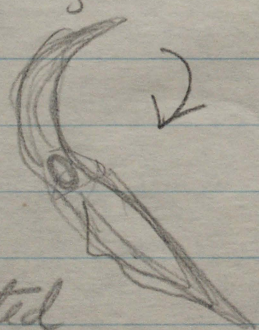
Lars 8

Stag Horn. Body horizontal. Not doing anything obviously highly ritualized. By the time that I get to the area the squid has moved to a rounded coral head. On which it is sitting, head up, extreme P. In ORD with WS and probably some Y. Belly is visible. More or less dark (more or less color of ORD of back). Then the animal retreats, backward. Then it advances, forward. In extreme E, still in ORD with WS & Y. The arms are actually brushing against bottom during advance in E.

Then the animal "sits" on a rounded coral head again. Again body nearly vertical, head up, arms extended in extreme P (perhaps P–Curl ?) Probably no change in color. Only peculiar thing is that tips of 3 or 4 arms are separated. Pattern flower-like effect.  from above.

Then my own observations are interrupted as my face mask fills. Wayne takes up note-taking.

The animal moves from coral head to coral head. Often changing colors during moves. Once in some sort of a Double Streak pattern. Once or more in pale and/or DRK with extreme DRK. Goes into extreme Curl, with vertical head-up at one or more coral heads.



Then I resume observations.

The animal flees from an isolated coral head across a very wide expanse of white sand to a

rather patchy coral reef. Turns very, very pale with extreme DM while crossing the white sand. Apparently trying to be cryptic and/or disruptive. Turns darker again, more or less ORD, when it reaches coral. And immediately assumes E. Now I see that the ORD is combined with WS and Y in the usual way.

Then the animal darkens off again. Turns a second. Also large. Both in Ord, WS, Y. One briefly assumes Pt. for 1-2 seconds. Then resumes ORD. No further sign of hostility between the 2 inds. I.E. they seem to form a real pair. They swim around together over patchy coral for several minutes.

Both assume vertical head-up P repeatedly. Obviously ritualized as a whole. Presumably defensive-cryptic. No more examples of spreading arm tips in P.

Color in P's is always more or less ORD-WS-Y. Sometimes ocelli on back of mantle are particularly prominent. Sometimes belly and under side of arms are slightly lighter than upper side. Sometimes not.

One ind. assumes extreme E, still in ORD-WS-Y while advancing toward me.

NOTE: All observations this trip would seem to confirm hypothesis that E contains appreciable - although not necessarily dominant attack component.

Then there is more movement. Both animals retreat over coral. In ORD+WS+Y with DM.

Then one takes off over white sand again. Apparen

the not frightened. Goes pale without DM. The other vol. remains behind for a couple of minutes. Then follows.

COMMENTS:

(1) Both ecology and social behavior of Sepioteuthis this would seem to have changed since July.

(2) Only large and tiny now?

(3) Most inds. in deeper water now?

(4) Only in pairs, trios, and other comparatively small groups now.

(5) Large are much less confined to Turtle Grass now than earlier. Often over coral and/or bare sand now.

(6) Large (at least) are shy-er now than earlier. Often trying to be cryptic (pale over sand, vertical head-up & mimicking coral and other growths). Perhaps a sheer consequence of reduced numbers???

Various people swim around Hialupo at various times this afternoon. Without seeing any trace of any squid.

Try lights at night. 8:30 p.m. A single Doryteuthis-type shows up. With "RL". Circles around several times; then disappears.

NOTE: Just to be clear .... All references to "squid" to at count, without qualification, throughout these notes, refer to Sepioteuthis — nothing else.

ADDITION: (7) "Territories" of single large and pairs of larges may be relatively large now. The pair seen

today ranged over a horizontal expanse of at least 100 yds.

November 23, 1971
San Blas

Starting at Isacos Island (end of Lemon Keys) Ca. 8:15 a.m. Weather clear, sunny, some slight wind, but water fairly clear. Get towed around island. Over immense flats of Turtle Grass (mostly shallow water) and some nice Large coral reefs. Continue almost steadily until 10:00 a.m. Without seeing a single squid.

COMMENT: It is possible that the presence of a group of 6 large animals at Halimeda now could be correlated with a superabundance of food in the area (outhouses, garbage, etc.) This might suggest that the rarity and dispersion of large squid at other islands is a consequence of scarcity of food. But I doubt it. Small fishes seem to be abundant everywhere. Perhaps more abundant, on the average, now than in July.

But do squid feed less in the breeding season, even before spawning, than during the non-breeding season?

In the afternoon, we move on to the Holandes Keys. Anchor boat in center of lagoon between Calubir (Caobos Cay on map), Pirutupo, Paretupo, and Morotupo.

Go touring around several of the islands.

1:25 p.m. Not far from Calubir. Wayne sees sin

gle large squid. In border area, 5 ft deep, with Turtle Grass to one side and scattered clumps of coral to the other. The squid immediately shoots off across Turtle Grass, passing through large expanse (100 yds or more) of water 20-30 ft deep. According to Wayne, it did something like PH — and perhaps even V (sic!) — during escape.

Come back to boat. And immediately see small squids!!! Ca. 3:00-3:45 pm. All quite close to boat (which is anchored in approximately 40 ft. of water). But behaving in slightly different ways in slightly different areas at different times.

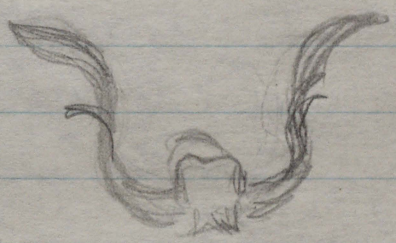
A. A few inds. just drifting or floating around singles. Pairs. Once, according to Lucho, group of 8-10. Each individual separated by 2-3-4-or more feet from every other. Sometimes only 2-3 ft below surface. Sometimes much lower (out of sight). I swam after one single. In more or less ORD with WS, probably Y. Apparently not greatly disturbed. But as I came closer, it gradually went lower and lower. Going low would seem to be an escape reaction.

B. Then a group (varying from 7 to 10) shows up (or-appears?) near anchor chain of boat. All clustered close around chain. Usually with tail-ends toward chain, heads and arms pointing outward. Quite near surface at first. In more or less ORD with WS. A broad transverse band of dark, almost certainly rich reddish brown, across top of head. Probably combined with at least traces of Y. Dark of head apparently semi-separated from dark of back by

lighter transverse streak (front border of mantle whitish?)

Then I swim around toward them. All react to my approach by doing P. Apparently quite extreme, as all I can see is their undersides at an angle. Belly light, with one dark longitudinal streak down center. Bottom of arms probably dark-ish with some golden yellowish. Yellowish probably along edges of arms, but generally most conspicuous on center arms. I imagine that back was more or less ORD-WS at the same time, but I can't be sure of this.)

When I come closer, they all retreat backward. And downward. Two ends do V as they do so. One V is quite conventional. The other is bizarre.



Presumably just an aberration?

All ends disappear out of sight in a few seconds.

Then I back off. In a few minutes the group reappears. Now hang around chain much lower in water (15-20 ft down). Not displaying. Tail-ends usually pointed toward chain as before. ORD-WS, probably Y. Can't tell if they have unusually dark transverse bar on head or not.

Then I swim further away and go back on board ship. Almost immediately, the little squid move higher on the chain. Obviously less afraid now. I can see their color better. Most usually ORD + WS, with dark bar across

head and Y. One or more occasionally turns pale (Pale) all over, with no further display.

COMMENT: It would appear that small squid are semi-pelagic in fairly deep water at this time of the year. Presumably not territorial. Usually rather scattered. But prepared to "cluster" at some sort of substrate or attachment area. (Does this mean that they are approaching the stage of settling inshore?) In any case, their ecology would appear to be quite different from that of the large animals now.

Which raises several questions.

Why do smalls join social groups which include large and mediums during the breeding season?

What has happened to the mediums now? (Perhaps the large seen in July have died, while the mediums seen in July have become large. But what has happened to the smalls of July?

NOTES: The small seen today spent some time drifting. And some of them escaped in the direction of the current (which is quite strong today). But they also are quite capable of swimming strongly against the current.

Once, the small squid scattered when an outboard motor started 20-30 ft away. Can they hear???

Do they have any sort of internal buoyancy mechanism?

Although all the little squid seen this afternoon

were tiny (a matter of a few centimeters), they were not equally tiny. Some almost twice the size of others

All small squid gone ca. 4:30 p.m.

A single large presumed Doryteuthis - type appears at light ca 8:15 p.m. Reddish. No RL

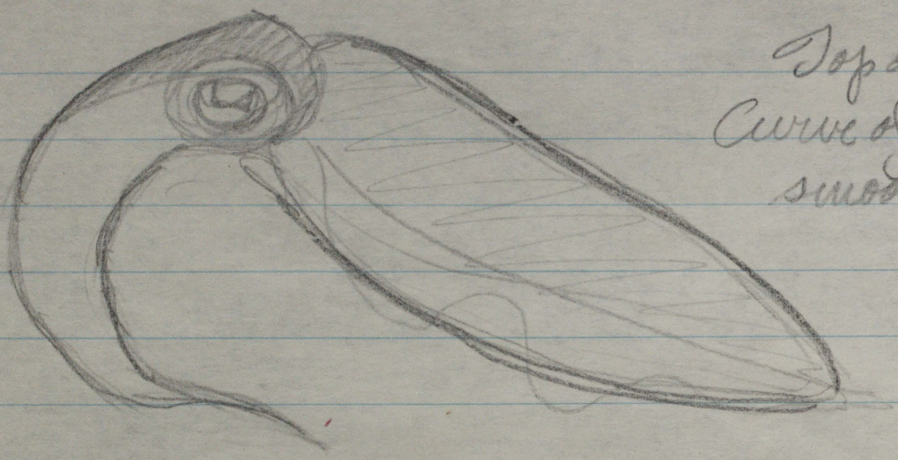
November 24 1971
San Blas

Starting out at other end of Holandes Keys this morning. Off Mariatupo 1 and 2. Weather is clear, sunny, windy. Ca 9:30 a.m. Water rather murky. Arcadio & Wayne Drag over sand, coral, some Turtle Grass. I swim over large coral reef. No visible squid.

INSERTION. All the natives we have met, at all islands, say that squid are difficult to find now.

Arcadio shoots Nassau Grouper on reef. We find moderately large octopus in mouth, nothing in stomach.

This afternoon, we go to Canti Yantupo. Drag around island. See squid almost immediately, 1:15 p.m. In approximately 4-5 ft of rather dirty water. Mixed sand, garbage, and coral, near Turtle Grass. A group. Two pairs of large, extending over 10-12 ft. 1-2 ft above bottom. Not greatly excited by our appearance. In ORD-WS-Y. No other display at first. Then one mid. does E as it passes by me. Quite extreme. Notice that arms and tentacles go Pale, but not the head or body.



Top of head dark. Curve of forehead quite smooth.

First one "pair" disappears. Then the other. We can't find them again. Nor other pairs on other sides island.

NOTE: There are lots of medium size fish around here. Ignore and are ignored by squid.

COMMENT: It would appear to be true that groups (and small groups) of large squid (still) occur around deep, inhabited islands. Presumably a food factor involved.

Arcadia 254467 after p 76

Jan 30, 1972
San Blas point, opposite playita point on the Mainland (San Blas)
Encountered group of thirty INDS of all sizes with a rather high incidence of juveniles. Bottom was sandy & grassy with spare coral becoming thick in deeper water. I noticed several isolated INDS and a couple of trios far from the main group. I covered an area of about 200 yds. I noticed no feeding behaviors but the stray squids seemed quite excited. The main group was relaxed.

Nalunega Jan 30 1972
Fifteen or so individuals grouped near dock on west side, some stray individuals not far from group. Group was not well formed, but was ragged (no social order) Both stray individuals and group seemed quite excited. There were several predators in the area but I saw no attacks

Jan 29-30 Poponi (No squid)
" " " Pico Ko (No squid)

SEE ARCADIO'S NOTES ON VISIT
A FEW WEEKS AGO

February 16, 1972
San Blas

Starting work at Nalunga 12:30 pm.
Cloudy. Light wind. Fairly clear.

Begin area of Groups I, II, and III. Lee side now. Swim around and around without seeing a trace of squid. Then go along west side of island. Again no luck. Arcadio swims along east side. He doesn't see any squid either. We continue until 2:00 pm, then give up.

NOTE: Fish seem to be enormously abundant here now. Immense schools of "anchovetas" of all sizes. Plus many large predators (barracudas, etc.). Have the latter eaten or chased away the squids?

Go on to another area. Mainland coast, inside San Blas Point, south of Pico Teo. Area where Arcadio saw lots of squid a few weeks ago.

2:15 - 3:15. Swim over wide area. Stretches of Turtle Grass, expanses of Staghorn Coral, lots of mixed coral, sponge, etc., on sand bottom. Still no squid. (Not many large predators either!)

3:30 - 3:55. Arcadio tries another area, slightly further down along mainland coast. Again without success.

What is happening.

February 17, 1972
San Blas

Stop briefly at Valunega on way out in the morning. Talk to local people. Most of them seem to agree that squid are rare now. One man says that he saw four individuals three days ago. A little boy claims to have seen three individuals early this morning. It all seems rather vague.

We also pick up a helper at Valunega. Arquimedes Question him rather closely. His story is that squid are not more abundant, on the average, in some seasons than in others. But that they are exceedingly variable in the short term. Here one day, gone tomorrow. This seems very improbable, or at least insufficient as a general explanation. (Possible confusion with Dorytheuthis?)

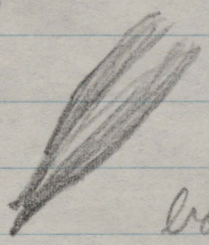
Then we go on to Lemon Keys. Usual area: Thalassia. Sunny, little wind. Go into water 9:40 a.m. Clear. Start at first site, place where I first saw squid here months ago.

9:50 a.m. See two large mids. 2 ft above bottom in 10 ft of water. Border of rock and Turtle Grass. Apparently a pair. Tend to stick close together (2" to 3" apart). One slightly larger than the other. Larger = ♀? Smaller = ♂?

Both are in "Ord" (see below) with WS and Y when I first see them. Then one or both go(es) into mom

Ceph., Feb. 17, 1972, II.

entan, PH. Notice that clusters of arms has conspicuous light streak down center (viewed from above) in "Ord". Probably also PH.



Then more alternation periods in "Ord" and brief PH's. Some E and/or P by both mids., in both "Ord" and PH. Also a few, occasional, brief retreats by one or both mids; always accompanied by brief Pales.

On the whole, these particular individuals do not seem to be very nervous.

NOTE: There are 3 broad dark bars on the back during PH's of at least one of these mids. Separated from dark "cap" "Cap", in turn, contrasts with arms which are generally light (yellowish ?) in PH.

One mid. does extreme E in PH.

The larger of the two mids, the presumed ♀, Pales somewhat more frequently than its companion.

E's and P's continue off and on.

Notice that smaller mid., presumed ♂, is generally quite dark, including belly, during both E's and P's. This may be an extreme version of ordinary Ord, or perhaps a separately ritualized type of coloration ("Dark").

The smaller mid. also stays closer to me than the larger mid. Further evidence that dark is intimidating, light an indication of escape.

Smaller mid. has injured arm. Should be easily

recognizable.

Smaller mid. does another E, in Ord and/or Dark.

Both mids. tend to stay quite close to particular rounded coral head cum reef. Over Turtle Grass more often than not.

One "writhes" its arms. Apparently in ordinary Ord. clearing? Neither seems to pay attention to any of the numerous small fish in the area. Not hungry?

Both mids. drift off a few yards away. Then drift back. Some Rocking. Also some Forward "Passes." All very low-intensity. Then one buzz PH. A few Pulse waves.

10:00 a.m. Arcadio calls me to say that he has found a group of squid 100 ft away. I go over to see them. 5 mids. On outer edge of small reef here. (The pair seen earlier this morning — and most of the mids. seen here on previous visits were on inner edge.) Three of the mids. certainly large. Two are medium or medium-large. All 2 ft up in 10 ft water. They all give the usual hostile reactions (E, P, PH, etc.) to me.

Then one mid. definitely goes Pastel. (Arcadio tells me that we may have seen Pastel, with "Pass", earlier.)

Return to "normal" coloration. Then all turn Pale and shoot away, backwards, into area of deeper water. Disappear from my sight.

Go back to first pair area. 10:10 a.m. Both mids.

still there. Behaving as before. Lots of P + E. Quite extreme in form but not sustained long at any given time. Is this (another) sign of low intensity?

Then I go back to group area. Inds. apparently still gone. Are groups less sedentary than pairs?

Take a break 10:20.

A few minutes later, Arcadio calls to say that he has found group again. Some yards further out than their first site and in deeper water. 2 ft up in 20 ft of water. Arcadio says that they were all darkish when he first saw them. Then perhaps some indications of "courtship" (rocking and passing?)

I swim over to the area. Find that inds are located above bare sand dotted with many lumps of coral, sponge, etc. Little or no visible Turtle Grass. Mostly in Ord with WS and Y. Some P, Curl, E. I does RL during slight retreat. Then I see that there are only 4 inds. present. Has the initiator of the "courting party" gone?

In any case, it looks very much as if we are seeing the first "adumbrations" of the breeding season!!!

Go back to see pair again. Still there. Extreme E's by both inds. in dark coloration. The presumed ♀ has a prominent WS. The presumed ♂ has little or nothing in the way of WS. (If there is a "Dark" separate from "Ord", this is it.)

NOTE: I think that the behavior of this pair sup

ports the hypothesis — which I probably made earlier — that E is less escape-ish and/or more aggressive than P.

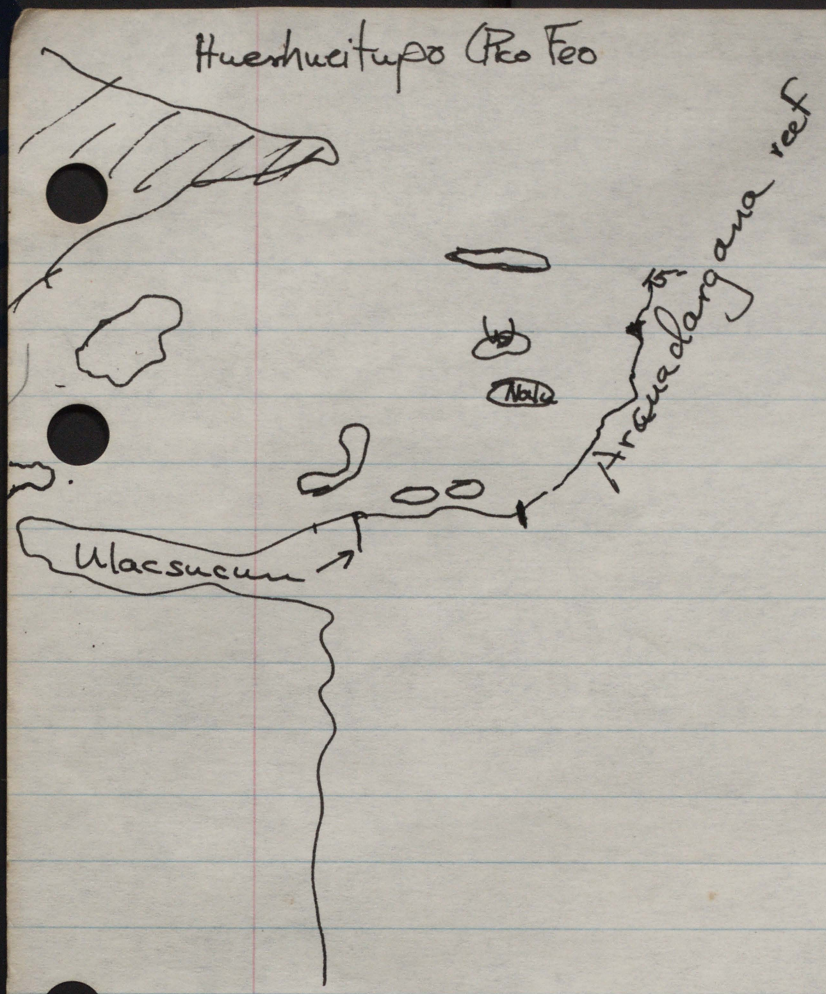
Stop observations temporarily 10:40

GENERAL DISCUSSION: There is a peculiar problem connected with sex and social structure in this species. Species tends to be divided into pairs and groups. Pairs are apparently long sustained. But overt sexual behavior seems to be more characteristic of groups than of pairs. Why? I can see advantages to sex in groups, big gang-bangs. But why retain or develop pairs if gang bangs are adequate?

Back in water 11:05 a.m. Water has suddenly become much murkier than earlier. Group seems to have gone.

But pair is still here. Exactly same place as before 1-2 ft up in 10 ft of water, over Turtle Grass, 4 ft. from coral head. Presumed male does prolonged E near me. Presumed ♀ does prolonged P a little farther away. Both in "Dark" or "dark Ord", belly dark, with some WS (and Y ??)

Sudden brief panic. Both mids dart away a foot or so. Return immediately. Presumed ♂ does not change color. Presumed ♀ does. As she retreats. Interesting sequence. First goes into PH. PH with DM! (But I think that the DM may have appeared a fraction of a second after the barring of the back and other characters of typical PH). Then "she" goes Pale. (DM perhaps disap-


Huenhueitupoo Pico Feo
Arguadarga reef
Nala
Ulacsucum

pearing a fraction of a second after typical PH characters) All very rapid. Then back to Ord or "dark Ord" again

Neither vid. shows any reaction to outboard motor starting 200 yds away.

Stop my own observations 11:20 a.m.

Arcadio goes into water as I come out. Can't find group either. But does find pair in same place (they are calm). Sees a few traces of what he thinks may be "counting". Rocking by presumed ♀. With RL. No response by presumed ♂.

He tries making various noises. No reaction

Work stops 11:45 a.m.

This afternoon going to work on "outer" reef. Start 3:00 p.m. Reefs just off tip of San Blas Point. Swim around for some considerable time, both over reefs and very large beds of Turtle Grass in adjacent areas. No squid!

4:00 p.m. Go further inside Point, along coast of mainland. Area where Arcadio saw squid a few weeks ago. And where Arquimedes saw 4 vids (3 large and 1 smaller) only yesterday (sic!?). Again nothing. NOTE: this general region is called "Macsucun" — see accompanying sketch by Jean Porter. Again nothing.

Stop 5:00 p.m.

February 18, 1972
San Blas

Going to work on Miatupo usual area. Arrive 8:05 a.m. Cloudy. Windy. Cool. Water moderately clear.

The group seen yesterday ("Group A") is not around when we first look for them. Neither is the pair seen yesterday ("Pair A") at 8:15 a.m.

A minute or so later a single mid. shows up. More or less large. Definitely alone. Swimming forward, with arms tucked under his body (presumably E — to us? — rather than a mechanical "side effect"). 2 ft up in 10-12 ft. of water. Swims right through Pair A area, proceeds straight ahead, passes Group A area and continues for some yards farther. Mostly over Turtle grass. In more or less ordinary Ord throughout. Then suddenly turns around and shoots backward. Joins 3 other mids. All more or less large. In ordinary Ord. No "greeting" as far as I can tell.

The 4 mids. drift off in general direction of Group A area. Gradually accelerate. Go down into deep water. Arcadio sees one near bottom; the other 3 seem to have disappeared (temporarily).

Then we see another group of 4 mids some 20-30 ft. away. All approximately same size (perhaps medium-large, perhaps young adult or sub-adult — as might perhaps be expected at this time of the year?)

3-4 ft up in 10-12 ft water, over mixed coral and grass. Swimming around close together (9" - 3' apart). Mostly in ordinary Ord, some WS (and Y?). The ind. farthest from me does PH from time to time. None of the inds. does either E or R. Why??? Several inds. show traces of RL when making little spurts backward. Three inds. (incl. the 2 who do RL, but not the one who does PH) show what may be traces of Pastel. Acquire a general pinkish or purplish "bloom" (partly powdery, partly iridescent) "superimposed" upon Ord (at least upper parts). The total effect is darker than an extreme, really pale "true" (?) Pastel. One of the inds., the one nearest to me, acquires this "semi-Pastel" more frequently than do the others. Several times, this ind. swims forward, slowly, away from the rest of the group, gradually assuming semi-Pastel as it does so. Then shoots rapidly backward toward group in "fully developed" semi-Pastel. No flutter during this shoot. Only responses by other inds. are evasive movements and at least one brief PH.

I shall call this second group "B".

Get out of the water 8:35 a.m. Arcadio stays 10 minutes more. He sees Group B joined by more individuals. Quite probably all or most of group A. Then all go off into deeper water (again).

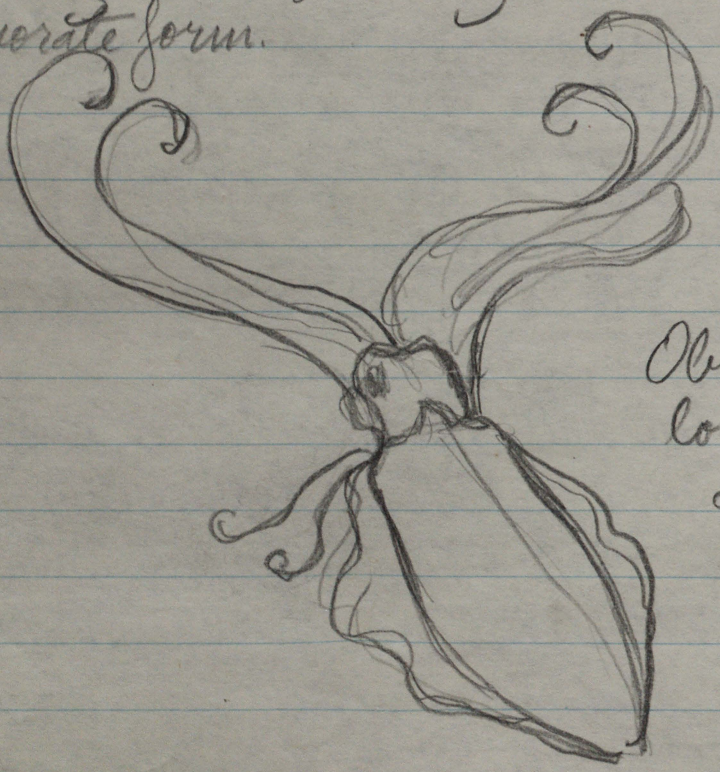
Is this morning's "gradual assemblage" typical of the species? I rather think so.

Cozh., Feb. 16, 1972, III.

NOTE: The Ords seen today were quite conspicuously different from the "Darks" seen yesterday. Not as dark on back. And quite light below.

Go back into water 9:10. And all Hell breaks loose!

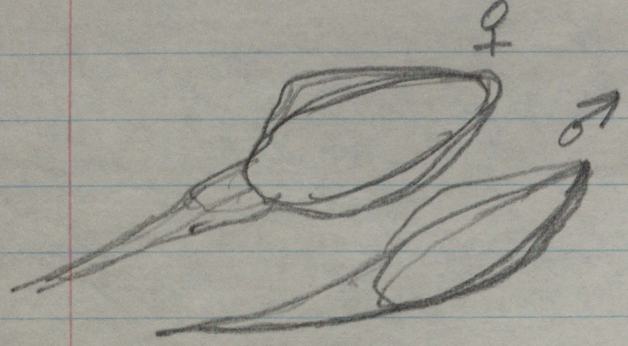
Go to Pair A area. No squid 9:15. Then see 1 large. Being photographed by Arcadio. Later observations (see below) indicate that this is adult ♀. Call her "female B." She is 1½ ft up in 10 ft. of water. In PH with DM. Otherwise not very obviously disturbed. (Can color change be a substitute for more overt activity?) Suddenly she swings around (arms going under into E-type position), then immediately goes pale (probably retinalized Pale, but very extreme, silvery all over). And does extreme V of elaborate form.



Obvious, arms too long! But general effect not bad.

See drawing. Some curl all arms. Smallest arms stretched downward. This performance may be a reaction to Arcadio's approach. But a few seconds later, I see that another squid is approaching from Arcadio's direction. Also large, but slightly smaller than the other mid. Certainly ♂ ("♂ B") — see below. (NOTE: I can tell that this pair B is different from pair A. The ♀ of pair B has scars on back. The ♂ of pair B does not have visibly damaged arms like the ♂ of pair A.)

♀ B relaxes V-Pale as ♂ B gets closer. Goes into PH or Ord-PH in ordinary posture. ♂ B approaches at normal speed. He is in Ord or Ord-semi-Pastel. Joins ♀. Both swim together, facing in same direction. About 6" apart. ♀ now in PH most of the time. PH of a definite type. Barring not conspicuous. More or less dispersed mottling on back. Rather light in tone, as PH's go. No DM. Her fins are speckled along the edges, quite clear, transparent, medially. ♂ in definite Pastel. Not extreme. A "trace" of Ord, probably also WS (probably not Y?), underneath the Pastel. Both mids. do a little Rocking. But not much. When not Rocking, the animals just swim, backward, back and forth. No fluttering. ♂ often "bent" toward ♀. See drawing next page. When ♂ approaches particularly close, the ♀ tends to spread her arms. Rather conspicuously "broadside." With conspicuous PH pattern on some or all arms, but no real Z



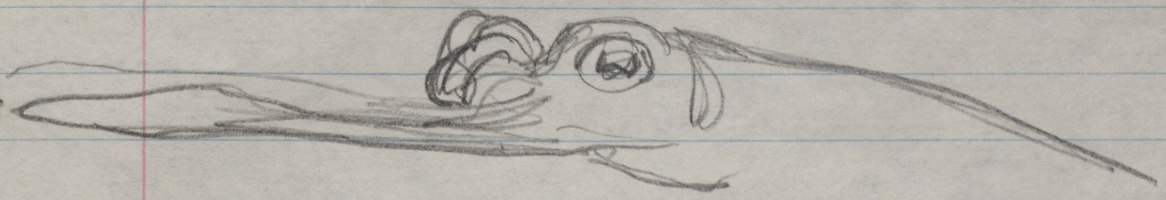
"Bending".

Then we get copulations and copulation attempts.

① ♂ suddenly darts in to ♀. Forward. Strikes at her head area (base of arms?) with 1 or 2 arms (not tentacles). He is still in his usual Pastel as he does this. She darts away, backward, immediately. Some color change as she goes. I think some complicated combination of PH and Pale (possibly other elements), but I don't follow the sequence well. Then the 2 inds. separate (each going away). ♂ reverts to Ord.

② Then the 2 inds. come together again. Swim side by side. Little or no Rocking. ♀ in PH as earlier (mottled, bordered fins). ♂ in Pastel as before ("over" trace of Ord). Bends from time to time. Suddenly he strikes again, with one or two arms (2 more probable?) This time the ♀ does not flee or change color (at least not much). Copulation obviously successful. ♂ goes about 10 ft away immediately after cop. Changes back to ordinary Ord as he goes. The ♀ sits in PH or PH-Ord. After a few seconds, she uses all her small arms, but not her tentacles, to "tatillon" her frontal area. Obviously,

rearranging spermatophores on frontal gland.



(3) Then ♂ comes back. Assumes Partel as before. Whole process repeated as before. Only difference is that ♂ doesn't do much re-arranging. Is his arm getting better with practice?

Then I leave. Get out of water 9:35 a.m.

NOTE: All of these 3 copulations occurred during a space of approximately 5 minutes!

Arcadio stays in water after I leave. Rediscovers pair after 10-15 mins. Sees 2 more copulations. Then he also leaves water.

NOTE: In all 5 cops., the ♂ appeared to attach, or try to attach, spermatophores to frontal gland rather than inserting them within mantle cavity. Is this "normal". Are mantle-cavity-insertions artefacts of captivity? Due to shortage of space and/or bad timing?

I go back into water 10:05 a.m. Go straight to pair B area. Animals not there. But we find them a few seconds later in deeper water a few (20) yards away. Pair B now associated with 4 other inds. Group A? 2-4 ft up in 15-20 ft water over scattered coral and bare sand bottom. The six inds. seem to have formed a "courting party"!!!!!

Social organization of group obviously complex. ♀ + ♂B at one end. Followed by another mid., presumably another ♂ ("B"). Another 2 mids., presumably ♂ and ♀, are showing very mild traces of sex at the other end (Rocking, some RL). 6th mid (smallest of group) doesn't pay much obvious attention to others, but does do E in Dark to me (not sexual yet?).

♂ + ♀ B doing a lot of Rocking now, in these circumstances. ♂ is in Ord most of time. All passion spent. ♀ repeatedly RL and Pic (sometimes extreme). Presumably repellent. Repelling either ♂B and/or ♂B. B just tags along behind B's. In Ord all the time. Every once in a while, ♂B drifts or darts back toward ♂B. Assumes PH as he does so. B always retreats immediately. Then ♂B rejoins ♀ and rearssumes Ord.

COMMENT: It would appear that the most spectacular "courting parties" are "post-hoc" rather than "pre-hoc" (note that displays of pair B today, while they were alone, were not very exaggerated — much less extreme than some I saw last June). "Courting parties" may develop when already fertilized, at least partly satisfied, ♀'s rejoin groups. Presumably pairs separate from groups in order to achieve successful copulations and/or do not go to groups until successful copulations have been achieved.

What is the sex ratio in this species? Are ♂'s

more abundant than ♀'s. Or simply active sexually over longer periods of time? Or what?

I get back out of water by 10:15. Arcadio stays in a half hour longer. Continues photographing. Notices that all activity gradually dies down.

NOTE! Some of the obvious hostile PH's (to us) this morning were accompanied by light streak down center of arms. But probably not (?) the PH's of the ♂ B showing sexual encounters. Light streak an "ait. mov." of Pale?

Going back to same place this afternoon. Arrive 3:00 p.m. Clear. Calm. Warm. Water fairly clear.

Find group of 6 large mids. more or less where B's seen last this morning. 1-2 ft up in 20 ft of water. Bottom mixed sand and clumps of coral. One does extreme E. Another does extreme P. All in Ord with WS (Y?). Light streak down center of arms.

Probably 4 mids of "group A-B (including ♂ B), plus B pair.

4 mids. move off. Presumed B pair remain. Ord, WS, Y. Do some E's. Then move off into still deeper water.

I go to A pair area 3:15. No squid.

Go back to group area. Find 4 mids. 3:25. 20-30 ft. down. Perhaps pair B plus ♂ B plus a friend (probably another ♂) Swimming around in Ord & WS. One mid, possibly B ♂, does LP(!). White

side of body directed toward other presumed ♂'s.

Then I go exploring over a large area of Turtle Grass. In fairly shallow water. Nothing.

Go back to A-B group area. 3:40 p.m. 4 ind's. back. Behaving rather as before. 1 ind. more or less semi-apart. Other 3 in low intensity "courting party". ♀ does some Rocking, some escaping with RL and Pie. Otherwise animals in ordinary Ord with WS.

Why does a ♂ stay with a ♀ after copulation? Does he help in defense of her, or in care of eggs?

These 4 continue for some time. Then the semi-detached ind. also starts to follow ♀. She "escapes", alternating Pie with Ord + RL. Then the animals appear to become more excited. One ♂ starts to follow the ♀ particularly closely. He assumes Partial (and at times dark, like Pastels sent this morning). ♀ assumes "mottled" PH coloration. ♂ "bends" while swimming beside ♀. Then starts to make "copulatory forward rushes". Obviously unsuccessful. He always stops short. (Presumably stops in response to some information from ♀, but I can't see that she signals in any ritualized way.) The second ♂ follows behind. Usually in PH. Sometimes spreads arms. Z on arms while back remains PH. Or assumes Z on one side of body (with and without spread) while retaining PH on other side. The Z side is always the one facing first ♂ and ♀. The third following ♂

is much less active.

I get out of water 3:55 p.m.

Arcadio gets out some minutes later. Tells me that there was "another" group of 3 mids. quite close (less than 10 ft?) from the 4 mids. I was watching. Rather smaller on the average. Apparently 1 ♀ and 2 ♂'s. Some very low-intensity "courting". Some RL's.

The smallest ♂ of the group of 4 sometimes darted over to join group of 3 temporarily.

Obviously the situation is fluid!

COMMENT: Why have we not seen any baby squid this trip. Are they all in deeper water? Or are there no babies at this time of the year?

February 22, 1972
San Blas

Start out at Pico Teo (Don MacPhail saw squid here yesterday or the day before.) 9:15 a.m. Cloudy. Very windy. Surf in all around the island. Through a considerable variety of habitats (Turtle Grass, small-ish patches of coral, etc., huge expanses of discarded coconut shells), areas of fairly clear water as well as extremely murky ones. Without seeing a single Sepioteuthis. Come out of water 10:30 a.m.

Go to Matapo in the afternoon. Still extremely

windy. Start out in usual area. This is windward now. Water found clear but very agitated. Visit all A and B areas. Continue swimming until 2:00 p.m. No squid (quite definite)

Then go to leeward side of same island. Swim 2:20 - 2:40 p.m. Water is so full of sediment that we can't see anything at all.

On way back, stop at Nalunega. Water is pure pea soup!

COMMENT: Presumably all or most of the squids retire into deeper waters under the conditions which prevailed today. This may help to explain why the main part of the breeding season comes after the dry season (if this is indeed the case).

February 23, 1972
San Blas

Try leeward side of Pico Teo this morning. Some cloud. Still extremely windy. Start 7:30 a.m. Water is not quite as murky as might be expected.

8:00 a.m. Arcadio sees single baby squid. 3 ft up in 4 ft of water over Turtle Grass near large coral. Disappears immediately. But this does seem to indicate that there is some breeding all year round.

I continue swimming until 8:30 a.m., without seeing anything of interest. Arcadio swims all around the

island, until 9:00 a.m., without seeing any squid at all.
Start again 11:20 a.m. Sand bank in area known as MacSwain, south of Pico Teo. Enormous bed of Turtle Grass, some fringing coral reefs. Not many fish in the grass itself, but lots around the coral. 11:35. Area of grass. See single squid (medium? large?) just on bottom, in 15 ft water. Darts under sunken log. Disappears. (NOTE: I thought that this animal was dragging something long (a feeler") and white behind and below. It could have been an egg mass. But I could be — probably was in fact — mistaken.) Continue swimming until 12:30, with quite negative results.
Try Halimeda in the afternoon. 3:00 p.m. Wind still strong but perhaps a little weaker than earlier. Group I - II area(s) too murky to be feasible. So we start group III area and swim around island. I get 3/4 of the way. Arcadio completes the circuit. Pass through all sorts of habitats, Turtle Grass, Eel Grass, Coral Reefs, mixed sand & coral, etc. 4-20 ft of water. Considerable current in some places; much less in others. The area, at this depth, looks ideal for squid (and we have seen many here before) — but we did not find any this afternoon. It must be the wind!
NOTE; Talking to more of the natives of Halimeda this afternoon. Including Carlos, who seems reliable. He says that he saw a group of approximately 100 squid near San Blas Point. Juvs. of all sizes. This tallies

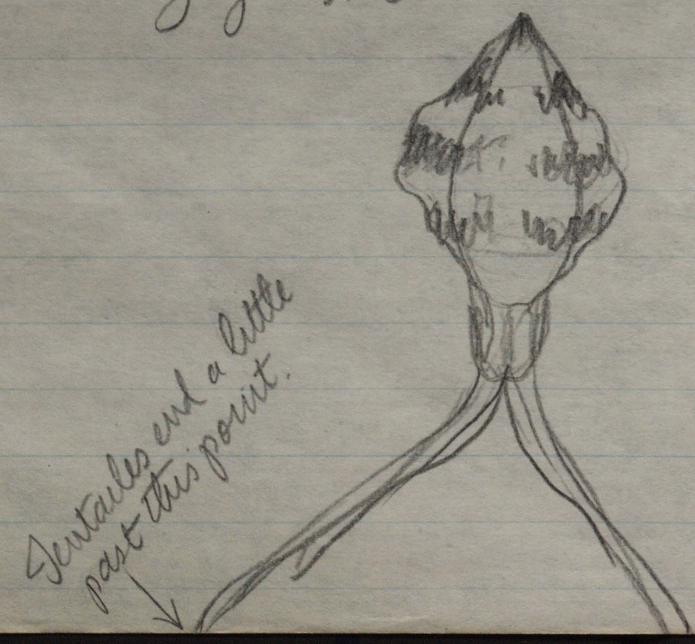
with Arcadio's account. There really must have been large groups only a few weeks ago.

Does the species have two breeding seasons each year. Or was the local population "misled" by the peculiar nature of the dry season this year (even dry all of December, rather wet in January) to start to breed prematurely, only to have to regress later on?

February 24, 1972
San Blas

Wake up this morning to find that the weather has not changed.

8:05 a.m. Pico Teo. Sitting on porch. See a single baby squid (not quite as small as some) in shallow water right beside house and island (inside rocky wave barrier) in semi-PH (3 interrupted bars on body, apparently extending to and through fins). Also extreme V



Ceph. Feb. 24, 1972, II

Presumably these apparently single baby squid are being swept along by winds and currents more often than not. But this particular mid. certainly went against the current for at least 4-5 ft.

Five minutes later, see another (?) baby squid in same general area. Same size. Same PH and V (notice that PH is accompanied by extreme, extremely viridescent, Y). This mid. is about 1' down in 1-1½' water. Drifting or swimming in same general direction as current.

COMMENTS: Arcadio makes the enticing suggestion that these baby squids are mimicking bits of Sargassum. The resemblance is certainly close!

Which may be correlated with another peculiar feature. There would appear to be a fairly rigid ecological separation between smalls and medium-larges now. The latter probably have retired to deeper waters. Some or all of the former are near the surface. Are babies always, at other times of the year, more likely to remain not far from the surface than some mature individuals?

If so, it might be a simple consequence of their mimicry. (Or of two types of mimicry in different classes of the species. Viz "adults" on Staghorn Coral in November.)

Go exploring later in the morning. Weather still unchanged

Arrive at Ammen Islands 9:35 a.m. Naranjo

Chico Water like soup. Locals haven't seen squid for some time. We don't even bother to get in to the water.

Go on to Naranjo Grande. Same story.

Then go on to some islands to the west. In Roberson group. First Numutupo. Water fairly clear. Lots of Turtle Grass; also small coral reefs. Lots of fish, including needlefish, but no squid 10:15–10:35.

Go on to Ailitupo. Again beautiful series of habitats. Again no squid 11:10–11:25 p.m.

This afternoon we decide to look for Sargassum (guessing the idea of infantile mimicry).

Follow one long drift line, starting from Porvenir reef, almost to Malinega. Extending over fairly deep water (Turtle Grass on bottom, when we can see it). Composed of floating Eel Grass leaves, Turtle Grass leaves, and lots of Sargassum floats (very few whole plants or substantial fractions thereof). See one school of small fishes. Nothing else. Give up 3:30 p.m.

Then Arcadio explores a solid mass of floating vegetation, largely Sargassum (largely semi-intact plants), more or less "hung up" before sandbank–coral reef in front of Porvenir (lee side). Lots of fish. No squid visible. But when he sticks spear-gun up into mass, he provokes release of a puff of ink. Dark (i.e. not Dorytenthis); either Sepioteuthis or, possibly, pelagic baby octopod. So there is something around in this environment after all.

Stop work ca. 4:20 p.m.

NOTE: Jim Porter says that Sargassum grows, rooted, on the outer reef here.

February 25, 1972
San Blas

It is a little less windy today than during the last few days. But still far from flat calm. Going to work at usual place Hialupo. Get into water 8:45 a.m. Some sun. Water fairly clear. Lots of fish. No squid anywhere. Leave water at 9:25 a.m.

Then Arcadio is towed in and around the southern boat channel, in both deep and shallow water, all around Hialupo pequeño (called Achutupo in some of my earlier notes), and also around a large part of Hialupo itself (excluding the whole of the lee side). Until 10:25 a.m. Again no squid.

Then I go back into water in usual AB area. Until 11 a.m. Still no squid.

I think that it is safe to say that the squid simply are not here this morning! Evidence quite definite

ADDITION: While I was swimming the second time this morning, I followed a drift line of nearly complete for some considerable distance without seeing any babies

NOTE: The small sardines near the surface here seem to be more dispersed than usual. Is this because the squid are absent now?

Cyph., Feb. 25, 1972, II

This afternoon we work along the inner shore of San Blas Point. Beginning at a place called Arcadia, where Carlos saw ± 100 squid some weeks ago. Get into water 2:15 p.m. Area of Turtle Grass near Mangrove. Water moderately clear, calm. No squid. Swim further down point (inward). Part a considerable variety of habitats until 3:00 p.m. Still without seeing anything of interest to us. Then Arcadio is towed further, until 3:50. Not a sign of squid. I think that we can safely say that squid are not here now either!

Was there a big die-off last week or last month, after breeding?

Possibly so. But it cannot have been complete. For we return to Malaunega after the afternoon's work, to find that one of the little boys on the dock has just caught a Sepioteuthis, large (!), and cut it up for bait. He says that this ind. was one of a pair. Caught near inshore (3-4 ft water?) at far end of Group II area.

So the whole situation is just as complicated as I thought it was!

III.

Indexed for displays
" " courtship and copulation

March 22, 1772
San Blas

Going to start work at Mulanega this morning. Clear. Sunny. Rather calm. (Note: yesterday was rough coming down from Colon. But it was calm a few days before.) The locals say that they saw squid, all sizes, in Group I - II area yesterday and the day before.

Get into water 7:35 a.m. Swim around Group I - II area. Water clear. Quite a lot of fish. But no squid. Stop observing 8:00 a.m. Arcadio looks at Group III area during same period. No squid there either.

Is it too early in the morning?

Get into water again 8:25 a.m. Group I - II area. Still no squid by 8:40. Go over to III area. No squid by 8:55 a.m.

Arcadio has himself towed around island 8:10 - 8:55, again without seeing anything of interest.

Then one of the Indians calls me. He has found two squid in extreme II area in shallow water. I get running over and plunge in. Squid still there. Two mediums, one considerably larger than the other. Quite close together. Perhaps 6 - 8" apart. I lift up in 3 ft water, over miscellaneous rubbish near TG.

Both males in extreme P when I see them. Alternating Quadruple Streak with Quintuple Streak, i.e. belly stripe coming and going.

Then the smaller ind. stops streaks while remaining in P. Goes into a very yellow version of Ord (with WS and probably Y). This sort of general yellow may be related to PH, but I couldn't detect any PH-type dark mottling on the back (of course, the animals were facing me, and thus I couldn't see the back at all part of the time).

The larger ind. stays in streaks, but settles down into steady Quintuple version.

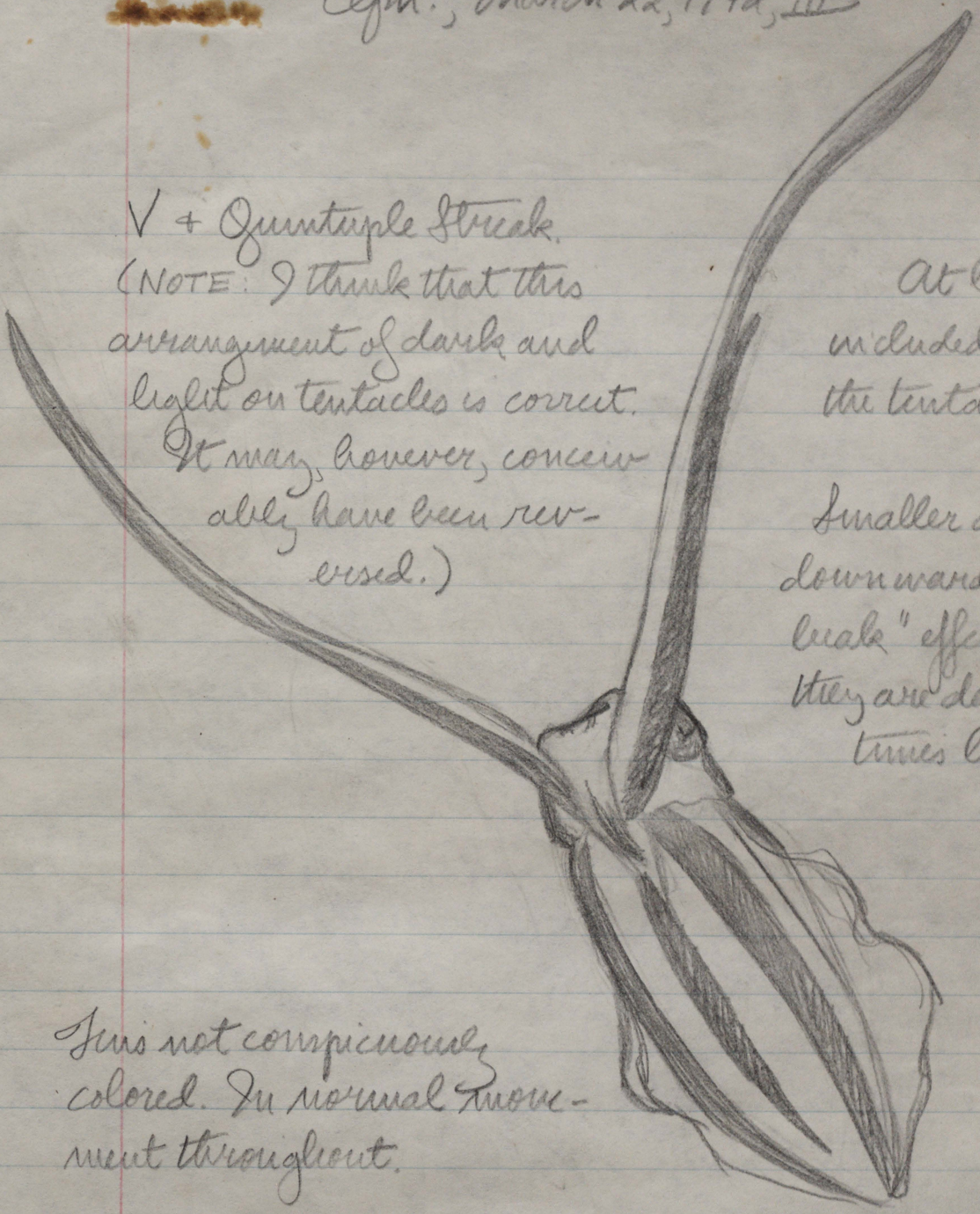
NOTE: I didn't see either ind. make an attempt to feed while in streaks, but they might well have been feeding before I arrived.

Then the larger ind. does extreme V while retaining Quintuple. See next page. Holds this for a couple of minutes.

Then suddenly shoots backward a foot or so. In extreme E, in Ord, WS, Y, and DM. (The smaller ind. also shoots backward at same time. I think in "yellow Ord" with WS and Y, nothing else, but I am not sure about this.)

Then the two begin a sort of hesitation dance, obviously directed toward me. Advances and retreats. Advances usually longer than retreats. They are obviously trying to edge around me, to go on somewhere else. Some P's and E's by both. E's are more frequent and longer sustained by the larger of the 2 inds., who is also the one that advances most vigorously and stays closest to me. The larger ind. is in Ord-WS-Y throughout.

Ceph., March 22, 1972, III



V + Quintuple Streak.
(NOTE: I think that this arrangement of dark and light on tentacles is correct. It may, however, conceivably have been reversed.)

At least one arm included in V with the tentacles.

Smaller arms point downward in "pseudo-beak" effect. Sometimes they are dark. At other times light.

Iris not conspicuously colored. In normal movement throughout.

Eye quite visible from this point of view.

Cephs., March 22, 1972, IV

The smaller retains more or less of its "yellow-Ord" etc.

Finally they shoot by me and disappear 9:05 a.m.

I think that this series of displays confirms some of my earlier conclusions and hypotheses. P, E, V, and the Streak patterns are all hostile. Probably purely hostile. V higher intensity than P (with escape slightly less predominant ????) E contains relatively less escape than P (and V. ?), possibly also higher intensity than P on the average (although lower intensity than V ?)

10:30 a.m. Arcadio has just gone for a deep dive across some outlying banks and reefs. No squid.

Go into water again 10:55. Swim all through I-II-III areas. No squid. (NOTE: it is low tide now. Area where mids. seen earlier this morning is very shallow indeed now. Do squid come near shoreline only at high tide? If so, why?)

Then we go on to Miatupo.

Start usual area 1:35 p.m. No squid in any of the A or B sites. I also patrol a stretch of shallow shoreline; Arcadio and I explore other reefs; Arcadio inspects another stretch of shallows; and Arcadio has himself towed around most of the whole island; all without seeing a single squid. Stop 3:30 p.m.

NOTE: Most of Arcadio's tows here at Miatupo this afternoon and some of the tows at Nalunga this morning were deep. They indicate that the squid are not now in moderately deep water near the

particular islands. I.E. they probably did die off after the last "flush" of breeding.

After Niatupo, we go on to the Salar Islands. Anchor off island which I think is the one I called "Headbody" in November (p. 59). Arrive 4:45 p.m. See squid immediately!

Group of 9 smalls very close to boat. Somewhat variable in size; some smaller than others; but (probable) none is quite as small as the tiniest I have seen elsewhere at other times. Definitely "pelagic". Swimming 1-2 ft down in 30 ft deep, very broad, channel. When first seen mids. are rather scattered (disturbed?). They dart away after a few minutes.

But then they come back almost immediately. Now quite tightly integrated. Ends ¼"-1" apart. All in Ord. Some with WS, some without. (I presume that all or most also have Y, but I can't see it.) No trace of V. All mids. are facing toward the boat. (Facing toward is obviously defensive.)

Bottom here is sand and TG.

NOTE: There is no floating Sargassum or other weed here now.

After approx. 5 mins., all these smalls swim away. Lost to sight. Swim past the anchor rope (white cable now, instead of metal chain) without stopping or showing interest in it.

We get into the water and try to find them

Ceph., Mar. 22, 1972, ~~VI~~

The subs. were heading in the general direction of "Ucubmay" when they disappeared. So we swam all the way to the island. No luck. Quit up 5:15 p.m.

Running light this evening. Began ca 6:30. No cephalopods show up by 8:25 p.m.

March 23, 1972
San Blas

Working same place (Solar) this morning. Sunny. Windy. (Full dry season again?)

Begin 7:40 a.m. Arcadio goes on shallow tow. By several islands, through a variety of habitats, mostly on lee sides. No squid by 9:05 a.m.

We go back to the "Settings". They haven't seen any squid here either.

So I go into water 9:10 a.m. Swim to nearest island. Follow anchor cable. No squid "attached" to it. Swim around and near shore for some considerable time. Mostly extensive TG (rather thin, sand visible almost everywhere) with many Diadema, few fish. Some areas with scattered coral heads, sponges, etc. Still no squid.

Then, 9:35 a.m., come across a group. 5+ All small (or perhaps, in some cases, small-medium) 1-2 ft down in 8 ft water. Area of pure TG and abundant Diadema (I think that this may be the first time I have seen Sepioteuthis in an area so rich in Diad

March 23 1972
Salan (San Blas)

Deep exploratory dive at 1pm. Dove down to about 160 ft on windward side of island along fringing reef. Side of reef is steep & cliff like solid coral with a lot of caves, patches of Gorgonians & Hydroids. Coral reef ends at about 140 ft. into sandy sedimented bottom that slopes deeper. encountered some small fish but no potential predators except for one nurse shark of about four feet resting inside of cave. No Squids. Dive lasted about 45 minutes & covered of about 150 yds. Visibility was about 100 ft. (very clear)

March 24 1972
Ogopukip (San Blas)

Shallow tow on windward area of island. Sandy & TG Through length of island, then coral reef from northeastern end of island and

extending about 200 yds. Towed along windward edge, then turned at end of reef and went along its lee side. At about 100 yds from turning point I spotted 14 mature INDS and. 10 ft from surface, bottom was 30 ft down and solid coral sloping down into deeper water. Group seemed to be travelling in opposite direction from mine, mantle end first & in a sort of wedge formation with the larger ones in the lead. Some INDS flushing pale on and off as they went. Upon noticing me they broke formation to face me and retreated about 6 ft all pale; then stopped and ORD with P & some PH & a couple PM over ORD & PH. as I approached them. Some social order but in general the formation was ragged Throughout my observations. Group seemed relaxed but curious and a little wary of my presence. I was able to come very close to them while snorkeling, but since they were a little too deep I donned a scuba. From then on they became hard to approach. The

group became quite excited and retreated at the sight of my bubbles but impervious to noise (I screamed into my mouthpiece without releasing bubbles & they did not even pale) After a while they allowed me to come closer but would balk and retreat whenever I exhaled. The group was formed by two very large individuals, eleven medium large and one medium small which could always be found at the opposite end or near the opposite end from the two large INDS. The two large INDS seemed to be the same two that we had encountered 1½ hours earlier and about 300 yds away in the shallows by the windward side of the Island. There was some courtship but of a very low intensity. Some RL over ORD with P & PH with posteling from the largest of the two. Some rocking back and forth. During Photographing session the main group deserted the two large INDS or viceversa but remained about 40 - 50 ft away and did not rejoined

until I left the area. Length of observation about 30 minutes between 12 and 12:30 pm. They moved on or seemed to as I left the area. I went back later on with DR Moynihan but failed to see any. Visibility was about 50-60 ft. I made a shallow tour around Island and in certain areas visibility was less than 40 ft. I felt several warm water pockets especially on southwest end of Island (extreme lee) visibility there was poor (due to high salinity?) also over the shallow sandy ½ TG area on windward side of Island

cma. I rather suspect that the two species were almost mutually exclusive.) Area is about 100 ft from beach. i.e. about 2/3 of the way in from the ship. Quite possibly (angel) the same group seen yesterday. Quite well integrated now. Inds. approximately 1 ft. apart. All inds. in more or less Ord (can't tell if with WS and/or T or not). Shoot away and disappear almost immediately. (NOTE: There was no drift in this area at the time. Of course, baby squid can "mimic" Sargassum without actually associating with it.)

Stop observation 9:45 a.m. Swim back to ship. Still no squid by anchor rope.

In the meantime, Arcadio has been deep towing without success, until he gets back to "Tethys" 10:00 a.m. Finds group of ca. all more or less small, some yards behind ship. Same group? Disappear immediately.

The young squid here seem to be definitely shy now.

They may well have a daily rhythm of movement. In shallows at night. In deeper water during the middle of the day. But almost always near surface in all areas.

Misc. Arcadio has been talking to Carlos, our local guide from Malumega. Carlos says that there are times when there are only small squid around. Confirms "big bang die off" hypothesis. He also says that the squid are being fished very intensively at Malumega (for bait). There used to be much larger groups a few years ago.

We prepare two "decoys": floats with link

chains, dangling frayed ropes, and attached Sargassum. Put one out in deep water (30 ft ?) near ship; the other in shallow water (4-5 ft ?) near shore. We shall see if they attract anything. Both floats launched 12:30 p.m.

Start field work 12:55. Go to small bare island about ½ mile away. Extensive shallows. Lots of TG. Both with and without Diadema. Also some coral. Both in rocks and scattered among TG. Water very clear. All very beautiful. No squid. Leave 1:30

Then visit several other islands: "Corgi Tupo" (?), "Uausui" (?). Arcadio does shallow tows around them. Nothing of interest. Go on to Ualbuay 2:10 p.m. Nothing (no squid, no fish, no crustacea) at shallow water decoy. So I swim out to "Jettys" and deep water decoy. Nothing there either. Swim back to shore. Arcadio has been exploring shallows. Nothing. Stop observations 2:30.

NOTE: We have been having trouble with "deep" water float. Rope and/or chain get caught in coral heads. So float is sometimes stuck in no more than 10 ft. of water. And freeing it entails a lot of movement. The movements may have frightened things off.

Go out to check this float again 4:30 p.m. Nothing there. Then swim in to check shallow-water float. No squid on the way in. Nothing but one fish hanging about the float. I swim around general area. No squid.

Obviously the small squid here are not very abundant. Probably they also are extremely mobile. (As might be expected?)

March 24, 1972
San Blas

Start out same place (Heubway? Salar) this morning. Sunny. Fairly calm. Into water 7:15 a.m.

Nothing at deep water float. I swim into shallow water float. No squid on the way or at the float itself.

In the meantime, however, Arcadio finds a group of 40 plus! (probably large plus). Quite near ship. 20 ft of water. Bottom of rock and sand. Some sponges etc. not far away. Inds. ranging 2-10 ft up, i.e. not near surface. Group quite well integrated at times, inds. 1-4 ft apart. Tends to break up when disturbances appear (e.g. when a Red Snapper swims by, when I join Arcadio). But then reforms again.

All the inds are certainly young. Some quite small. Some almost small-medium.

The first two inds. seen by Arcadio react to his approach by V + PH. Then one darts away with puff of ink. The other moves down and away more slowly. Gradually goes (back) into Ord (+?).

When I arrive, all the inds. are in Ord with US and Y. All apparently calm.

Arcadio sees some feeding in group. Inds dart forward, shoot out tentacles, and grab something. Prey too small to be identified. But needs some manipulation by arms before being bitten and swallowed. Inds turn pale thef-

ore shooting forward to catch prey. Then darken afterwards (assume unusually dark Ord?).

While I was aroused, the squids ignored, and were normally, I think approximately the same size (small wrasses?) swimming and feeding nearby.

COMMENT: Does this concentration suggest that small squids congregate in large groups on or near the bottom to sleep at night? And then break up into smaller groups, to come inshore or rise to near the surface during the daytime? And, if so, is this different from the adult routine???

NOTE: The Red Snapper which disturbed the group this morning was shot by Arcadio. It did not have any squid in its stomach. Nor did a small Barracuda shot by Arcadio yesterday.

Stop observations 8:00 a.m.

Then go out to Rolandes Keys. Stop at island called Agupuki.

Arcadio starts shallow tow 9:38 a.m. Sees small 9:42. In 4 ft of water over pure TG. Gives a shot of ink and darts away. I get into water. We swim around for a while, over TG, without seeing anything more. This is windward side. Water only moderately clear.

Then, 10:00 a.m., come across two large. Area of mixed bottom. Sand, TG, miscellaneous corals, sponges, etc. Water 2-3 ft deep. Animals 6" - 2' above bottom. More often low than high. The 2 wids are enormous.

Probably the largest I have ever seen. "Last year's crop". Obviously a real pair. One, presumed ♀, even larger than the other. Perhaps 18" or more in length. And heavily built.

When first seen, one mid (♂) is in Double Streak with Fin Stripe (sic!). The other mid. is in Ord (probably with WS and Y, but I can't see back). Both animals gradually drift away, usually backward. Both in what looks like a combination of Pastel and Ord (with WS and Y). A sort of pale, pinkish version of Ord. Ocelli unusually conspicuous (enlarged?). At first I thought that the pinkness might be an indication of sex. Now I doubt it. The general lightness of the Ord in these circumstances may have been "semi-cryptic", a partial attempt to match "background" (the whole area, shallow with much exposed sand on bottom, is relatively very light).

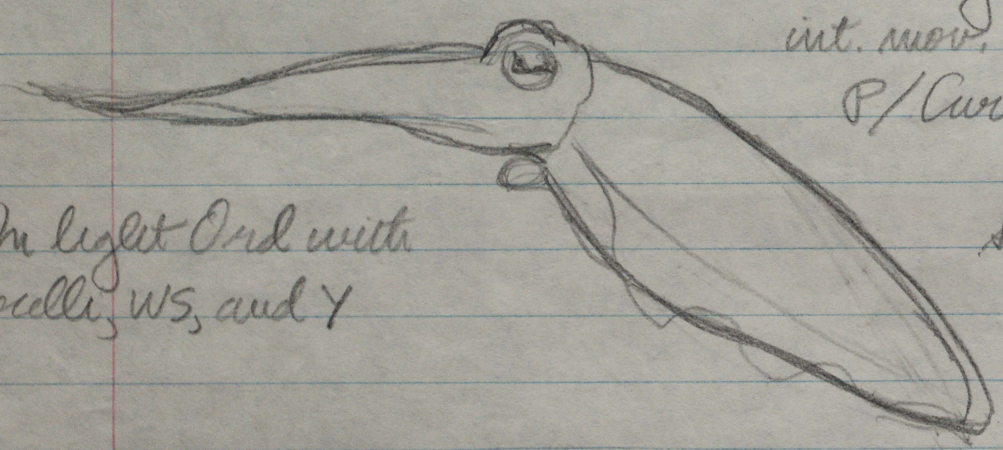
As they retreat, this light Ord is sometimes briefly interrupted by traces of PH. Once, one of the mids. does DM in Ord. After a while, both mids. begin to do lots of E. Quite close to us. At the same time, they stop retreating. E's often very extreme. ♂ tends to do E's more frequently, and sustain them longer, than ♀. Once, I notice that his arms are dark in E, while hers are light, whitish. There is little or no trace of P before or between first E's.

Then the animals seem to relax almost completely. Still very close to us (2-3' away). Both in light Ord with prominent ocelli, slight trace of WS and Y.

Occasionally they Rock together

When we approach the animals even more closely & audio-photographing. This seems to stimulate more E. Again especially by ♂. At first in light Ord +. Then the ♂ suddenly turns dark. All over? (Belly certainly uniformly dark brown — I am not sure if WS disappears completely or not). Then back to light Ord again. Both inds. completely ignore rather large fish swimming very near by.

While the ♂ is E-ing, the ♀ often rests in posture commence:



This might be an int. mov. of E and/or P/Curl.

In light Ord with ocelli, WS, and Y

Sometimes combined with DF

Both inds. sometimes "show-back" to us. With and without E or int. mov. of E-P.

Then ♂ suddenly does P and turns very dark again. This dark must be a display.

Then the ♂ does brief PH when I approach particularly closely (my hand only 1-2' ft away). I notice that the mottling of PH is also visible on the ventral side.

Then a whole series of apparently hostile displays in such proliferation that I get rather confused. Only a few points fairly clear:

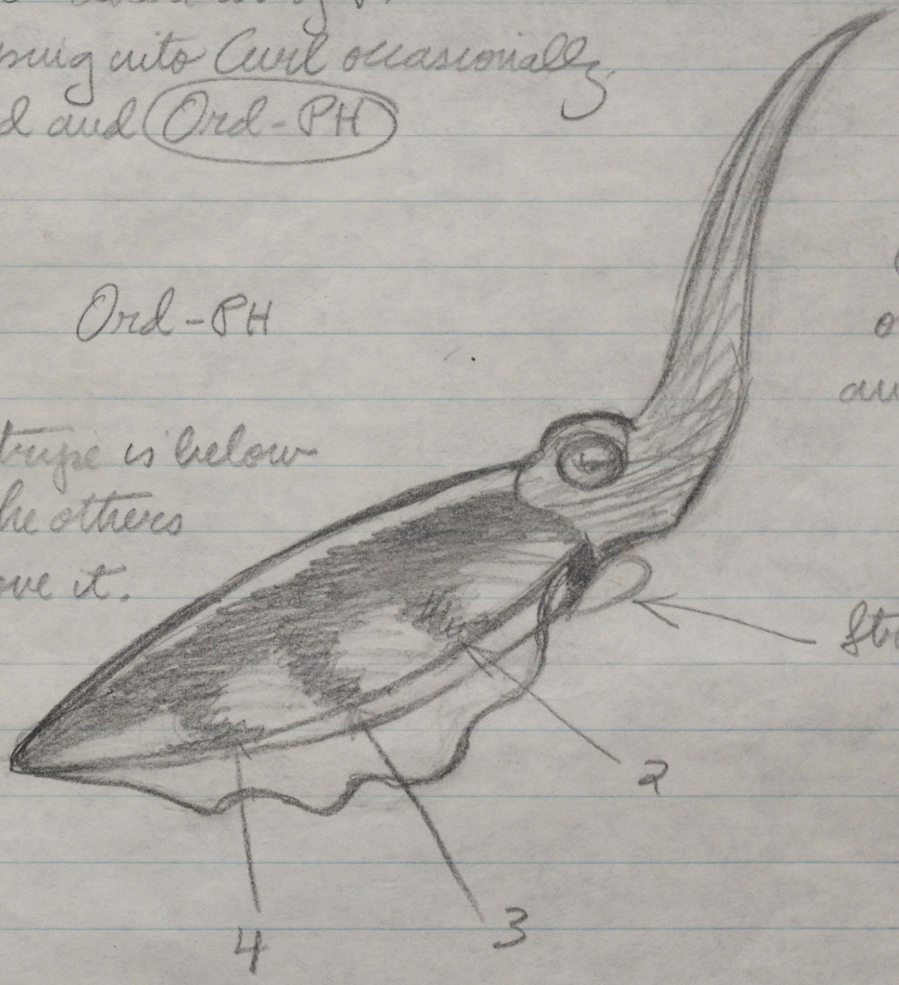
Ceph., March 24, 1972, V.

♂ does a lot of P.
Developing into Curl occasionally.
In Ord and (Ord-PH)

Ord-PH

Arms more or less dark and "normal"

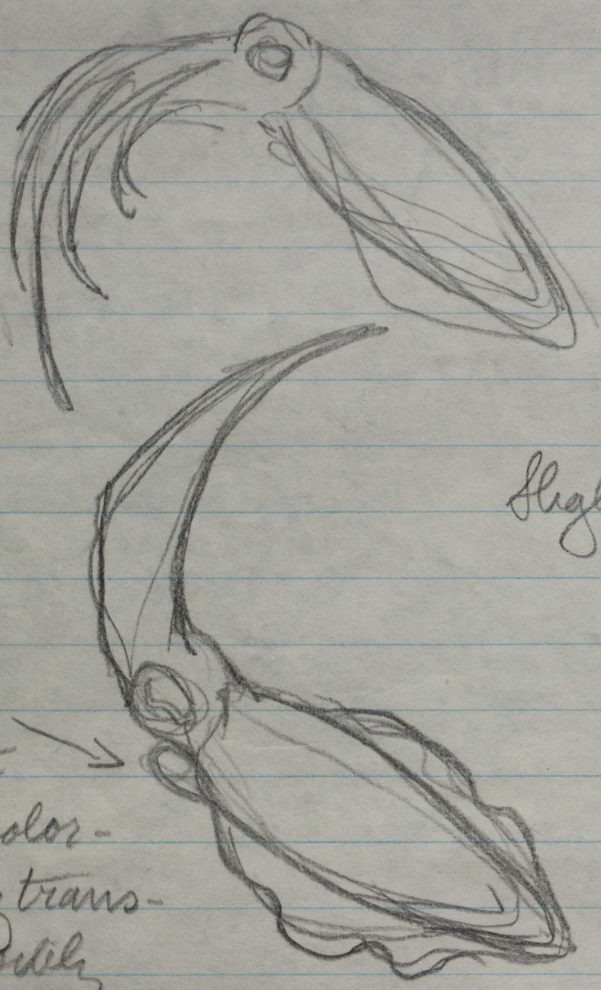
First stripe is below
first the others
are above it.



Whenever we approach the animals, they tend to show DM. Quite extreme. In unintimidated postures, E's, and P's. With Ord and/or PH coloration. (It is the ♂ who tends to assume PH. The ♀ hardly varies from light Ord with prominent ocelli.)

Once the ♀ assumes E with arms "splayed". Both this posture and a ♂ Curl are shown on the next page:

Cepla., March 24, 1972, VI



Slightly caricatured

The funnel is really quite large, but it seems to be colorless, probably transparent (possibly always).

Stop observations 10:20 a.m.

COMMENTS: Why have these large nids. survived so long? Why are not, apparently, courting and copulating now? Have they survived simply because they have not copulated.

Adults of this species are much less shy than infants and juveniles. Presumably because they have fewer kinds of predators. They certainly are not much bothered by human beings and most fish. It is only a few things (only Barracuda in my own experience) which really frighten them very strongly

The ♂ of the pair seen this morning certainly displayed more frequently and intensely than the ♀. Why? Was he "defending" the ♀? Or was he just slightly more alarmed?

While we were observing these larges, Carlos saw 2 smalls, over TG, a few hundred yards away. They darted off toward shore when alarmed. And when we return to the ship, Lucho tells us that he saw 5 smalls nearby. So it would seem that smalls are predominant here as elsewhere now. The pair of larges is exceptional.

Arcadio goes back to photograph this pair again, ca. 11:45 a.m. Finds that they are gone. Goes around to lee side of island. Finds group of 14 in 20 ft water, area of coral. 2 very large, perhaps pair seen earlier, plus 12 medium larges. All mids. quite low. Lots of PH. Some RL. Perhaps some counting in presumed pair.

The various islands here are certainly out of phase with one another. Why?

SEE ARCADIO'S NOTES.

Working same region this afternoon.

Start where Arcadio saw the 14 mids. this morning. Get into water 1:55 p.m. Sunny. Moderately calm. Area is superb large reef. Swim until 2:20. No squid.

Then Arcadio does shallow tow around island. Until 2:50. No squid.

So I go swimming around ship and on to area where pair was seen this morning. All sorts of habitats. Then walk back to ship along shore. No squid by 3:45 p.m.

At same time, Arcadio has gone back to explore reef again. Still without success.

Obviously, the squid around here are highly mobile now, even in the short term!

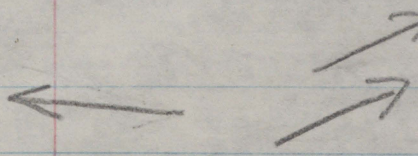
NOTE: Arcadio caught a large Red Snapper and a small Nassau Grouper this afternoon. Neither had squid in its stomach.

March 25, 1972
San Blas

Starting out early this morning. Same places as yesterday. Sunny. Windy. Arcadio begins shallow tow 7:10 a.m. Goes past area where large pair first seen yesterday. Then out along reef.

7:40 a.m. Approximate area where group of 14 seen yesterday. Find three large squid. One very large, presumed ♀. Two slightly smaller, presumed ♂'s. When I first see them, they are about 4 ft up in 8 ft of water. Over pure coral reef. Swimming about quite calmly. In Ord, with some WS and Y. The ♀ writhes without color change. Then I notice that there is a definite social structure within the group. ♀ and one ♂ definitely a "pair". The other ♂ is an onlooker, hanger-on, and/or intruder. (I shall call the pair "X", the other ♂ "O".)

The orientation of the animals is characteristic. (i.e. X's same backs to O♂ and vice versa, of course).



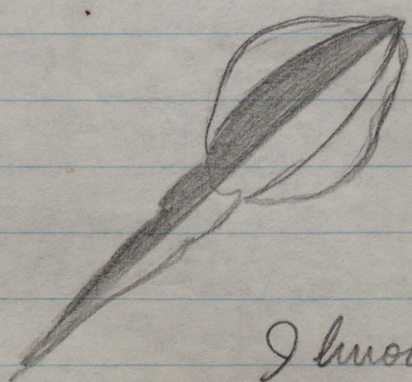
But they still move around to gather (i.e. the ♂'s backward while ♀ goes forward or again vice versa). This showing of the back, — or fading away — must be definite, "unfriendly" (see also below).

Then both ♂'s do ♀ without color change. Perhaps a reaction to approach by Arcadio.

One or both ♂'s may show very brief and slight traces of Pastel from time to time. But, if so, the performance is so low intensity that I can't even be sure that it exists.

8:52 a.m. All three mds. shoot upward toward the surface. The ♀ first. She has DM with her Ord. The two males don't change color at all. I can't tell what provokes this movement. But the ♀ loses DM and all three mds. come down again immediately.

Then the ♂ leaves. Immediately the ♂ starts to display. Turns brilliant silver along longitudinal side of the body away from the ♀.



NOTE: I think that the fin on the dark side remains essentially colorless, but this will have to be checked again later.

I know that I have seen this pattern before (e.g. p. 16), but I did not realize quite how

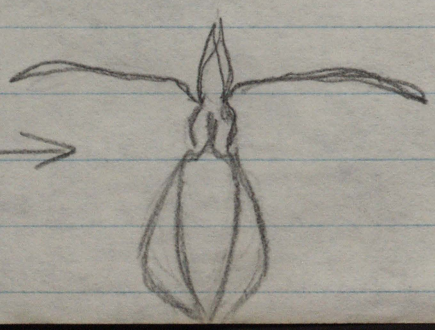
distinctive it is. I originally thought that the light side was Pastel. It is not. It is bright iridescent silver — like the silver of Pie. The silver is particularly bright on the eyebrows (or eye protuberances). I shall call this pattern "Lateral Silver".

The ♂ ♂ assumes Lateral Silver again and again. Always on the side away from ♀. The actual side differs according to the relative position of the two animals. (The ♂ shows a very strong tendency to stay below and behind ♀, perhaps ½ ft away from her. But there are occasional variations. He certainly switches from one side to the other of her. He may even twirl himself above and/or abreast of her when she switches direction. As far as I can tell, she is setting the course.) Once the ♂ does Pie Lateral Silver. Between Lateral Silvers, he resumes more or less undistinguished Ords (probably with only slight WS, little or no Y).

Throughout this performance, the ♀ retains the same color pattern. A more or less light Ord with conspicuous oodle. Probably no Y. And WS reduced to the absolute minimum, perhaps completely suppressed at times.

Then another presumed ♂ (re) appears. Presumably ♂ ♂ comes quite close.

♂ ♂ does extremely but rather peculiar Spread ⟶ with Z on arms but probably not on back. Intending mt.



leaves immediately! 8:02 a.m.

The ♂ goes back to Lateral Silver displays as soon as the intruder disappears. One Lateral Silver is combined with extreme Curl. Then more Lateral Silvers without Curl. Again and again and again. Then more extreme Curls. Some with Lateral Silver. Others with undistinguished Ord (definite). Also more Lateral Silvers without Curl. And brief intervals of normal swimming in Ord without any display at all.

Who are these displays designed to "impress". The ♀ can see the Curls, but not the Lateral Silvers. Perhaps these displays help to "warn off" rival males?

The ♀ remains in light Ord with prominent ocelli almost throughout. Only very occasionally and briefly does she assume a darker Ord (never very dark) with more WS. Then display stops fairly abruptly 8:07.

An intruder, presumably ♂, presumably ♂, (or) appears a few minutes later. The ♂ reacts by another extreme Spread with Z on arms but probably not on back. Form of Spread is different from that of earlier performance

But apparently equally effective. Intruder leaves at once. (Spread with Z seems to be one of the most rapidly effective displays in the whole repertoire of the species!)

♂X goes back to Lateral Silvers. Then stops. The two animals just swim peacefully side by side. ♂ in usual Ord. ♀ in usual light Ord. (NOTE: Throughout the period that I have been observing this pair this morning the two mids. have always swum with their heads pointing in the same direction.)

Then ♂X starts Curls again. Both with and without Lateral Silvers. Then resumes normal swimming. Both of the mids. are in Ord without Y and with minimal VS.

Then the ♀ starts RL! Very slight. Both mids. Rock together. Then relax. Then ♂ Curls in Ord. Then does Lateral Silver in normal swimming posture. Relaxes again. Then ♂ writhes without color change. Only for a second or so.

NOTE: The Ord of the ♀ appears to be rather bluer (a "powder" blue) than that of the ♂. An effect of ocelli?

All relaxed 8:15 a.m.

Then ♂ Curls. And there is some more Rocking. At this point, I see that two small-medium mids. have appeared on the scene! These smaller mids have certainly joined the group, but they also keep themselves to themselves within the general social unit. Determination commence:

♀ ♀

Cepl., March 25, 1972, VI.

♀X, still swimming by ♂X, does RL with some PH (sic!) on upper part of back. Then both ♂ & ♀ Rock together in what appears to be semi-Pastel (real)! Then both relax. Gradually drift apart.

The small-mediums seem to have disappeared by 8:20. (They did very little display while they were around. Just floated in "ordinary" Ord with some WS and Y.)

The X mids. have now changed their orientation. Swimming back to back. But still definitely moving in the same direction. I.E they are no longer quite as friendly as they were earlier, but they are still associating with one another. They are not displaying any more, at least for the moment.

Stop observations 8:25 a.m.

COMMENTS: The behavior of the X's this morning is exactly what one would expect of early "courtship." Almost too good to be true. The ♀, in a semi-encouraging color, allows the ♂ to approach and stay with her. At least for an appreciable period of time. He "displays" her against other ♂'s. But nothing more develops.

I would have supposed that this behavior could also be pair-formation. But it may conceivably be significant that mediums and small-mediums also occur in duos, probably with some appreciable frequency. Does pair-formation tend to occur early in life???

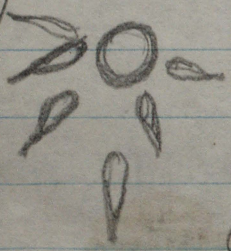
Cephs, March 25, 1972, VII.

The appearance of the two smaller mids. relatively late this morning may indicate how larger groups are formed as the day draws on.

April 29, 1972
San Blas

Arrive Malinega ca 7:45 a.m. Cloudy and rather windy.

Find that Arcadio has been watching group of squid near dock and boat. Group III area. When first seen approximately 9 mids. Ranging from tiny to almost medium. All clustered around pole in a few ft of water, near surface. SEE ARCADIO's NOTES. When I arrive, there are only 6 left. All quite close together. All facing outward from pole.

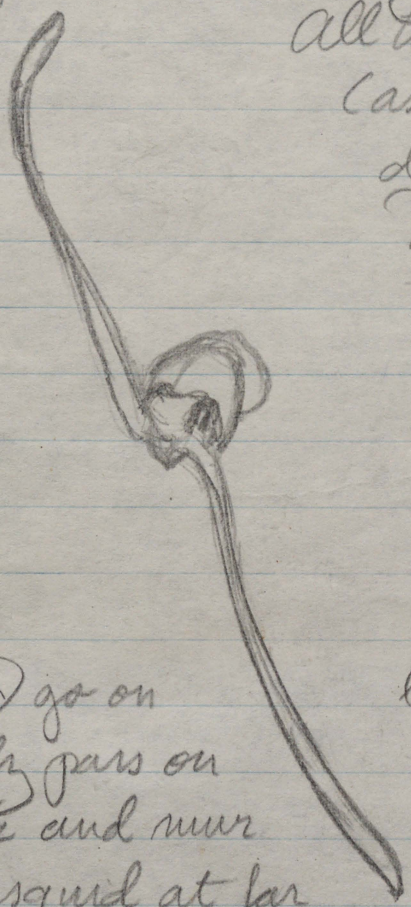


All in more or less Ord Clarkish with Y and WS. Largest does brief Curl when we approach (waiting on dock) Eventually frightened off by cayuco coming in.

8:45 a.m. Go into water. Start Group I area. Water very murky. Nothing. Go over to Group III area. Water perhaps a little clearer. Nothing.

Then 8:55, see group of 3 squid. Small (but not tiny) 1-2 ft below surface in water 6-10 ft deep. Above a large group of anchovetas. All three close together, swimming quite rapidly. In more or less ordinary Ord, with

WS and Y. One or more do(es) several V's. Sometimes straight forward. Sometimes downward. Once with extreme "Split" — something which I have not seen before



All these V's combined with retreat (as usual) Animals go out over deeper water (to at least 20 ft.) Disappear from view.

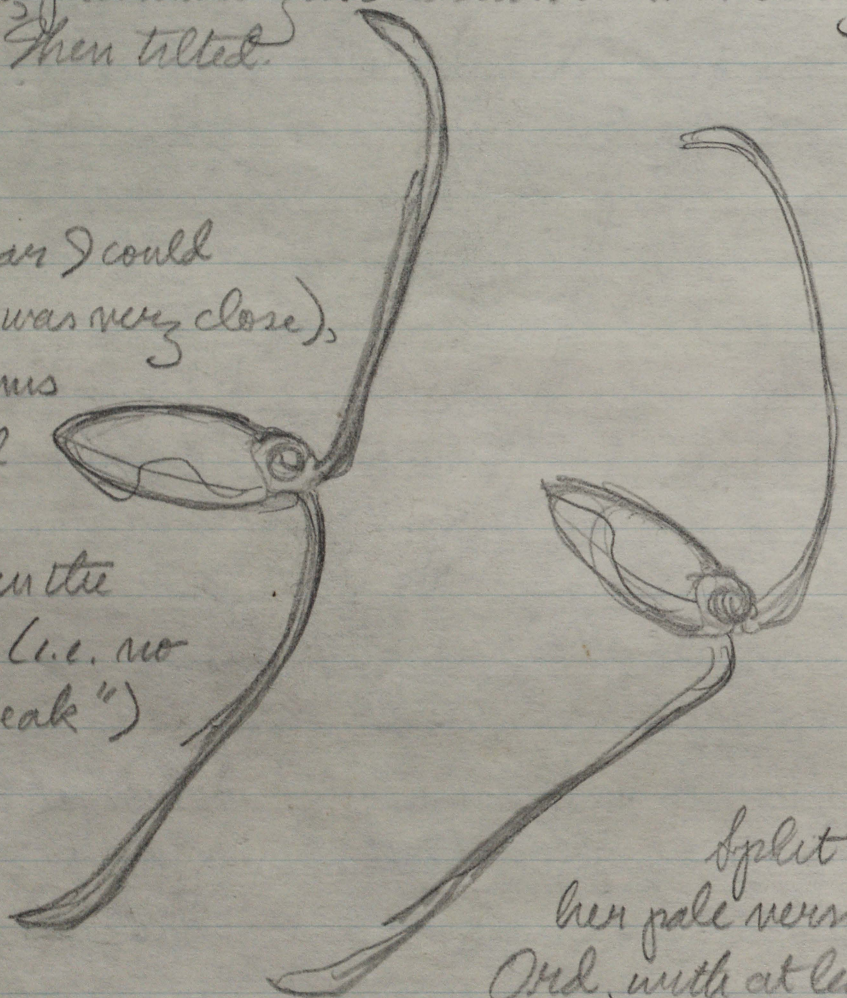
A few minutes later, Lucho sees single small at more or less same place where these seen first. Near surface, above anchovies, but then goes down, through fish. Lost to view

I go on gradually pass on Munkier and more group of squid at far back to Group I area. Nothing. to Group II area. Water getting deeper. Finally 9:12 Squid end of II area. In very shallow water 1½-2½ ft. Very near shore. Mixed TG, sandy pits, large tree trunks. Miscellaneous garbage Animals about midway between surface and bottom. Group is very large. 47+ individuals. Ranging from very small (not quite tiny) through ordinary, small to small medium. The mediums number 4-5. All mds. quite close together (2-6" apart). Drawn up in the usual "Lepanto" sterning or semi circle with the largest mds. at the two ends. All mds in Ord, WS, Y when first seen.

Then some of them begin to display as I drift closer

Some Quadruple Streaks without ritualized postures or movements. Some Quadruple Streaks with P. Some Quadruple Streaks with V. Some V's with Ord (+ presumably WS & Y). All or most V's straight forward.

Two of the larger mids. at one end of the line (is this a real "pair"?) gradually drift away. At the same time, a nearby smaller mid. becomes isolated. Does very extreme Split, presumably as reaction to me. Body horizontal at first. Then tilted.



Note: As far I could tell (and I was very close), all the arms were involved in the Split. Even the short ones (i.e. no "pseudo beak")

Split first in not her pale version of Ord, with at least some WS and Y. Then with PH (mottling very conspicuous on belly).

Then the upper group of arms is gradually lowered. To form conventional E. Partly with Ord etc. Partly with

Quadruple Streak

Presumably all or most of these Splits were with more or less strong traces of V; but I never saw the animal from the right angle to confirm this.

All the squid move away while I write. Find them again a few yards away, same habitat, 9:22. All in Ord, WS, Y. Some Lo V, straight forward. Then retreat. I notice that the smallest mids. retreat first (and fastest). Larger mids. tend to bring up the rear. All mids. retreat backward, facing me as they go. (This is characteristic.)

Stop observations 9:30.

Comments. Groups seem to be very highly integrated now. Composed of young, as would be expected. But it was surprising to see a large group in such filthy water.

There seem to be a rather surprisingly large number of intermediates between typical smalls and typical larges around here now. Have "clades" broken down? If so, why?

And why have the locals suddenly begun to do Splits? Did I just overlook them before? Or are there "fashions" in display?

Go back into water 11:00 a.m. Patrol all three areas. Visibility even poorer than earlier. Don't see any squid. (Probably really all gone. There has been a lot of disturbance this morning. Lots of kayucos and other swimmers.)

Move on to Matupo in Lemon Keys in the afternoon. Go into water usual spot 2:35 p.m. Clear. Rather calm.

Within a few minutes, come across 8 large squid

Cegla., Apr. 29, 1972, V.

In deeper part of "B" area. 2 ft up in 20 ft of water. Apparently 4 pairs. But one or two of the ♂'s Lo-(es) some moving around. See below.

When first seen, all 8 inds. in Ord, with more or less WS, probably more or less Y. Then one pair starts to Rock. ♀ of this pair does Spread in Ord. Stops Spread. Does RL. Stops. Then does Spread in Ord again. (No trace Z at any time.) Then relaxes. Then a ♂ (the ♂ of this particular pair, I think) starts to approach other pairs (can't tell if he is aiming for ♀'s or ♂'s or both) Assumes lightish colors as he does so. Sometimes finely mottled PH. Sometimes paler, more uniform. Light Ord at/or semi-Pastel. None of this seems to provoke much response. ♂ eventually rejoins "mate". A few minutes later, ♂ of another pair behaves in same way. With equal lack of conspicuous result.

Then there is some (more obvious) "courtship" Among at least 2 of the pairs. Probably 3. Perhaps all. Same sequences performed repeatedly. In much the same way by each pair. ♂ approaches ♀. ♀ assumes exaggerated RL or complete Pie. ♂ assumes what looks like Double Streak from above (I can't see the bottom sides of the animals) or a pattern more or less intermediate between darkish Ord with extreme WS and "Double Streak". Then both inds. relax, at least temporarily. All done very fast.

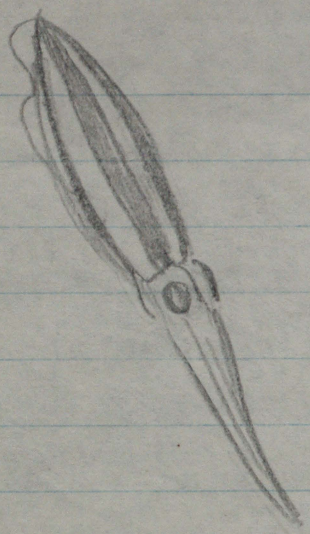
The animals move off 2:48 p.m. I find them again, some yards away, same habitat, a few minutes later All in Ord. No Y. Some with WS. Some without. No other

conspicuous display for the moment. (I do notice, however, that some mids. have light streaks down the center of the cluster of arms while others do not. Of course, I have seen it before, but what does it mean? Is it part of // or close related to WS?)

Suddenly I see that 2 medium mids. have joined group. They would appear to have come from the reef side. A few seconds or minutes later, see 30 mediums approaching from the other side! Coming from deep water. Approximately 10 ft below surface. Group is very cohesive. Mids. only a few inches apart. All comm. with tail first. (All of the larges are facing toward them head on.) There is some but not too much variation in size within this group of 30, small medium to large medium (probably averaging on the smaller side).

This group of 30 "joins" the others (within a few feet). Not much reaction at first. Both newcomers and old timers in Ord, WS, pound, 4. Then, suddenly, the ♀ of one of the pairs of larges goes forward and approaches one of the newcomers. In what looks like Partel (sic!!!). She may even touch the newcomer briefly with the tip of a tentacle. (Is "she" really ♀? I think she must be. The rest of her behavior fits.) Then she retreats with RL. Then her mate advances a little, hangs head down in water, facing newcomers, displaying conspicuous streak pattern on upper surface. Certainly double streak on back and either fin stripe or some sort of streak just below

Jnn.



I can't see if there are stripes on belly or not. Almost immediately the 30 medusins start to drift back in the direction from which they came. Rather slowly, no signs of panic, but also quite steadily. The larger ones then drift away in another direct coin. Soon all lost to view.

I think that this must have been a territorial encounter between groups or (perhaps more probably — vrs I and II at Valmiega some months ago) sub-groups.

The Streak patterns may be quite effective as threat COMMENT: This species does seem to have a remarkably large number of threat, or at least repellent, displays. Why? Are they "segregated by" (primarily adapted to) particular social contexts. RL and Pi by ♀'s in semi-sexual contexts. (Lateral Silver by ♂'s in comparable situations?) Streaks during encounters between groups and sub-groups. Z and probably PH during non-sexual encounters between individuals. (PH also anti-potential-predator.)

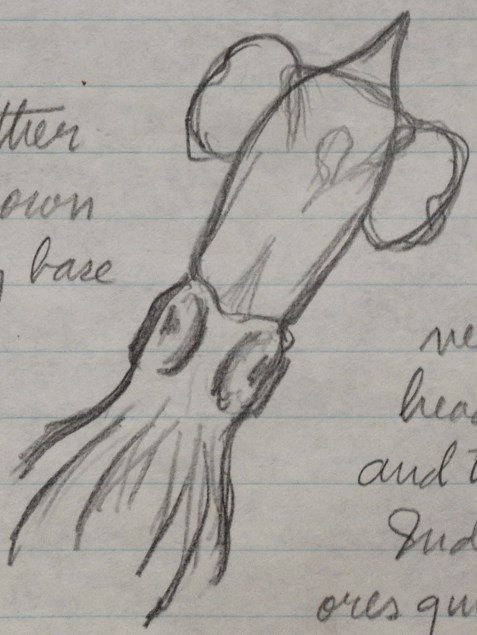
Compare use of Streaks this afternoon with pp. 51-52 and similar incidents.

Stop my own observations 3:05 p.m., when I can't find any of the squid again.

Arcadio continues longer, in deeper water. Sees a group of 9 medusae which may be part of the group of 30 mids. Then sees a group of 28 medusae which may be different (perhaps rather larger medusae on the average). About left down in 25-30 ft of water. Somewhat further on, sees group of approx. mated 50 smalls low in water of similar depth. SEE ARCADIO'S NOTES

There are a lot of Sepioteuthis around now!!! This may be typical of the beginning of the breeding season and/or the period immediately preceding.

Arcadio goes for tow ca. 3:45 p.m. Picks up 2 small squid "hovering" under Sargassum. Almost certainly not Sepioteuthis. Rossia? Very young Lolliguncula?



Usually (?) rather dark reddish brown on top (including base of arms). Ridges above eyes a brilliant, shiny, greenish gold.

Pointed "tail" Rounded fins (usually fluttering very rapidly). Broad head. Sub-equal arms and tentacles. Individual chromatophores quite distinct.

Both mids. were kept in bucket for approx. 1/2 hour. Very disturbed. Usually dark with "Y".

Cepla., Apr. 29, 1972, IX.

One shoots ink, immediately turns pale, darts away. Ink is blackish. (NOTE: This may be the species which shot ink when we prodded Sargassum some months ago.) Then retturns to "normal" color.

Then both turn transparent and die.

(In the meantime, Arcadio, who has been collecting Sargassum to put in bucket, sees another single mid. of the same type in open water.)

Whatever this species is, it must compete with tiny and small Sepioteuthis.

We run a light off the stern for a couple of hours after nightfall. Without success. Apparently, no squid.

April 30 1972
San Blas

Working at Matapo again this morning. Clear, sunny, calm, water beautiful, clear in most places. Start 7:25 a.m. at usual site.

Swim around A and B areas until 7:50 without seeing a single squid. I think that we can say that they definitely are not here now. Then Arcadio and I split up. I go to explore shallows along shoreline. He goes out into deep er water. I stay in shallows until 8:25. See lots of usual anchovetas. Also lots of very tiny, almost larval fishes. But no squid. Most of the smallest fishes are in rather dispersed groups, which suggests that they are not being preyed upon

I

April 29, 1972
Wahuega, San Blas

6:45 AM Northwest side of dock about 20ft from shore 9 inv (small) clustered about vertical floating pole. Their mantle to the pole one pattern Throughout group 3 different sizes 3 small large 3 small medium 2 small and one very small. The Two larger sizes stuck very close to the pole and swayed back and forth with movement of pole The other three remained at a distance of about 2½ feet from pole and floated near surface.
I threw a small sardine in their midst and only succeeded in scaring them. They all turned an extreme velvety black brown, ejected ink and sank rapidly close to the bottom. They did not change color as they retreated nor immediately after calming down. One went with a complete 2 pattern with spread

II April 29 1972

Went back to same place. There are 6 (small large & small medium) around same pole ORD no interacting still swaying back and forth with movement of pole.

2 small medium ind next to bow of TETHYS displaying D.M. (probably reacting to ships proximity). Few minutes later passed two small IND (small med) as ♂ motor to Porpoise both looked ink black and retreating. No ejection of ink.

There have been a lot of ink puffs in the water all morning. Could it be that they are being predated upon or is there an extreme large population inhabiting the area now? 9:15 AM South East side of Island 6 ft of water over T.G. blotch of ink about 14 inches under surface (no squid)

9:25 AM 3 IND (juvenile) one double streaked under mantle & DM with dark tentacles very limp. I noted a fourth & try to get closer to it. It does an E & DS under mantle as he lounges towards me (to scare me off?) then stops turns around and hangs almost vertically very limp, the underside of his mantle to me & DM (I can see it through the mantle) goes ORD Turns to me & does E. There were two IND close to the displaying IND

III April 29 1972
Wallenega, San Blas

one in PH and the other looking nondescript and bored
10:15 around the island with sea sled, did not see anything. end of dive at 10:45 a.m.
Wiatupo 2:32 pm Start dive in usual area & water is clear (about 35 ft visibility) no squid on shallows. & head for deeper water. & spot group of 8 large IRD almost immediately, they are down very close to the bottom. (coral, sand & some rubble) they are hard to detect amidst the coral ORD with us. & leave Martin with them & go to survey another area, didn't see any. back to where & first saw them. The first group is still there plus a group of juveniles 32-34 incl, Younger group heads away from older-original group and goes into deeper water but staying about 6 ft from the reefs they all follow very disorderly with the smaller inds on the lead. & loose them and a few seconds later 9 incl from that same group pass me

going down the channel between the two islands towards where the TETHYS is anchored. Moments later a group of 22-30 going 1100 swims past and right below me close to the bottom (same group?) They look a little bigger. I follow them for a short distance Then I notice a group of 50+ juveniles down below me very close to the bottom in about 25-30 ft of water OKD with a lot of arm spreading. They are spread all over the bottom and hard if not impossible to count.

Second Sea-sled dive: 330 pm around smaller island (small Miatupo?) I am still trying to familiarize myself with its operation so I concentrate more on getting used to it than making observations Down to about 65 ft over varied bottom.

Almost near starting point I run into two very small squids (obviously not Sepioteuthis) about 14 inches from surface under sargassum line. I collect them and brought them back to ship.

Third sea-sled dive down to about 40ft for 20 minutes no ink puffs & no squids.

very intensively at the moment.) Then go back to reef area and explore A-B areas again. Still can't find squid. Stop observations 8:40 a.m.

Arcadio stays in water until 8:55. Sees a medium squids near reef, apparently coming from shallows (!). Also 1 medium large and 1 small (not together) along outer edge of reef. SAN.

All this would seem to confirm the hypothesis that large groups of Sepioteuthis break up in the late afternoon or evening, and only (re) assemble [illegible], late the next morning.

9:28 a.m. See group from Jethro. 12 individuals ranging from small to medium (or small-medium). Only 6" down (perhaps less) in water of ca. 10 ft. Basking in sun? All very close together. No more than 1"-2" apart in some cases, perhaps occasionally touching. All except one moving head forward, approaching boat, at first. Even the exception eventually turns around and conforms. The animals may have been in Ord with WS when first seen. As they get closer, it becomes obvious that they are in a pattern which may be closely related to "typical" Ord (see also below) but still slightly different. Back of body rather light ("pale Ord"). WS (still) present, but not very conspicuous because of lack of contrast. The top of the head, on the other hand, is very dark brown or blackish (little or no Y). At one point, an anchovy dashes through the group. At least 2 of the squids react by forward V. Then they gradually drift off again, still staying very close to the surface of the water

NOTE. There have been no pelicans here yesterday or today. Presumably breeding elsewhere. This may help to explain why the squid are so abundant. And also why they can afford to remain on the surface for minutes on end. (There are still some Black Terns around. They may compete with the squids but probably do not prey upon them.)

9:40 a.m. Storm out from Jettys still. Come across a squid almost immediately. In channel between the 2 Miatupos (or between Miatupo and Achutupo). About 4 ft up in 8 ft of water. Area of sandy bottom, with scattered small corals, gorgonians, sponges, etc. No TG. All the inds. might be classified as large, but certainly at the smaller end of the class. Obviously divided (in space) into 2 trios. Inds. usually 1½ - 4 ft apart, i.e. not as cohesive as younger animals.

They react to my appearance by doing a few P's. Probably in "ordinary" Ord (+ usual accessories ?). Then two or three inds. do repeated E's. Some of these in more or less Ord. +. But many with some indication of Pale and/or related patterns. This "Paling" can take various forms. Sometimes just general, more or less all over. In which case, seldom or never very extreme. (Pale-Ord in my conventional terminology.) Sometimes concentrated and extreme on arms (usually most extreme near base of arms, I think). Perhaps I should recognize a separate category of "Arm Paling"???

The precise circumstances in which Paling and Arm Paling with E occurred were rather revealing. With both advances toward and retreats from me. But not by

mids who were stationary. All this would seem to indicate that E is moderately high intensity, produced when both attack and escape tendencies are fairly strong (presumably stronger than in P). Certainly the escape tendency must be appreciable in E's with Pale or Arm Pale.

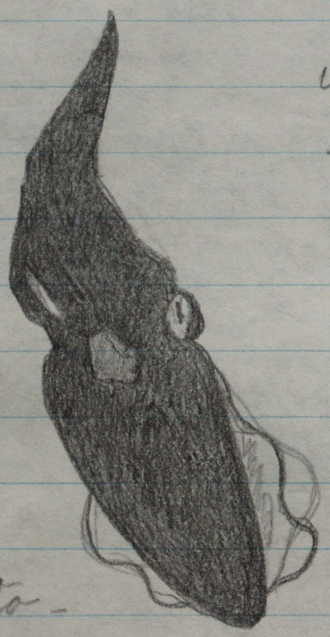
While some of the mids. are going through these Pale-E routines, two others (members of the same trio, perhaps mates) remain essentially immobile, neither advancing nor retreating, quite close to me. In unmentalized postures. But very dark (mostly rich brown) on top, probably all over. No WS or Y. (I can't see the bellies of these mids. at the time, but I should imagine that they were dark like that of the "mimic" described below.) Although the dark coloration of the back is almost uniform, it is possible to detect a trace of a gold streak along the sides, halfway between fins and center of back, in good strong light. Presumably iridocytes expanded below melanophores. Possibly a special signal, possibly not.

These dark mids. are either less excited or less afraid than the Paling ones.

Suddenly a 7th mid. appears. Approximately same size as others. Storms through group, not very rapidly. Provokes PH-Z spread by one of the members of the group as it passes close by. Very brief. 7th hangs around for 1-2 minutes. Then drifts off and disappears from view.

Then one of the mids. close to me does first E and then P in dark coloration. Rich dark brown almost all over, coarsely including bottom of arms, head, and mantle. After it

been in P for some seconds, I realize that it has sunk lower in the water until it is hovering only a few inches over a dark (rounded irregular) coral head. And is also tending to keep its body semi-vertical. P sometimes develops into slight Curl.



Definitely no Y or WS!!!

Note that arms are spread at base (gaps are visible) but tightly pressed together at tips.

The annul retains this position and posture for at least several minutes. Continues to maintain it, even when its companions drift away! It is obviously "mimicking" a branch of coral or some other sessile growth (Certainly not the particular coral with which it is associated at the time.)

The only areas which are not dark are the eyes, funnel, and fins. Both of the latter are almost transparent and very inconspicuous. The eyes, on the other hand, are bright silver and very conspicuous indeed. So are some of the gaps between arms at the base, at least when the light sand is seen between them.

It is evident that I must recognize "Dark" as an important (separate) component of the color repertory. What does it mean? Is it purely a social signal (and/or "auto-signal")? Is it, like some other patterns, partly or wholly, sometimes or always, cryptic or cryptsis???

Why do individual Lepotenthis sometimes flee

from predators and at other times try to hide? It might, conceivably, be significant that I was floating almost absolutely motionless during this last example of "mimicry".

After some considerable time, the "mimic" suddenly shoots away a few yards. With extreme CWch, turning very Pale all over. Notice that it becomes semi-transparent during Pale, only the blue ocelli on the back relatively conspicuous. I don't know what provoked this sudden movement Possibly the animal's "nerve" broke. Possibly it became aware of a cayuco, with motor, passing 20 yds away. In any case, it starts to relax again. At the same time, its companions drift back. Also disturbed by cayuco?

New thought. Is it only isolated inds. (although not all isolated inds.) which attempt to be cryptic?

All the animals are relaxing now. Back into Ord. (sometimes +). Only occasional E's and/or P's, with few or no color changes.

Stop observations 10:00 a.m.

COMMENT: There was absolutely no trace of "courtship" among these 6-7 inds. this morning. Are they still (slightly) too young? Does sex occur only near the shelter of a reef or something comparable?

Continue to work at Niatupo this afternoon. Still sunny, but now windy. Low tide. Start 1:10 p.m. Explore usual A-B reef area and environs. Also drift lines. Nothing. Stop observation 1:40.

Comment. The squids would appear to have

abandoned this O-B area almost completely today. Both in smooth and in rough weather. Why? They are inconstant in their preferences

4:58 p.m. Near adjacent small island (Mat upo Pequeño or Achutupo. Arcadio is being towed when he sees a large or medium-large squid. I go in to water to see them too. 3-4 ft down in approx. 7 ft water. Sandy bottom with scattered coral, rubble, etc. Inds. in Ord with WS. Little or no Y. Some traces of P. Then all the inds. turn Dark. Davo do E in Dark. Then one P's in Dark. Then there are more E's in Dark. I can see that Dark usually or always extends over lower as well as upper surface. And even the fins are dusky in complete Dark (although somewhat lighter than body, lightest at edges).

One ind. does brief Pk, with DM spot on one side of body only (!), when a medium sized fish passes close by unidentified, overhead.

One ind. shows Arm Pale on Dark as it advances a few feet toward me.

Inds. retain more or less Dark for some time. But perhaps starting to relax. At least fixating me less continuously (but perhaps Arcadio, who is photographing them, is a distraction). In any case, they start to do E's and P's more frequently, still in dark, after a few minutes.

Once they interrupt this behavior by a somewhat surprising maneuver. All shoot backward toward me,

"displaying back". In Ord with conspicuous WS and Y. Perhaps this is a reaction to some move by Arcadio. In any case, it is brief. After a few seconds, the annuals go back to Dark and E's and P's.

COMMENT: I have no idea what really provoked all this Dark. Is it possible that Dark is partly a reaction to strong sunlight? Certainly the water is as clear here today as I have ever seen it.

NOTE: This area is not very far (20-30 yds) from where I saw the group of 6-7 mids. this morning. Could it be the same group. The problem is that these 8 show very little sign of pair structure. If they are sub-divided, it is into 4 pairs. No trace of trios at the moment.

COMMENT: These annuals have shown absolutely no trace of "courtship". It would appear that the local population has not yet advanced very far into the breeding season. Perhaps next month?

Then we go on to Holandes Keys. Ogupuksip. Same place we worked March 24-25.

Go into water 4:10 pm. Lots of Sargassum around, so we decide to follow drift lines. Water fairly clear, quite calm. We swim around for 10 mins. without seeing anything of interest. Then Arcadio goes for a shallow tow. A long distance along a drift line, past the site where enormous pair seen last month. Then, some yards further on, 4:35, comes across large group 33+. Of these, 11 are medium, or small medium. The re

mainder range from large medium to large (quite a nice ly graded series). Including at least 3, probably 5, pairs of larges. Ranging 2-10 ft up in 20ft of water. Very varied bottom: sand, coral, sponges, rubble, little or no T.G. Lots of fish, including large ones.

The social organization of the group is very complex. The smaller mids. tend to remain slightly higher than the larger ones. All usually very close together, only a few inches or feet apart (but see also below). This is remarkable as part of the assemblage is a very high intensity courting party!!! At least 3 of the pairs of larges are engaged in active and long sustained copulatory behavior.

In the next few minutes, we see many, many cases of Rushing, brief pursuits, etc., by members of pairs. Also at least 4 copulation attempts, involving 2 pairs. At least two of the cop. attempts apparently successful!!!

The color patterns assumed by the various animals were diverse, highly ambivalent in many cases, at least among the larges. It is my impression that the smaller mids. did not do anything exciting. The usual assortment of Ord, WS, Y, Bomb, PH, Pale Arm, etc.). The larges managed to produce almost all combinations of hostile and sexual patterns. I paid attention only to those engaged in copulatory behavior. They were so active that it was almost impossible to follow them; but I think that the following notes may be a fair partial summary:

When they were swimming together (which was all the time in most cases, perhaps only almost all the time in one case), the members of copulating pairs of Cangos showed the following ranges of color patterns:

Males: Pastel, PH, Ord., Double Streak (on back) with Fin Stripe (unfortunately I couldn't see belly), and almost all possible combinations thereof.

Females: Pastel (at least semi-Pastel), PH, Ord, RL, Pie, and almost all combinations thereof.

Members of pairs coordinating movements very closely. Swimming both backward and forward. ♂ usually behind and below ♀. Sometimes in front, especially when there is a change of course. Only very infrequently above.

Some or all pairs of Cangos engage in vigorous courting while they are in the middle of the group. But this seldom leads to an actual cop. attempt. Merely Rocking and chasing. And the ♀'s do lots of RL and/or Pie in these circumstances. (NOTE: I did not see a single cop. attempt this afternoon while the ♀ of the pair was in RL or Pie, or even shortly after she had been in either pattern. RL and Pie must be very discouraging!).

The cop. attempts occur within pairs which are on the outskirts of the group at the time. Sometimes only 1-2 ft away from nearest neighbor. Sometimes 4-6 ft away.

Successful cop. attempts take following form: ♂ suddenly shoots forward, head and arms first, and

(his tentacles (and arms) to "forehead" of ♀. He is in Pastel, perhaps initially dull Pastel, or (Pastel-PH) at the time. She is in dull Pastel or (Pastel-PH) or (Pastel-Ord). His dashes forward are accompanied by fluttering. (Perhaps he starts to flutter long before.)
NOTE: I was amazed that the color changes accompanying copulation were not more spectacular. Is this typical? Perhaps so. Viz. cop. seen at Rialto a couple of months ago. Presumably the cops can occur only after the inds. have begun to feel secure with one another. No need for the most extreme color patterns which are signs of conflict or motivational stress.) After the ♂ jabs his tentacles at her, and presumably attaches his spermatophore, the ♀ starts to fiddle with her shorter arms, presumably readjusting the packet. Then the two animals resume swimming as before. Often without any great change in color pattern(s).

NOTE: I did not see any pair copulate successfully more than once this afternoon. Probably (?) because I was distracted by trying to follow too many individuals simultaneously.

The apparently unsuccessful cop. attempts were not very different from the successful ones in some aspects of form. Only the ♂ apparently did not make contact. Accelerated toward the ♀, twirled his arms toward her, perhaps extended them, but not to their full extent. Certainly some ♂'s made several unsuccessful attempts

within a few seconds or minutes. And one of the successful attempts was made by a ♂ who had made at least two unsuccessful attempts previously.

With one possible exception (one of the 2 incidents described below) I saw nothing like an attempted exchange of partners among the courting pairs. Pair bonds would seem to be strong in this species.

The smaller squid did not pay any obvious attention to the sex occurring all around them. As usual, I wondered why they were there. Arcadio, however, noticed that the larger followed the smaller mids. whenever the latter made a marked change of direction. Perhaps the younger mids. are acting as "sentinels." (Obviously advantageous to the large. Also to the young. Brock and Reifenbergh effects. Kin selection.)

Quite a large number of fish of various sizes, including large ones, moved through and around the group of squids almost constantly. The squid ignored them. The squid paid less attention to their neighbors this afternoon than I have ever seen before. Presumably an indication of the intensity of their "preoccupation".

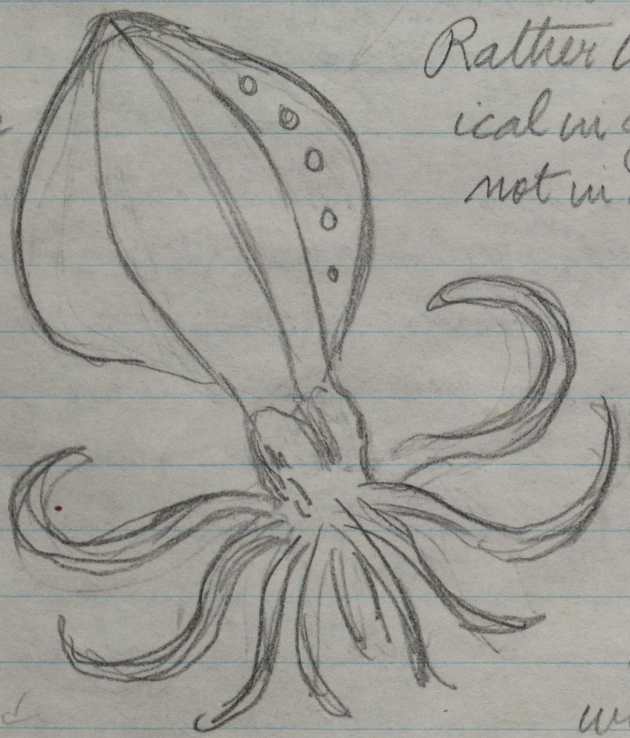
I stop observations 5:00 p.m. to rush back to the Jettys to start writing. Arcadio stays behind to make more observations and to photograph.

ADDITIONS: The course of events described above was interrupted by two kinds of hostile behavior while I was still in the water:

Once, all the mids. in the group turned to face me in Ord, WS, Y, and Pale Arm. Then stopped Pale Arm, continued Ord, WS, Y, for some seconds more. Presumably I had done something to alarm them.

NOTE: None of the mids. in this group ever did either P or E this afternoon! Why? Presumably because of their preoccupation. They could not have been paying any serious attention to us.

There were several peculiar "I incidents" in the midst of the "counting"



Fins appear to be broader than usual (i.e. moved less than usual?)

Rather too symmetrical in general, if not in all details.

The two outer pairs of arms appear to be sub-equal in length. I am not sure which are the real tentacles.

Suddenly one individual was seen hovering close above another. Both in extreme Spread as shown above, both facing in same direction. Bottom mid. in extreme

Z. All over, both body and arms. Bold black markings, separated by extensive white (ponder silver ?). Upper mid. in "Dark Z" on top (unfortunately can't see under side). Like conventional Z, but dark markings much more extensive, almost running together on back (and head). Probably some trace of WS retained, and less reduction of white or silver on arms. This is also very dark on the whole. Only a few large light ocelli, extending in line, down center of each fin (again see above). The two mids. stayed this way for some seconds. Not moving much, except for some waving or writhing of arms. Then stopped. Spread to Z to Dark Z, darted away, still more or less together, in extreme pale.

I saw performances of this type at least 4 times. Couldn't see what started them. Upper mid. in Dark Z always smaller than lower mid. in ordinary Z or above ♀. Rape attempts? I think that one presumed ♂ performed in this way with 2 presumed ♀'s in rapid succession, but I may have become confused. All very strange.

ADDITION: After I left, Arcadio saw two more apparently successful copulations. SAN

5:20 p.m. Arcadio coming back to Jetty 3. We see that there are at least 18 small Sepioteuthis by the ship ladder. Not far below the surface in deep water. Rather scattered (perhaps by approach of motorboat).

Running lights at night. A moderate number of

small fish show up. Then, 7:55 p.m., 2 large Sepioteuthis is appear. Circling around. Apparently not courting. Often back to back. Do some feeding. Also PH. Also peculiar V-Curl, perhaps with some spreading. SAN again.

ADDITION: Arcadio caught a large Red Snapper this afternoon, shortly before encountering group. Its stomach was found to contain a squid. Partly digested. But right size, and mantle right shape, for Sepioteuthis.

May 1, 1972
San Blas

Still at Ojupeke Summ, but Winds increasing morning. Start out 7:38 a.m. Arcadio goes on shallow tow. Arrive area of large group (which I shall call ϕ) 7:47.

Group is there (still or again). Now numbers 28 inds. Difference is due to mediums. There are fewer mediums with the group now than yesterday afternoon (possibly the group is still reforming. With the smaller number, it is obvious that the larger inds. include at least 5 pairs, probably 6 or 7 in fact. Inds. small, ranging 2-4 ft up in 6-7½ ft of water (slope is steep here). Over a variety of bottoms. Patches of TG as well as sand, coral, rubble, etc.

When first seen, all or most inds. in Ord, WS, Y, and low intensity Pale Arm (i.e. pale streak down center). Obviously slightly disturbed by our approach. But soon re

I

Matupo San Blas
April 30 1972

Usual area, start dive at 7.27 AM
went straight into deeper water 30-40 ft
range, no squid. Then in shallow
7-10 ft motoring back to deeper water at
7:50 AM visibility 40-50 6 IND coming
from shallows medium small about 6 ft
under surface travelling mantle first
ORD with W.S. They see me and go down
to about 5 ft off bottom. Depth here is about
20-25 They start moving back and
forth facing me. They are spaced about
5 ft. apart and swimming forwards and
backwards like so ~~~~~
and doing curls & C when moving
tentacles first. loose them group of blue
runners seems to have scared them away.
They did not seem to be going into deeper
water. 4 Minutes later one IND. FROM same
group? PH with WS & DM swimming ~~~~
tentacles first and curl motues see and
does DM Tweed goes deeper and swims
~~~~ back and forth RL with PH
& DM loose it at 30 ft blue runners in
~~~~

area. I don't think it went into deeper water I notice a large barracuda in area. It's The second time I seen wite this same IND in the last half hour. I follow The barracuda trying to scare her away Then noticed 3 very small ink puffs. probably from a very small or several very small squids. 8:35 2 puffs of ink one close to surface Then down to about 8 ft looks like squid squid again but did not see any. 8:38 one juvenile Lepidotheutis PH & WS does a split Then starts to retreat from me. It's about 7 ft from surface with bottom at about 30 ft I follow and goes into open waters (I can't see bottom) 8:45 still following it it takes off but I keep up with him. Turns whitish while moving and goes PH whenever it stops. Takes off again going whitish Then starts teasing dark as if it where going to ink. I try to induce him to do so and I try to come closer. It sounds and I follow Then surfaces and darts out of sight. End of dive at 8:48 AM.

9:38 AM Small Miatupo 7 ft depth 30-40 visibility. Area where I found 2 new specimens yesterday. no squid

10:18 AM group of eight medium large

III

Mamitupo, San Blas
April 30, 1972

about two feet from bottom 7-8 ft deep coral & sand one PH very close to a light brown coral. The rest are ORD some E. One RL and its partner pales and Double checks both swim back and forth then they relax again and all is normal. They are all in line facing me. More E & curls when they move tentacles first, very Dark ORD. Suddenly they all pale turn at right angles and make a two foot dash towards deep water. Then stop & go ORD and everything goes back to normal. They repeat this again a few minutes later when a grackle flying overhead cast its shadow in their vicinity.
A lot of debris on seafloor is passing over them and they all become interested curls & E with a lot of fluttering of fins I cannot see their pattern. Suddenly four rid go into E with fast fluttering of fins with their tentacles staying away from all. Mamitupo 1.07 pm usual area. Went on deep water area

 April 30 1972

making one long circle along its perimeter
Then back into shallows 7-10 ft no
squid. 1.33 pm one small puff about 20 in
under surface in 20 ft of water. end of
survey at 1:45 pm. Shallow tows from
study area in Miatupo to small Miatupo
lots of ink puffs in the water in
vicinity of area where I collected
Two small specimens. Spotted one juvenile
Sepioteuthis but nothing else. Kept going
East of wreck and found the same
eight ind I had seen earlier Today
Took about 24 shots of TRIX Hasselblad
white pictures. end of dive 2.20 pm
ogo per kip (Holander Keys) 4:07 pm
Follow line of sargassum for 10 or 20
minutes, Then decided to go on tow along
same line no squid near it or under it.
Arrive to SW. end of island windward side
and see into 35 or so ind from
med small to extra large. The large ones
are courting, not much group order except
for younger members of group, who are
keeping pretty close together and more or less
leading the group from one place to another.
Part of their pre-copulatory display seems
to be a flashing from dark pale to light pale

V

Ogopa Rip San Blas
April 30 1972

very quickly, like fluttering as he approached her from one side and tried to get under her, I also noticed that the female extends her inner tentacles out 1" to 1½ inches Then retracts them after copulation or perhaps if it loose interest. One perhaps two successful acts of copulation Both times male approached female from left side and under pushed with some of its arms into arm base of female. After both attempts I noticed female moveing her short arms as if rearranging spermatophores

lax. Almost all the larges begin low intensity "courtship" Pairs moving around close together. Quite a lot of RL and Pie by ♀'s. Some Pastel and semi-Pastel by both ♂'s and ♀'s. Lots of obviously hostile patterns. Some Darks and PH's and intermediates between the two and between either or both and Ord +. Also quite a lot of Spreads. Some low intensity. These can be performed without any change in color of the arms (remain ordinary Ord color). Others moderate intensity. With definite Z od arms. But I see that arm Z can sometimes be combined with Ord, WS, or back. These various hostile patterns can be performed by either or both the ♂ and ♀ of a pair. But they tend to be performed much more frequently by the ♂'s. The ♂'s are obviously "defending" the ♀'s. I see a couple of nice cases of a ♂ switching from one side of a ♀ to another when she is approached from the "far" side.

Again, there is no E or P during intraspecific encounters. Very clear indeed. See also below

The general arrangement of the group as a whole is not very different from yesterday. All mids. usually quite close together, only a few feet (1-4 body lengths) apart. Pairs courting most vigorously tend to be on outskirts, sometimes stray slightly further away, but never more than a couple of yards (this morning). The smaller mids. form a definite sub group. Sometimes slightly higher in water than all or most of the larges. Sometimes at one end of the group. Group in general sometimes a line, sometimes a cluster. There is constant but not

usually very rapid "milling around." Despite all this, the group as a whole is quite sedentary. Brief mass movements in one direction or another, occasional drifts, but never go very far. Why is this area more attractive than any other?

Sexual and pairly sexual behavior certainly is less frequent and/or less energetic this morning than yesterday afternoon. Possible diurnal rhythm?

Fish milling around in or near group.

Everything rather quiet 7:58.

See some Spreads with trace Pale Arm but no other color change (rest of body Ord, WS, Y).

Watching one particular pair. Call them "♀A". On outskirts of group. They seem to be peculiar in one respect. The presumed ♀ is not larger than the presumed ♂, possibly smaller if anything. Swimming and Rocking together. "♀" does RL in semi-Pastel. "♂" in Ord, WS, perhaps Y. Both have slight Pale (center) Arm. "♂" stays behind and below "♀" almost all the time. But, rather surprisingly, they seem to be sharing "control" of direction of movement. Sometimes "♂" follows "♀", but sometimes also the reverse. (This variability may be correlated with the slightness of the sexual dimorphism in size.)

In other pairs, the ♂'s also tend to remain behind and below the ♀'s. With more constant "control" of movement by the ♀'s.

8:04 a.m. Large Barracuda appears 10-15 ft away. All the squid turn Pale and shoot away. (NOTE: "Pal-

ing" may be adaptive in almost all circumstances, against all backgrounds, simply because it does greatly increase transparency.) But everyone comes back almost immediately.

Following what seems to be pair ♀A. Same size relations, same behavior as before. And they occupy the same geographical position vis a vis the others of the group as before. Does each pair or individual have its preferred "station" within the group? If so, it indicates a very elaborate social structure.

Watching ♀ of another pair 8:10. She seems to be in Pie almost all the time.

Another ♀ is in Dark. Does vigorous Writhing. Notice that both her mate and an adjacent pair are also in dark. (WS seems to have disappeared almost or absolutely completely in two of the individuals).

RL and Pie becoming rather more common now (again). The reaction of a ♂ to RL or Pie by his mate is quite characteristic, stereotyped. He assumes Double Streak on back with Fin Stripe on sides. The "WS" with Double Streak is remarkably conspicuous. Related, broad and very bright silver, much more so than in WS combined with Ord. In one case, at least, there were no stripes on belly in Double Streak - Fin Stripe.

NOTE: The water is really quite murky here now. Lots of sand and mud stirred up by feeding fish, our anchor, etc. Doesn't seem to bother the squid.

COMMENT: The groups, and even the constituent indivs. are really quite remarkably sedentary on the whole. No great

"coursing" back and forth over wide loops like some of the mids. seen at Pomeroon (and Mahaica?) last year.

See a ♂ do E (w Ord+?) as fish passes by. Obviously provoked by and directed toward fish. ♀ E? definitely interspecific. Very nice.

♂♂ of ♀A pair courtships. In Ord (+?).

Notice that both ♂'s and ♀'s of all or most of the pairs tend to keep their arms slightly spread at the base, more so than usual, even without color change. This could be an attention movement of spread and/or (more probably) an indication of sex, getting ready to transmit or receive spermatophores.

8:18. RL's and Pics temporarily less common now. Only 1 ♀ in nearby constant Pic

One ♂ does Spread with extreme Z on arms, Pt on back. To neighboring ♂ or pair.

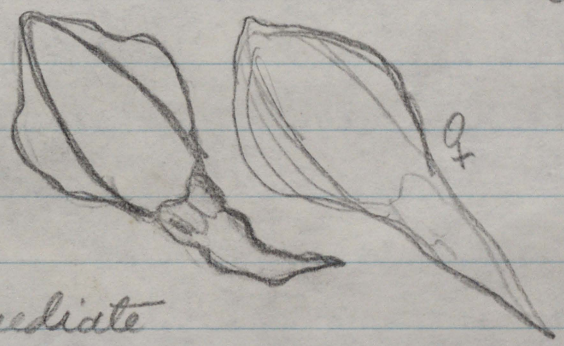
Aha! Joint copulation of the day seen by Arcadio. ♂ does rapid Fluttering, Pastel Fluttering beforehand. Cop. successful? (NOTE: These mids. obviously take some considerable time to "warm up" in the morning.) The ♀ may have done RL before (some time before?) the cop. It would be nice to see further sequences of the same sort for confirmation. SAN.

Watching another pair. Rocking together, sometimes close, sometimes rather far (3 ft - 4 ft) apart. ♀ once assumes extreme Pastel when the distance between the 2 mids. is

greatest. Then Pie when closer. Then subsides into Ord, WS. He goes from Double Streak - Fin Stripe into Ord, WS.

All fairly quiet 8:32

Watching a pair which may be ♀A. Behaving in a way which I would expect to be post-copulatory (or characteristic of periods between copulations). Swimming and Rocking together, ♂ with "Bent" arms. ♂ sometimes in Ord & WS, sometimes in "Granular PH" (see below) and/or intermediate between PH and Ord & WS.



♀ in intermediate between Ord & WS and Pastel.

Then the ♀ Writhes conspicuously. ♂ switches from side to side of her, to protect her from "intruders". Then the ♀ also Bends, toward her mate. At the same time, she begins to show trace of RL. All very ambivalent

Stop my own observations 8:45 a.m.

COMMENT: I am beginning to worry about "PH" type patterns. "Typical PH" is characterized by bold semi-stripe-like blotches of relatively large size. But there also are yellowish patterns with much finer markings. I have been assuming that there are intermediates between typical PH and Ord and/or Pastel. Is this assumption justified? Or is there a distinctive "Granular PH"??? Must check.

Arcadio stays behind a few minutes to continue observations of ♀ group. Sees a couple of cop. attempts.

When he returns to Tethys, we see a large mids in group right next to ship. Arcadio watches them feed, etc.

SAN.

Starting out again 11:15 a.m. Back to ♀ area. Weather unchanged. Water still rather murky. Find group almost immediately. Still contains 26 mids. Still over mixed TG and other bottoms. All mids. in Ord, WS, Y, and Pale (center) Arms at first. Some P in Ord +, to us. Relax almost immediately. Resume "countstrip", sex and hostility. RL's, Pies, Darts, Spreads, "PH"s, etc.

One mid. does E in Ord + (to us?). Then another E to (Jaring) Jerk passingly.

Suddenly there is a burst of ink in water. At same time, whole group darts a few yards sideways. Can't see what provokes this. Animals relax. Then they all shoot out into deeper water, hover about halfway up. In Ord, WS, Y. Again a release of ink. Why? Is there a Barracuda around? We can't see it. After a minute or so, the squid relax, drift inshore to previous area, resume "countstrip".

11:24. Two cop. attempts. A pair swimming around in group. Often near middle, seldom on border, never far out. Going back and forth and Rocking as usual. ♀ in semi-Pastel or Ord-Pastel. ♂ in ambiguous color, sort of intermediate between Ord and (Granular) PH, perhaps with a touch of Pastel thrown in. ♂ makes two forward copulatory "passes"

of the usual type, at intervals of about one minute. First definitely makes contact. Second may have missed. Both probably unsuccessful. ♀ makes no attempt to arrange anything (spermatophore) with shorter central arms. Neither cop. attempt is accompanied by any conspicuous color changes. (Again notice comparative unimportance of color in some cops!). But then, some seconds after second attempt, she does RL-Pie as ♂ continues to swim by her side.

Then whole group darts away a few yards. Back again almost immediately.

Then there is a whole burst of "Z incidents", more or less like those seen yesterday afternoon 11:30

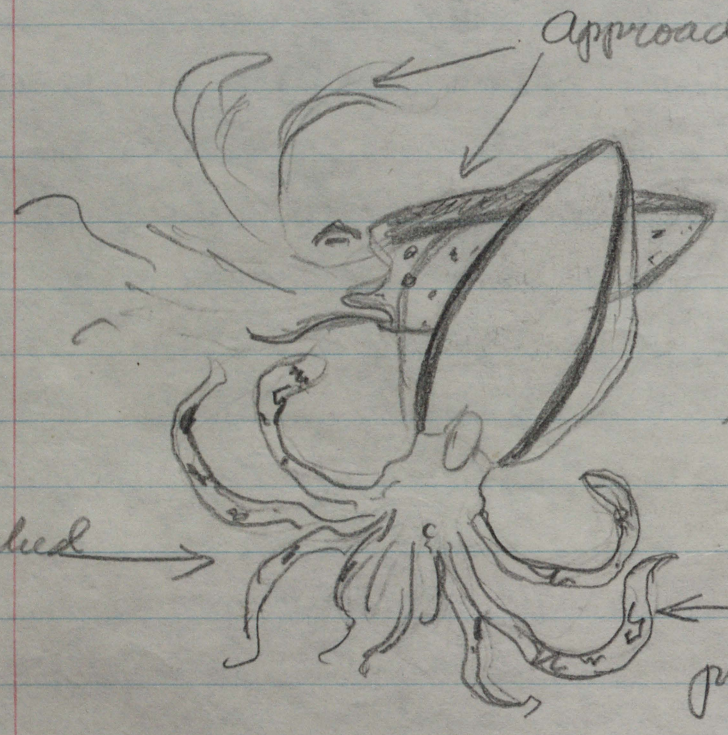
2 encounters involving same ♂. Approaches another mid., assumes dark Z with extreme spread while the other assumes light, conventional Z, also with extreme spread. (It is impossible to tell which assumes pattern first.) Then the upper armed moves off. Lower goes pale and retreats. Original "aggressor" moves on to third mid. and repeats performance in same way.

Then I see several more (4-5?) performances of the same type, involving the same or different individuals.

Certain regularities become apparent:

The "aggressive" mid. (I shall call this the "approacher") goes straight to the approached. Always gets above the approached. The two mids. assume their characteristically different Z patterns almost or absolutely simultaneously. The approached usually up ends, tail up, almost immediately,

while the approacher remains approximately horizontal. As a result the tails of the two animals meet or overlap while their front ends remain several inches apart



I get a good view of patterns on undersides. Both have very conspicuous Dri Stripes. (Are Dri Stripes characteristic of all 2 patterns, or all 2's which extend to the body???) The lower animal, the approached, is light below (just plain light, not silver, or pastel). The upper animal, the approacher, is light below with rather sparse, scattered, small black spots. If there is any difference in the width of the Spreads of the two animals, it is the lower, the approached, which has the wider. (I am not sure that the Dri coloration of the upper ani., the approacher, is always the same in all circumstances. Always largely dark above. But perhaps not always

marked with prominent light ocelli as described yesterday. (Certainly some Dardus or other kinds of encounters have dark fins without prominent ocelli.)

The animals involved in these "Z incidents" always stay together for some seconds. Then the lower, the approached, always darts away in more or less extreme Pole.

What is the point of this behavior??? In one case, an approacher shot his tentacles and arms toward the upper (central?) forward border of the mantle of the approached just as the two animals separated (the lower going forward, the upper backward). This shooting of the tentacles and arms might be copulatory. If so, these encounters might be "rape".

Arcadio saw one of these encounters in which both animals may have been males. In all the cases I have seen clearly, the approacher was smaller than the approached. I.E. presumably males attacking females. N'importe.

If rapes do tend to occur as the day wears on, this must be because the ♀'s tend to become satiated.

In one case, I thought that a presumed ♂ who had just attempted a presumed rape upon one presumed ♀ immediately (sic) joined another presumed ♀ after the rape, and then swam peacefully with her for some seconds or minutes. Thus, the "rapers" would seem to be mated rather than unmated. Unsatisfied rather than unattached.

(This hypothesis may be supported by other evidence. There does not seem to be a "surplus" of adult ♂'s in

this group now — in contradistinction to some other groups seen elsewhere at other times. When the situation is not confused by the supposed rape attempts, the barges here tend to go nearly two by two.)

In one incident, a presumed ♀ which had just been "raped" or attempted, rejoined her own presumed mate, and swam in RL with him.

COMMENT: Perhaps the above description is not quite clear. It may be useful to recapitulate in part. The "Rape Z incidents" seem to have several diagnostic features: 1. Both Z and Spread patterns are very extreme. 2. There is always one ind. above and one ind. below. 3. The upper ind. always assumes a characteristic Dark Z. Hostile Z encounters in other circumstances, e.g. between males in counting groups apart from rape, are rather different, perhaps lower intensity. Spread tends to be less. Z may be confined to arms. There is less (perhaps no) tendency for one ind. to position itself immediately above the other.

Perhaps the "quality" of the Z motivation is much the same in all cases. Only the relative or actual strengths may differ.

Stop observations 11:40 a.m.

NOTE: The members of this ♀ group do not seem to be feeding now. An indication that they probably do die after breeding.

Start out again in afternoon. 3:10 p.m. Weather still the same. Sunny and somewhat rough.

Go to ♀ group area. Find animals almost immediately. Now approximately 22 inds. In much the same range of habitats as before. All react to our appearance by usual Ord, WS, Y. The ind. nearest us also does brief conventional PH

Apparently, there is still some "courting" in progress. See several pairs. Some RL-ing by ♀'s

The water is particularly muddy now due to actions of a school of 6-7 fish feeding on bottom. Don't know the species. Gray with yellow streak along sides, yellow tail. According to Arcadio, rather like "bonehead" in shape. But these fish are definitely grazing (while boneheads are supposed to be carnivorous)

The fish are staying close to some of the squids. They seem to be so active and to have raised so much silt that they have split the squid group. Now there are only 13 squid near me. All large or medium large. Not doing very much. It appears that they have almost lost interest in sex. All passion spent. Certainly they are much less active in "courtship" now than earlier in the day or yesterday afternoon for that matter. This is a rather rapid decline!

Squid nearest me does DM with alternate conventional Ord, WS, Y.

The grey and yellow fish go away several times but keep coming back. They would seem to be definitely associating with the squids. Why? And why do the

squid "allow" it? (The fish are considerably larger than even the largest squid.) More sentinels? Or just apathy?

Some of the squid do P to me in Ord+. Then one or more ♂'s do(es) more RL + Pie.

All quiet again 3:30. Only the usual forms of low intensity intra-specific and anti-potential predator hostility. So I go off to look for more. Find group of 12 smaller squid about 20 yds away, rather low in somewhat deep water. This is obviously the "other half" of ♀ group. All very placid. I go back to larger half. They dart off and shoot ink when Arcadio tries (unsuccessfully) to spear fish. But they don't go very far.

3:40. The 2 halves of ♀ group are still keeping their distance from one another. (Is this typical of "afternoon break-ups"?) Only very low-trades of "cowlstup" now. Pairs still visible as such, but only occasional Rocking and/or weak RL.

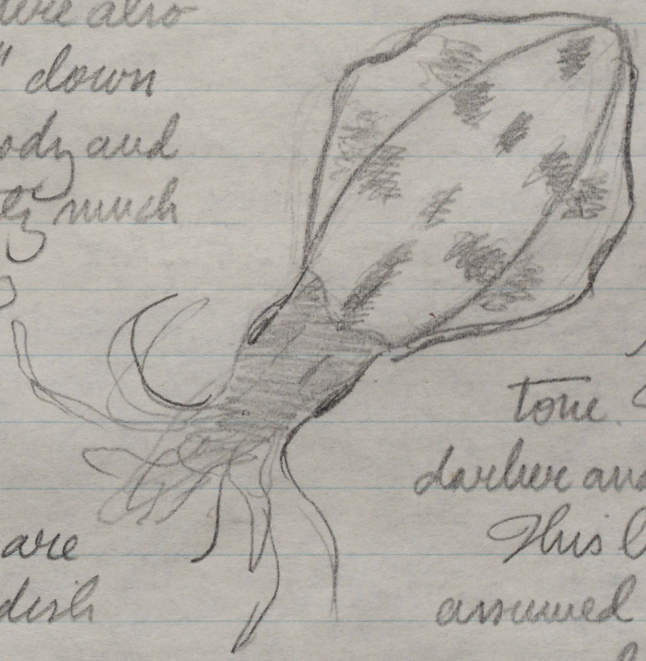
None of the larger pays any attention to small fish swimming overhead.

Stopping observations 3:50 go on to nearby island of Macalubes. Arcadio goes for shallow-water fish 3 small-medium squid in 4 ft of water TG area, but can't follow them. Then one both tow. Nothing.

Stop observations for afternoon 4:50.

NOTE: Large squid have approximately 17 ocelli on each fin. In a row. Ocelli are largest at center.

Running light at night. Groups of 6 Sepioteuthis appear, go off. Then a single ind., which Arcadio nets. We let this go back in water, where 3 others have appeared. All these inds. have been large. And behaving most peculiarly. Sometimes in Ord, W.S.Y. More often in very extreme, possibly aberrant, form of "conventional" PH. Dark blotches of three "bars" reduced to little more than 2 spots on each side. Side blotches "extend" onto fins. There also "dashes" down rest of body and apparently much ordinary stuff



Blotches are dark reddish

are some dark center of back. Fins is light, lighter than in PH, but probably rather yellowish in tone. Head is somewhat darker and not blotched.

This light PH tends to be assumed just as the animals approach the electric light. They also start to move their arms in remarkable ways at the same time. What look like all sorts of combinations of Curl, V, and Spread (no Z).

I should have supposed that all the light PH, Curl, V, and Spread patterns were purely hostile. But sometimes a squid performing these patterns shoots out its tent acles and catches a sardine, which it then proceeds to eat. The sardines caught have all been swimming near the surf

face at the time.

Very surprisingly, Arnadio says that the larges he saw swimming in open water this morning also fed in the same way, with the same distinctive PH and arm movements!!?!!

What can be the meaning of this? Is it a peculiarly adult form of feeding? Of feeding during the breeding season? Of feeding on certain foods in certain places? Or are all these animals both frightened and slightly irritated in these circumstances? I think the last, but it would be hard to prove.

9:07 p.m. Three larges still at light, still moving and occasionally feeding in the same way.

COMMENT: Looking both at the squid and at my drawing of one on the preceding page, it strikes me that the dark "eye spots" of DM must be related to one of the "bars" of conventional PH.

NOTE: I saw 3 pelicans flying around this island today; but it is still true that they are relatively rare now.

May 2, 1972
San Blas

Still at Ogupukip. Start work at PA area 8:10 a.m. Sunny and rather calm. Find PA group almost immediately. Now consists of 15 inds. 4 (possibly 5) real larges. The remainder range gradually from large medium down to small medium. Animals approximately 5 ft up in 15 ft of water, ov

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Ogopukip, San Blas
May 1 1972

May 1 1972 7:30 AM Tow from one end of
Island to other, scan into school group as
yesterday. Some of the medium small squids
are gone, only 28 ind left 22 large ones
and 6 med small & med large. Some
predators in vicinity. Shoot one snapper
& notice one barracuda & one large grouper
both seemed interested in group. Have had a
lot of grazing fish under the squids
most of the time. Still fighting over right
to copulate with any given female?

Visibility 30-40 ft cloudy and windy. I think I can see the ground in front of the ind. but I am not sure. Photographs 12 to 36 end of dive 9:00

9:15 6 ind under TETHYS. They seem to be attracted by sea-sled floating in back of ship, they stay close to it. They are taking the fish scraps thrown overboard by Dick who is cleaning snapper I shot earlier. There are a lot of arm displays splits, curls with V, extend curls of all arms PH pattern & pastel end of dive at 9:38 am

9:50 AM Deep tow with sled. Went for about 1 Km in about 40 ft of water along bottom of reef 6 large squids at about 30 ft. and 300-350 meters from starting pt. End of tow 10:30 AM.

Night Observations: These observations were made on the night of April 30, 1972 Starting at 7:30 pm. A pair of Sepioteuthis appear under the light. They approach the light one behind the other. The first one tentacles forward doing a V with curls, the second one moving in mantle first with its 2 tentacles trailing longer than usual. At 7:44 pm one takes a sardine and the other at 8:20 pm Sometimes when

approaching any object (Sargassum, small fish or the light itself). They will do an extreme curl of the tips arms radiating from mouth as outer very reminiscing of the antlers of a stag. I see one do a split. First time I see a mature specimen do it. The first attack I witnessed this evening was done with tentacles forward. That is the tentacles end of the squid were facing its prey before the attack began. On the second, the squid had its mantle pointing to its prey before beginning attack. it shot forward and at the last moment turned around and grabbed the fish with what seemed like very little effort. The color pattern at night is rather baffling. whitish with a reddish brown uneven banding across, no white shark, just some vestige of Drs. Could it be PH under artificial light? They seem to seek the sea-sled for protection. They always approach the light from the direction of the sled. Usually, they start close

to the surface and gradually sink as they approach the light. Most feeding tentacle first twice with DM & PH with W.S. one died shot ink PH with no W.S. It was really a half assed attempt to protect itself from god knows what. It did not retreat after releasing ink but remained in same place surrounded by its own ink smoking like a flaming idiot Ridiculous! When the boat swings into shallow water, the squid do not approach the light and I loose sight of them. When the boat again swings into deep water, they return to the light and resume preying.

Night observations. May 1, 1972

Probably same two IND as night before. Tonight they are bolder. They come to the light shortly after we turned it on and all the way on the surface. I picked one up with a dip net and put him in a bucket for a while. Ejected some ink and a mucous white substance which remained on surface. I put him back in water and swam away slowly and resumed preying as if nothing had happened. Tonight they are attacking the fish gathered under the light intermittently. They come into the area and start feeding right away. After a

V

Ogopukip, 1972

May 1 1972

While most of their prey quits the area and they too leave, to resume attack after the sardines have come back to the light. This went on all the Time we had the light on.

er usual curved bottom. They react to our appearance by usual Ord, WS, Y. No "courtship" for the moment.

Arcadio goes off to look for rest of group. I stay. See one ♂ in Ord, WS, Y, and slight Pale center arms. Then a slight trace of sex. Pair rocking ♂ with RL. 8:16. Then more ♂'s & ♀'s in Ord+. All by barges. The nids nearest to me, but not actually very close. Everything very calm and dull on the whole

There are still lots of miscellaneous fish around. Ignored by the squid and vice versa.

Some of the squids are feeding. Which raises an interesting question. How do the mediums support themselves when they are with a "courting party"? They have to eat sometime!

8:28. The group gradually drifts off to an area of pure TG. Where there is a group of gray & yellow fish grazing (sic!) as well as other fish

Squid are streaming out in a line now. Catch a glimpse of more Rocking and RL in pair at far end. Difficult to follow as the grazing is making water very murky.

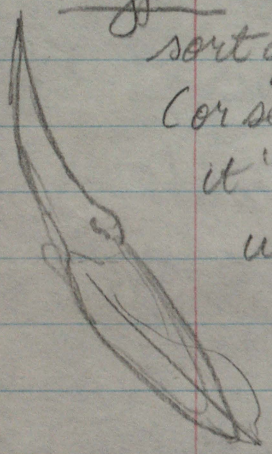
Arcadio comes back from exploring distant waters Saw only 3 squid, 1 large medium, 1 medium, 1 small medium Mimicking Octopora. In "V" (see below). In PH and Pale. SAN

One of the large in my group does ½ DM (one spot) in Ord, WS, Y, Pale (center) Arm. Then E with full DM in Ord+. Then E in Ord+ without DM.

Arcadio goes exploring again, into deeper waters. I go exploring in shallows. 8:40. I find lots of gray & yellow

finh but no squid. Stop my own observations 8:50. Then go back into shallows 9:10. Still no squid. Arcadio back 9:15. Haven't seen anything of interest.

Go back to PA area 9:20. Group is now reduced to 11 mds. Several larges gone. Remainder give usual alarm and defensive reactions. I go away for a minute. Return to find only 3 mds. General break-up? Not quite. Eventually find group of 10 mds (obviously the 11 minus 1). About 6" up in 12-15 ft water in area of pure TG. 9:30. All mds. being cryptic. Both arms and body inclined upward. This is the sort of posture which I have been citing as a sort of P (or semi-Curl) in my notes. It may be better to call it "V" from now on. (Reserving the term "P" for upward pointing of the arms while the body remains more or less horizontal.) Most of these mds. in V are in Ord with conspicuous WS, but no Y.



And I notice that the underside of the body is medium dark like the back. (This may not be typical of "ordinary" Ord's. Perhaps the pattern should be classed as Ord-Dark.) In any case, the net effect is to render the animals very inconspicuous against the "background" of TG.

After some minutes, the animals begin to relax. Bodies become more or less horizontal. See 1 E.

Stop observations 9:35. Start back to Jetty 3. Arcadio in shallow-tow. 9:40. He sees three larges in 4 ft of water over ruved bottom. They take off, but we follow them.

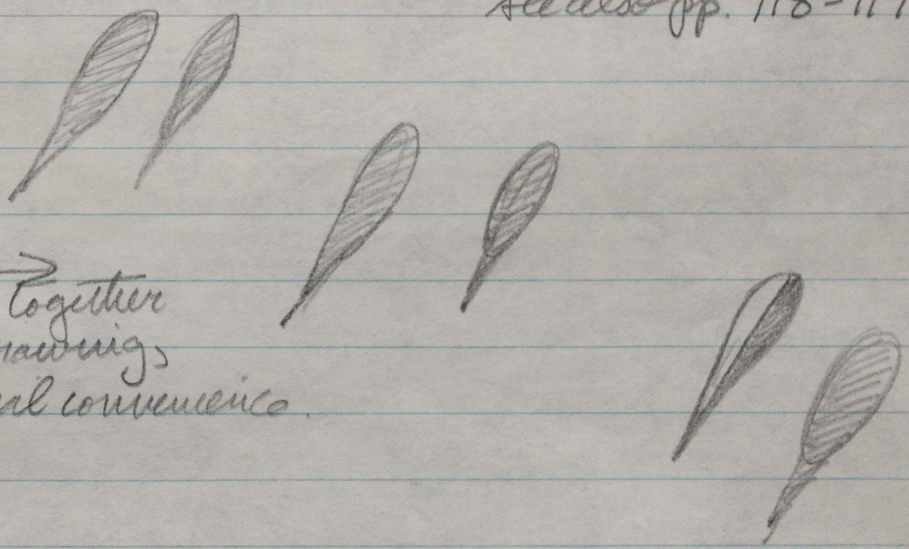
Catch up to find that the group really includes 6 mds.

Ceph., May 2, 1972, IV. (162)

All ranges. Rather far (2-4 ft) apart from one another, in line. But apparently divided into 3 pairs. Inds. of one pair are slightly larger than the others.

When we first catch up with them, they are 2 ft down in 15 ft. of water. Showing some "courtship" behavior. Some Rocking by at least 2 pairs. The ♂ of one pair does Lateral Silver like ♂ of pair seen near reef in March (i.e. silver half of the body away from his own female but directed toward possible interlopers).

See also pp. 118-119, etc.



→ crowded together in this drawing, for pictorial convenience.

Then there may be some cop. int. moves, in the most distant pair (largest inds.) Rocking. Perhaps some "bending" of arms. All very difficult to see in distance.

The group gradually drifts in to shallower water. Finally end up low in 8 ft water and stop "courtship". Lots of E and P (apparently to us). Gradually turning into, or repl and by cryptic V. Few out of the six inds. are in Dark, definitely without WS, Y, or Pale Arm, when in V. 9:50. The larg

ent ♂, however, in in Ord & WS during her V.

I notice that the mds. are much closer to one another when settled in V than when they were swimming in open water. But there are still traces of pair segregation.

Then all the animals swim off in Ord +. Back into deeper water. Largest pair resume "courting". 2-3 ft down in 15-20 ft of water. Rocking and Pie. I swim up to them. Whereupon they all sink down toward the bottom in shallower water. In Ord & WS. Some E by one or more mds. (They seem to be quite shy at this stage in their cycle!). Then go back into cryptic V's, interspersed with some E's, in Ord & WS (definitely no Y or Pale Arm). One md. does V with PH. I get a moderately good view of underside. Some dark below fins and a trace of a center stripe, but all "fuzzy", not very distinctive.)

Stop observations 10:00 a.m.

COMMENTS:

(1) This group of 6 mds. is [illegible] obviously not part of the ♀A group. It would appear to be in an earlier stage of the breeding cycle. I shall call it ♀B.

(2) The area of ♀B is only 100-150 yds. from area of ♀A. It is remarkable to find two groups so close together and out of phase with one another. (This must indicate that their development is not controlled by any single factor of the external environment such as phases of the moon.)

(3) Extrapolating from the bits and pieces available now, it may be possible to reconstruct the "normal" development of

breeding behavior in this species:

A. Juvenile stage (smalls and mediums in my terminology). Inds. in groups, sometimes large ones, usually small. In both deep and shallow waters. Shy. Some, or even all, inds. may already have begun to form pair bonds.

B. Doubtless pair bonds have to be reinforced and/or new pairs formed when the animals become adult and come into breeding condition.

C. The first stage in this process of reinforcement or formation is intermittent "courtship" in semi-open waters. Inds. still tend to be scattered in comparatively small groups. ♂ defends ♀ (Lateral Silver) and ♀ allows him to do so. But no cop. attempts. Inds. still very shy. Perhaps even more timorous than earlier.

D. When animals come inshore. Courtship becomes nearly continuous. Groups become large. (Attraction of juveniles. Also additional adults?) ♂ still defends ♀, but by conventional Z-patterns, etc. Copulations become common. Animals become bold or tame, tend to ignore potential predators (except such major dangers as Barracuda).

E. When most of the females become satiated. Still remain in same areas for a day or so. Occasional cops. Rape attempts. Still not very shy.

F. "Successful" adults move somewhere else. Remainders of "courting" parties (including juveniles) tend to break up. Become shy again.

G. Egglaying, etc. Where? How?

ADDITION: This ϕB group may well be the same as the group of G which Arcadio saw by the boat yesterday. It may also have included the mids. which came to the light last night. They may still be feeding occasionally as they move into the breeding phase.

2:05 p.m. See at least 13 small squid near Tettys. High up in 20 ft of water. Rather scattered. Disappear when I go into water. I cannot follow them.

We go to explore adjacent islands 2:20 p.m. Swim along beautiful coral reef. No squid by 2:45. Then explore large area of TG in shallow water, some mixed bottom near edge of steep slope. No squid by 3:05

Arcadio goes for shallow tow. Over huge area of TG Still no squid by 3:20. This species certainly does <u>not</u> like expanses of pure TG.

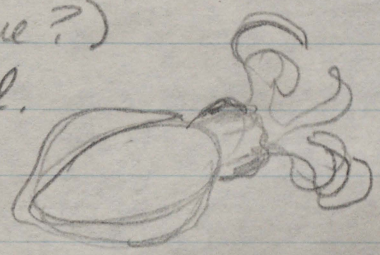
3:30. See a single small by Tettys. Disappears.

Then we go back to ϕ areas. I explore ϕB area. Until 4:10 p.m. Nothing! Are the squid out feeding somewhere else now? At the same time, Arcadio goes to ϕA area. Finds only 5 mids left, mediums and small mediums. SAN. Decline of group is progressing rapidly!

Run lights at night, but there is so much debris (scum) on the surface of the water that we can't see a damn thing! Then, 7:30 p.m., there is a gap in the scum. See a single large <u>Sepioteuthis</u> which has just caught a large sandlance-type. Fish is held by arms some considerable time,

at least several minutes. (The slowness to "swallow" may be characteristic of all Sepioteuthis, perhaps all squid. Viz early incident at Cobia.) The tentacles and the arms which are not engaged in holding the prey are widely "splayed out" (spread). Body in extreme light, PH like last night.

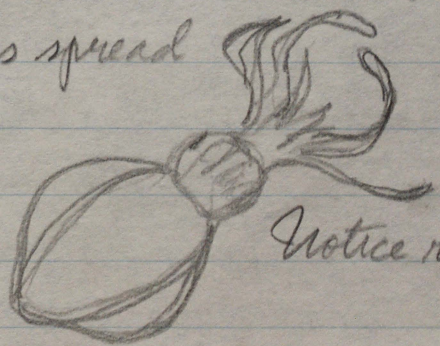
8:45 p.m. Another gap in the school. A single small Sepioteuthis shows up at light. With a very light body color, only marked by a few blotches. And arms very curled (probably in horizontal plane?) As far as I can tell, this ind. does not feed.



COMMENTS:

The very light coloration of both adults and young at the electric lights may be evidence that these animals do tend to adjust their color tone to ambient luminescence. And the frequency of "curling" (s.c.) of the arms apart from actual feeding may support the hypothesis that such movements are social indications of hostility, rather than purely predatory.

8:55. Another small Sepioteuthis shows up. Really very small indeed. Certainly not "larval" but about as tiny as any I have ever seen. Almost entirely colorless in white or under light. Arms spread Rather irregularly



Tentacles not expanded full length at this stage.

Notice relatively large head.

apparently not feeding in water. Arcadio dips it up and we put it in bucket. Immediately assumes extreme conventional PH (3 "bands", extending into fins), and does forward V, V-split, upward V. Toward the end of this V series, the PH gradually fades, becomes almost normal Ord (no WS). Then we throw mid. back in water. It swims off.

Are young usually single at night?

9:15 catch a glimpse of another tiny Sepioteuthis a few inches under scum. Colorless, with Curl.

Where are all these infants coming from? From same place as scum? If they originated nearby, they are good evidence that there are some kids breeding at all times of the year. Do squid have breeding seasons like monkeys?)

May 3, 1972
San Blas

Still at Ogunquit. Notice cormorant perched near ϕB area at dawn. But we still go there. Into water 7:35 a.m. Cloudy, calm, clear. Arcadio sees 9 ft shark (Carcharhinus milberti?) almost immediately. Then a single large squid in 8 ft water more or less edge ϕB area. 7:45 a.m. It disappears and we can't find it again. Then see a medium sized Barracuda nearby. Inclined against coral head. Hiding from shark? Then we patrol ϕA and ϕB areas several times, without seeing a single squid. (We also inject drift lines of Sargassum, etc., of which there are a lot after last night, with equal lack of

I

May 2, 1972 Dgo pu Rip SW.
8 AM T5 ind. 4 med small to med large
Go on to look for more.
8:10 am 3 ind 2 med med & 1 med small
all in P 2 larger ones in PH & W.S.
The other pair PH with W.S. they are
very close to a dump of acropora
cervicornis, obviously munching. d go
on and when d return at 823 AM
they are gone.
8:33 Dive down with tank to 40-60 ft
level end of Coral slope, some snappers
and groupers. Shot one. Covered about
250 ~~feet~~ meters or so no squids. 9.06 AM
Dive around shallows Trying to shoot grazers
no luck. Tow back to TETHYS
6 IND probably same d saw yesterday
under TETHYS. It is also very likely that
the couple that have visited the light
in the last two nights are part of this group

May 2, 1972 II Ogopukip

10:08 AM Start tow. ink puffs from small squid 11:15 AM one med large coral and rubble 20 ft of water sloping down to 40 ft squid is about 4 ft under surface ORD & W.S swims into deeper water to get away from me & bout d loose it. go on around d Island, no squid, not many predators either, go completely around to run into 3 land ind about 50 meters from TETHYS a lot of grazing fish under them. Again try to shoot one of the grazers but failed the squid disappear and so do the grazers a few minutes later d see the squid again, they are moving this time and the grazers (yellow and gray) are following behind. end of dive 12:20 pm.

2:15 pm Kalubin (West to Ogopukip)
Snorkeling along surface, visibility 30-40 dept 10-12 ft a lot of potential predators coral and sand flat becoming steep and deep only coral on East side of Island water a little cooler 40-50 ft depths end of dive 2.35 pm

2:40 pm other side of Island, coral, sand, rubble & TG a lot of grazers slopes to about 40 ft. d followed the fringe of the reef for a while then turned inshore and followed along length of Island

there's a little current going in the opposite direction some coral & sponges also well grazed T.G. no squids. A lot of empty "Strombus gigas" shells, no eggs.
go for tow until 3:15 pm.
3.25 pm Back to old area (Ogo pukiy
3.40 pm grazing fish & squids 5 medium small & medium medium. very small ink puffs in vicinity but no juvenile squids ORD & WS all in line DM faintly then stresses it was a coral close. All mature squids are gone & swim around for a while but find nothing. go back to boat. and tow back to TETHYS. End of Dive 4:10 pm.
May 2 1972 Night observations
Light on at 6.35 pm
Collected one juvenile & let it go
a lot of swim & sargassum. Ill water.
One or two large squids feeding but
not too exciting going on.
May 3 1972 7.40 a.m Begin dive
7.42 Shark about 7-9 ft long over study area. See large squid right after

shark went past. see Bonnacida, one grouper and two carangids in vertical position next to heads of coral or sponges. Could it be mimicry, to hide from the shark? a lot of grazing fish but no squids 9 am small puff of ink go for tow over to Mia Kalubia, no squid, a lot of predators go along reef across bay from Ogopukip, nothing, then go across bay back to Tethys, cannot see bottom so I am scanning both surface & deep water no squid. end of tow 9:07 AM

9:07 AM

10:04 swimming to area along reef 10:15 am small ink puff 10:20 am 15 squid in 30 ft of water, near the bottom 2 small 5 med and 8 large no action, a little low intensity courting from two IND at shallow end of line (opposite end from the youngest squids) female postels partially and moves away from male arms first. Male follows arm first and catches up with her, already he is under her, Then female RL end of courtship. Not much going on so we head for new area. 10 small squids in 2 ft of water. They all start displaying

III

May 3 1972

all sorts of alarm attitudes with their arms all very funny, I follow them into deep water & lose sight of them.

End of dive 11:10 AM

succers). Stop 8:20 a.m.

Then Arcadio goes for shallow tow. Along shores of Ogupuki and adjacent island. Then over both deep and shallow waters in center of "lagoon". Nothing. Stop 9:05.

Return to Jetty's to find 2 very large Barracudas near ship. Have been there for some time.

It is not surprising that squid have been hard to find this morning with the concentration of predators that has appeared! (Could the preds. have been attracted by the earlier concentration of squids???)

Going back to ϕB area 10:02. Arcadio does shallow tow on the way. Then we both swim. It is sunny now, still calm; the most spectacular predators seem to have gone. We explore the ϕB area, then go on to ϕA. Nothing. Then go on past ϕA area. Then, 10:20, come across group of 16 squid. 2-3 ft up in 15-20 ft. of water. Over mixed sand bottom (little or no TG). Inds. range from large (not the largest I have ever seen) down to small medium (two are noticeably smaller than the others). Only moderately close together (often in line, smallest at one end, largest at the other).

They give the usual hostile reactions to our appearance. Then settle down. Very placid. One ind. assumes Quadruple or Quintuple Streak with brief, short escape. One does Z (arms only) when another comes too close. Most inds. usually in Ord and WS. Some Darks. One ind. does E in Dark. One ind. writhes in semi-Dark, then does Curl in complete Dark. All these displaying inds. are more or less large.

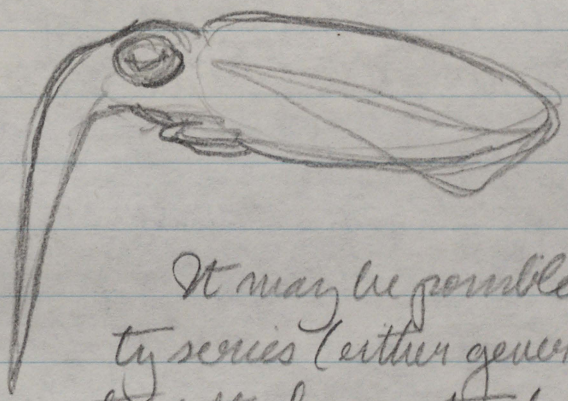
Arcadio sees brief trace of "courtship" in one large (largest?) pair. Reching: R2 Le ♀.

Several more mids. E in dark. One large mid., whose mate has strayed several feet away from the bulk of the group, goes to rejoin its mate, crossing pale sand, in an E with Pale.!!! Good evidence that displays are modified according to background.

This group obviously is not very sexual (yet). What group is it in fact? Some of the smaller members may be remnants of the original group ♦A. But I assume that some of the larger members have just "come in" to a potential courting site. I shall call the group ♦C for the time being.

Going back 10:40. Pass through ♦A area, through ♦B area, and well beyond. Nothing of interest. Then, 11:00, Carlos (Cuna pilot) calls us back to center ♦B area. Group of 9 squid has appeared. Ranging from tiny to small. In shallows, near surface in 2-3 ft of water, extensive area of pure TG. These animals are very shy and active at first, shooting around in all directions. Always close together. Very pale in color (probably a pale version of Ord — the light is brilliant here now). Then they stop moving, "huddle" under mass of floating Sargassum! We approach, and they all begin to display. All assume extreme conventional PH (3 "bars"). PH accompanied by conspicuous (but not particularly silvery) WS. And perform lots of V's. Forward, upward, downward, and Split! Several assume conspicuous Tri Stripes for a few seconds. In at least 2 cases, the

Dri stripes are accompanied by (or continued into) stripes along the arms. All this while V(s) continue. See also drawing p. 104. Unfortunately, I cannot tell if these stripes are along outer or inner surfaces of arms. Arms may be slightly twisted) Two mids. suddenly turn very dark all over (preparatory to shooting ink?), but then resume more ordinary, lighter, coloration. After some minutes, all the mids. tend to drop PH and go into Ord & WS. The Splits tend to stop at same time, then the other V's. Several mids. are left in what looks like a (straight) version of E. More or less comme ça:



It may be possible to arrange V's in an intensity series (either general intensity and/or relative strength of escape tendency): Split > upward > forward > downward.

Stop observations 11:10 a.m.

Go on to far end of Holandes Keys (Piatupo, Pauetupo, etc.).

Start work 12:40 p.m. Hot, sunny, calm. Arcadio starts shallow tow around Piatupo. Over lots of coral, TG, everything. No squid. I go in for a swim mufull 1:28. Coral, TG, etc. Still no squid. Come out 1:45. So we start over to Cuinquintupo. Arcadio towed on crossing. Arrive

1:55. Start around island. Arcadio catches glimpse of what may be large group. So I go in. We swim around. Finally find group. Point 3 semi-detached. Then whole group of 21 (presumably including 3) & I get up in approx. 12 ft of water. Over clear level white sand. But near steep, rising slope of TG. Well spaced out in line. One apparent pair at one end of line. ♀ of this pair is really large. All the others in the group are slightly "sub" large.

After some minutes, the group comes out of the open water to the TG slope. The ♂-& which pass closest to me are in Dark. Definitely no WS, Y, or Pale Arm.

The pair at the end may show slight traces of "courtship." The ♂ turns Pastel or semi-Pastel for a few seconds. No response by ♀.

2:15 All the mids. are down low near TG. Almost all Large ♀ or completely Dark. With the conspicuous exception of the large ♀ of the pair. She is in a rather pale version of Dark with WS. Does this mean that she is rather less frightened of us than are the others? And that Dark is an indication of alarm? The answer probably is "yes" to both questions. If so, how does the causation of Dark differ from that (those) of the other alarm patterns? Is there a basic motivational difference? Or is the Dark primarily a response to alarm and to certain external circumstances? Used only when concealment is possible and/or necessary? ? ? just before shooting mike and/or trying to be cryptic.

The large ♀ of the pair shows a trace of RL

All mids. retreat when Arcadio advances to photograph

Quickly relax. Come back. All calm 2:20. Inds just "sit". This seems to be an unusually sedentary group, even for this sedentary species. As the inds. relax, they start to break up their line. Make small movements in all directions, start to face every which way, and also come closer together on the average! S.E. a straight or slightly curving line of well-spaced inds., all facing the same way, is a defensive reaction.

Stop observing this group 2:28. Arcadio continues shallow tow around island. Completes circuit 2:45. No more squid. So we go on to Piniatupo, Arcadio being towed all the way

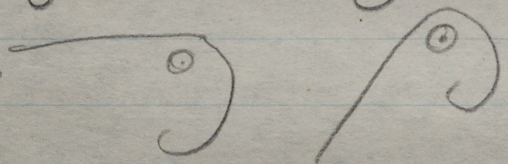
2:35 We run into a huge group of young. Difficult to track down at first. But we finally get close. Group includes 170+ (perhaps 174). They are in 2½-4 ft of water, over enormous flat of TG. Perhaps ½ to ⅔ of the way up. Inds. range from smallish small to largeish small. None really tiny or medium. In Ord, WS, Y. Exceedingly mobile and skittish. Start to dash this way and that. Usually very closely integrated, only a few inches apart. Whenever they dart away, many inds. change from Ord + to Double Streak on back and Fin Stripe on sides. (I can't be absolutely certain but I think that most of them were not streaked underneath.)

Rather surprisingly there were absolutely no V's, Splits, or PH's. Why??? In view of the fact that these animals were also in Ord + from time to time, I would suggest that they were relatively less frightened than inds. which perform the V-Split-PH patterns. (Of course, the inds. of this 170+

group did a lot of overt, unmutualized, escape. Perhaps this provided an outlet for much of their internal escape tendency. It is also possible that V-Split-PH patterns tend to appear when mids. are both badly frightened and yet reluctant to move away (attracted to something else, a bunch of Sargassum, an electric light and potential prey). This would mean that both smalls and larges are behaving in essentially the same way.

While I am watching these smalls, Arcadio finds a group of 8 larges 100 ft away. Approx. halfway up in 5 ft of water, sand and coral bottom. The mids. seem calm and uninteresting. Not very active.

The smalls eventually scoot away when a Barracuda appears. So I go over toward Arcadio. Find a single large, "caught" between the two of us. Assumes extreme E in extreme conventional PH. Body sometimes horizontal, sometimes inclined upward ("V")



I think that the horizontal position is an int. mov. of movement, forward or backward.

COMMENT: It is becoming increasingly obvious that mids. of this species can "adjust" their displays to their backgrounds and other ambient circumstances. Their displays are not simply expressions of internal motivation alone. They must have to make rather elaborate calculations — rather more elaborate than implied by Young et al.

I stop observations 3:25 p.m.

Arcadio continues observing group of larges. We think

that they may be starting to "court" now. ♂'s apparently defending ♀'s. SAN.

Put light on at 6:50 p.m., just as it is getting dark.

I think that I see a large octopus swimming on the surface of the water ca. 7:15. Dragging its arms behind it in a V!!! But it doesn't come close enough to be sure. Then, 8:10 p.m., an equally large octopus sees and crawls up a fishing line hanging off the stern near the electric light. Comes up almost to the surface. (This line does not go down to the bottom. I.E. the octopus must have been swimming about in order to have found the line.) Peculiar. Obviously a species that we have not seen before. A scattering of very large tubercles over body. Body finely pointed (quite sharply). Small horns over eyes. Whole animal large & pale when first seen. Then flushes red, but the tubercles and horns remain white. Quite spectacular. Then lets go of line, swims to side of ship, arms dragging in V, and then clamps on to side. Reverts to pale. Eventually swims away - while I am in the head.

8:40 p.m. 5 Doryteuthis-type squid show up near lights. Reddish. Circle a couple of times and then seem to disappear.

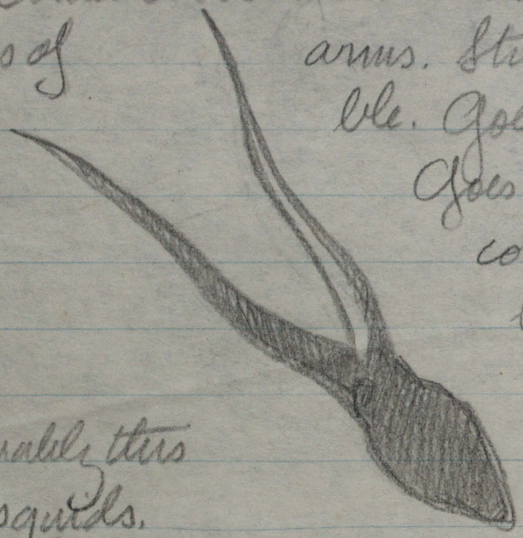
NOTE: We are quite far (1/4 mile) from the nearest island. This may help to explain why we have not seen any Sepioteuthis tonight.

8:50 A swimming octopus shows up. Almost certainly same ind. as before. Again in V. Grasps lamp cord.

Cepl., May 3, 1972, IX.

Then swims on and disappears.

Comes back again 8:55. Largely reddish except for insides of arms. Still with V. Tuberdes not visible. Goes off. Arcadio nets it.



Goes pale in bucket. Tuberdes conspicuous (again). Then we kill it with formalin. Let us hope that it can be identified

Presumably this species competes with nocturnal squids.

Stopping observations 9:25 p.m.

May 4, 1972
San Blas

Going to try Piriatipo again this morning. Semi-cloudy. Some wind. Run into motor trouble. Finally get into water 8:10 a.m. It is calm here. Water rather muddy at this particular spot (see also below). And warm (note: the water along this side of the island was actually hot in places yesterday afternoon, especially where the snails were clustered, presumably not coincidentally)

We swim over shallow TC flat. No squid. Then move on and outward to area of mixed sand and coral. Where 8 larges seen yesterday. Come across group 3 larges 8:27 2 ft up in 3 ft of water over coral reef. 1 does E in extreme conventional PH (notice that the "bands" "continue" around

Tiatupa San Blas
May 3 1972

End of The Holandes Rays Started at 1230 pm in tiatupa, went around both sides no squid, Then on to Quinquintupa, found 21 large ind. no action all very quiet On to Piriatupa where I ran into a group of about 20 small ind. Later on saw group of about 8 large ind low intensity courtship PH with stripe & some RL did not notice any fluttering of body and flaring of arms from part of the defender, end of observations at 330 pm.

on to belly or underside). The other 2 do P with Quintuple Streak, then a small (1½ ft) Barracuda shows up. The squid retreat some yards. Soon come back again. Now just below surface of water. One does (unsure, shallow) P in Ord, WS, Y. Then the Barracuda attacks the squid. Mimics? In any case, they disappear immediately. 8:33.

This is our first definite example of predation upon the squids!

Continue swimming in same habitat. 8:40. Come across a single large (Presumably ♀ — see below. Not as enormously large as some other females I have seen, but obviously fully adult.) 1½ ft up in 10 ft. of water. On border between small coral reef and semi-level area of sand & miscellaneous coral heads and debris. (NOTE: the water in this area is much less murky than at some other sites, but it is not absolutely clear.) When first seen this animal is in extreme E, body upward, with extreme conventional PH (bands underneath), and Y. Then she does series of P's and E's, and a few Curls, in Dark. (Notice that the animal is dark almost all over. Even the fins are dark. Only relatively inconspicuous. Only the funnel is light, semi-transparent.) Then the female swims away a few yards. Does E's and P's in Ord, WS, Y. Then more of the same postures in Dark as it comes down to us (see sketches next page).

I am rather surprised by the general behavior of the animal. Definitely completely alone. And obviously very reluctant to leave the immediate area. Suggests to us that it may be lay-

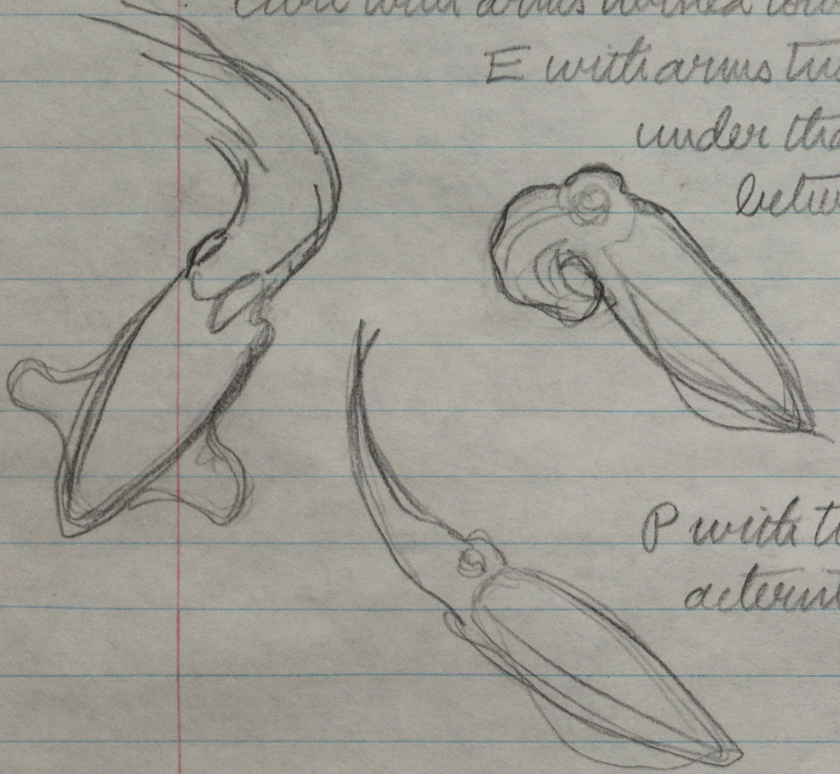
ing and/or guarding and/or caring for eggs.

Does more E's, P's, and Curl's, in both Dark and Ord+. Usually sticking quite close to bottom edge of reef (note: this is the inner edge). Still continuing 9:02 a.m. We become aware that it is showing a definite preference for a particular restricted site. Just about where we saw it first.

Some of the display postures are quite exaggerated:

Curl with arms twisted toward rear.

E with arms tucked so far backward and under that there is no visible gap between arms and body.



P with tips crossed (this was clear at center)

We move away a few yards. At which, the squid moves into the base of the reef. Disappears from view. 9:04 Then settles down into a definite routine. Rises and falls. Spends some seconds or minutes invisible (to us, in our position) in base of reef. Then rises up a few feet. Usually Dark. Sometimes E and/or P. Then goes down into base again. It looks as if she were attending to something important at or

near the base, but still feels that she must come up periodically to "check" on what we are doing. All very incubatory!

9:15. Now she is coming up less frequently, spending more time down. When she does come up, she is still usually in dark. Doesn't always display, but I see at least one P.

NOTE: She does not seem to make any effort to chase ruffles swimming by.

She usually or always goes up and down in a narrow passage between a Millepora and Siderastrea (check names with Porter).

Arcadio circles around to see what she is doing. She displays to him. P's, Cerd's, E's, in conventional PH's. Low in water. Arcadio also sees her go into "recess" of reef from time to time. Head and arms forward, fins beating madly. As if she were "aerating". Possibly with currents stirred by fins. More probably with jets from funnel (the fin movements merely helping her to keep her place).

9:25. We finally go forward to see if she does have eggs. As we approach, she goes into "crevice". Turns PH. PH rather peculiar. Sort of extreme conventional PH but with more prominent ocelli or (other) white or light spots. This makes her even more "cryptic" than usual against mixed (rather fine grained) coral background. Also makes movements as if aerating. Then dashes off a few yards. Hovers in PH. Then does DM in Ord+.

Arcadio goes down to check. Finds at least 3 egg strings, possibly more. In small crevice of coral which we

must get Porter to identify SAN

COMMENT: This female seems to be in good condition. Healthy and form in appearance. Which would suggest that she is still either laying eggs and/or taking care of them (ventilation rather than protection?)

The apparent absence of high intensity courtships among the other mids. here may be due to the fact that they have passed the peak of the breeding season, not that they have not reached it yet.

Stop observations 9:30 a.m.

This afternoon going to work at Piriatupo again. Swim and calm. Going first to look for ♀ with eggs. 1:45 p.m. Arrive site 1:50. ♀ apparently gone. There is a small Barracuda around. Eggs still O.K.; apparently the same as before, but Arcadio thinks that there are 10 strings (note: according to Arcadio, the ♀ was going back to the egg crevice when we left this morning).

Arcadio collects specimens of the sp. of coral to which the eggs are attached. Also some examples of adjacent corals.

Then we swim around other parts of the reef. I go over TG flat. Stop 2:20. Then Arcadio starts shallow tow. Finds single mid. (♀?), doing Pi in PH, 50-100 ft from "nest". Is this the mid. we saw with the eggs this morning? Probably not. See below.

NOTE: The site of the nest is only 250-300 ft from shore.

Arcadio continues shallow tow around island.

2:35. Finds 2 longs. 2 ft down in 8 ft. of water over sand and coral bottom. Apparently a pair (one larger than the other). Rather far (4-10 ft) apart. In Ord, WS, Y, Pale center Arms at first. Then revert to Ord & WS alone. All very calm and sedate. No signs courtship. Stop watching them 2:45.

See a single pelican flying around area.

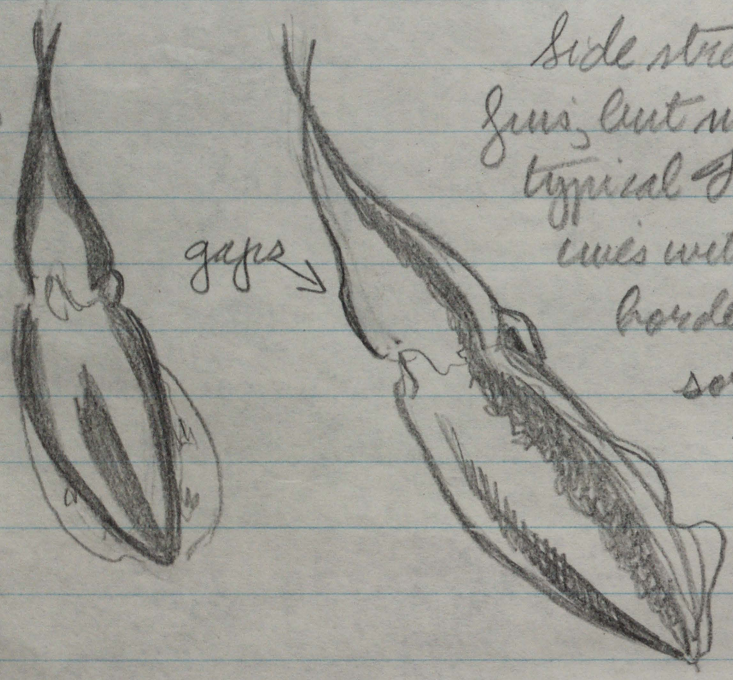
2:55. Arcadio finds smalls. Disappear by the time I get into the water. We try to track them down. Arcadio glimpses group of smalls which seems to include approximately 30 inds, 1½ ft up in 12 ft of water over extensive area of TG. Do young prefer TG more than adults? A few minutes later, we botch see group of 7 smalls. Presumably a fragment of 30 group. All in Ord, WS, Y, just like adults. Still low in water. Disappear 3:10.

Arcadio completes tour of Piriatupo, then goes on to Calubin (Casbo 2s.). Lots of mangrove on shore. Not much of interest in water. No squids. 4:15 pm.

Go back to Piriatupo. Check nest 4:25. Eggs still there. Apparently unchanged. No sign of ♀ at the site itself.

Then we find a single ind. 10-20 yds away. 3 ft up in 20 ft of water. Hovering over gorgonian. Reluctant to move, but does not show the conspicuous tendency to go to bottom. Quite probably larger than the ♂ seen this morning. Perhaps another ♂ who has just selected area for laying eggs but has not actually laid any

yet ??????? Does a lot of display toward us. Most peculiar. At first repeated P's. PH with WS on top. But the bottom half of Quintuple streak below !!! Quite definite Commecia.
S



Then starts to move backward and forward, a sort of "Rocking" to us. Usually moving no more than 3-4 ft in either direction. Forward movement always accompanied by more or less well developed P (sometimes almost Curl). Backward movements with more varied postures. Sometimes quite unvirtualized. More often trace of E or E init. mov. Both unvirtualized and E-type postures usually (not always) accompanied by some "splaying out" of the arms and tentacles. In not quite the same way as in Z spread and related patterns. Arms fanned out rather than curved. See figure next page.

Tiniatupo, San Blas
May 4, 1972

I

Tiniatupo May 4 1972 8:10 AM
at 8:30 3 large IND PH & E shallow
water right on the surface large female
posturing from PH - barracuda attacks

them & they ink and run for their lives over very shallow coral (not by choice, it seemed the only avenue open to them) They inked at least three times as they went changing direction right after inking. 9:40 one swims over & past Jerrold at bottom Martin points him out to me PH² (blotchy & banded over pastel) P & E mimicry? Then dark ORD or PH with end as she reluctantly swims away from area when Martin spotted her. She remains at a distance from us but does not leave from area. Instead she goes from one coral to another and does E while moving and P with PH² when next to corals (mimicry?) or gorgonians she is obviously very reluctant to quit this area. Martin mentions she may be guarding eggs. At this point we are very close to the spot where we found her so we move away about 15 to 20 ft. just as we start moving away she starts approaching area and finally we see her reach and disappear behind a head of coral. Every now and then we see her come up from behind, then she goes back

PH² (blotchy banded PH over pastel)

May 4 1972

M1

down behind the coral. (agaricia agaricites
she seems to be in a very dark
ORD or PH whenever she comes from
behind the coral Eggs? laying or guarding
them. I notice some fish around every now
and then. They don't look like grazers.
Then I notice a couple of grazers. Do
they eat the eggs? She still at it at 9:15
A.M. at 9:30 Martin and I close in to
inspect. She moves away reluctantly
and stays in the vicinity. I go down
and immediately notice a cluster of
transparent jelly-like strings clustered at
one end like a bunch of bananas. There
may be 5 to 10 strings about 2½ inches in
length and not too far from from
entrance of hole. (about tentacle length)
The female could not get into cavity
when eggs are and move around.
I could not count how many eggs there
are on each string, but will do so later
This hole is in a depth of about 6 to 7 ft
and about 1½ to 2 ft from bottom in a
heavy coralline area right on the edge

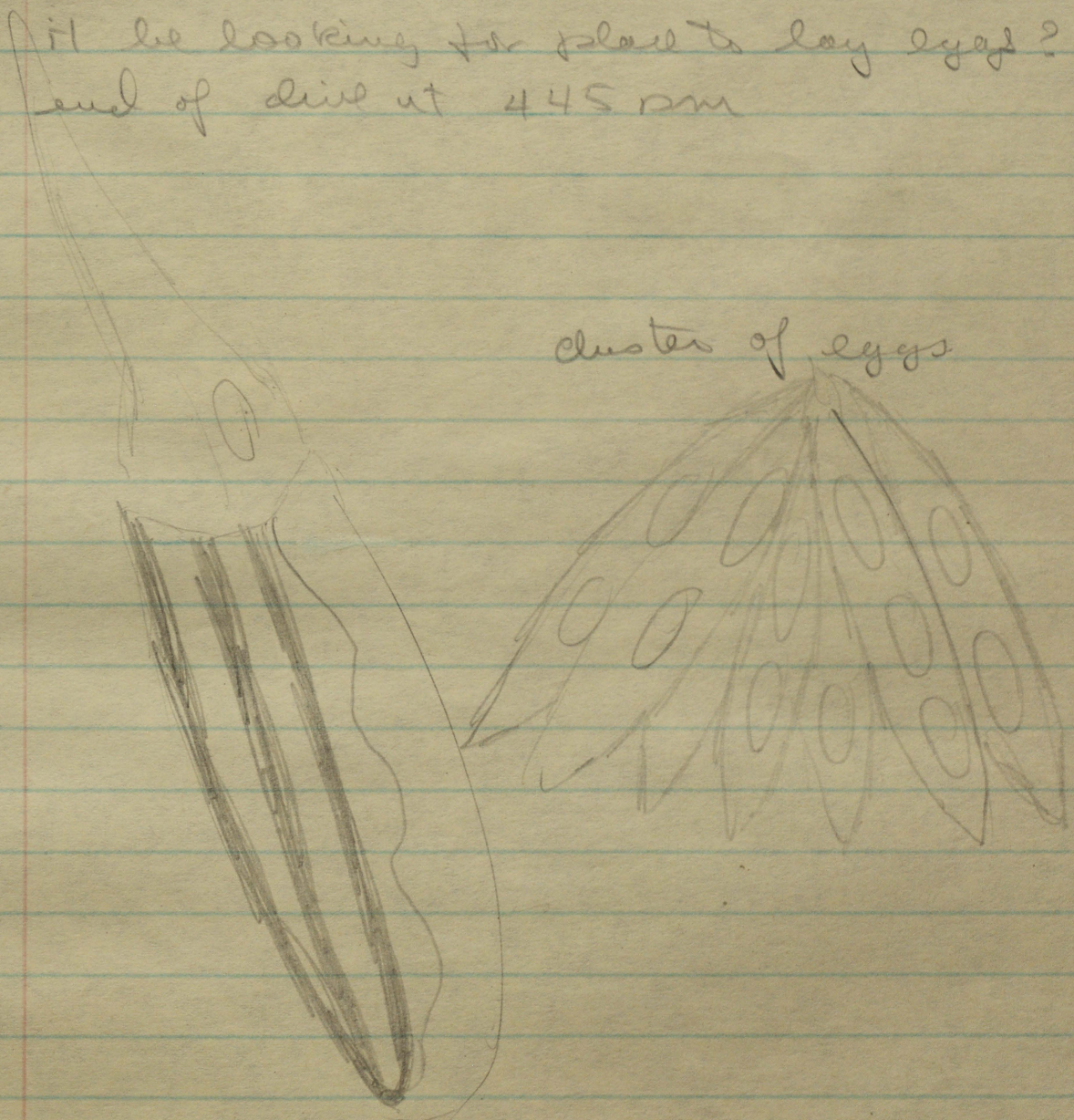
where the reef drops sharply into deeper water. The coral where the eggs are hidden is Leptoseris Agaricites which seems to me is ideal protection for it has a myriad holes and crevices and very sharp edges. After d surfaced and moved away from the hole. The squid returned in a very dark pattern and tentacles first and stuck her arms in the hole & turned pH^2, her fins seemed to flutter a little faster as if she were working them against the pressure of her funnel ejecting water. Ventilating the eggs? do she in the process of guarding or laying them? End of dive at 9:40.

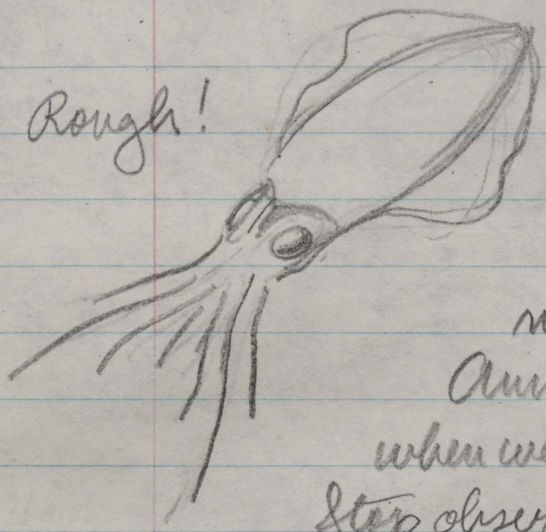
1:47 Piniatupo at 1:50 arrive at site of nest female is gone cluster of 8-10 strings 2-3 eggs per string everything looks the same. Spent some time looking for eggs in other corals of the same species as the one the nest is in. go for tow until 3:30 pm see two large squids and a lot of juveniles

Go for another tow, around Makalubir end of tow at 4:10 pm no squids or ink puffs. Go back to Piniatupo still no squid near nest. find another

Via Rabida San Blas
May 4 1972 V

squid in similar pattern and attitude close to a gorgonian, does a few P's E can see two lateral lines and one center line under mantle. could it be looking for place to lay eggs?
end of dive at 4.45 pm





Rough!

As far as I can tell, the annual retains almost the same color pattern(s) throughout. Only PH on top becomes less extreme, a little more Ord-like.

Annual is still displaying in same way when we leave 4:40.

Stop observations 4:45

COMMENT: Perhaps our observations today support Arnold's statement that females of the species die after egg-laying. If so, I shall be disappointed.

Why did the ♀ seen this morning seem to be aerating the eggs? Was the appearance misleading?

Running usual light tonight. Not many fish and no cephalopods by 8:30 p.m.

ADDITIONAL COMMENT: The behavior of the last ♀ seen this afternoon supports an impression that has been growing on me. There is considerable individual variation in this species. Perhaps more so than would have been expected in an invertebrate or a marine organism.

May 5, 1972
San Blas.

Going to work Piriatipo again this morning. Sunny. Rather windy. Get into water 7:43 a.m. Go straight to "nest" area. 7:50. Eggs still there. Apparently unchanged. But no si

gun of ♀. Then we go looking for last mid. seen yesterday afternoon. Have difficulty finding site, but probably do so in the end. Certainly swim back and forth a lot. No sign of squid. Continue exploring mixed sand and coral. Until 8:15. No squid. Then I go over to TG flat. Nothing. (Note: water is murkier everywhere today than yesterday.) Then back to mixed sand, coral. I go back to "nest" area 8:24. Still don't see a thing. Finally stop my own observations 8:35 a.m.

In the meantime, Arcadio has been exploring more or less the same region independently. Comes back 8:45. He saw one large, travelling, bruise. More important, he found another cluster of eggs. 5 ft down in 7-8 ft water. Attached to coral (not same species as the coral to which eggs of first cluster were attached). (Arcadio has collected the species for identification.) About 6 strings of eggs. Apparently older than eggs of nest found yesterday (sediment accumulated). In small "cave" (large enough for an adult to enter, i.e. larger than crevice in which the eggs found yesterday were deposited). The site of today's nest may be approx. 50 yds from site of yesterday's nest.

Arcadio does not see any squid near the eggs found today.

All this is suggestive, conclusive in some respects:
① ♀'s apparently do not take care of their eggs. ② the ♀ seen yesterday probably was engaged in laying. ③ the population of larges on this side of the island seems to be declining fast, i.e. the breeding season may be essentially over for the adults here. Where have they gone to die?

Then we go on to Panetupo. Arcadio does shallow-tow 9:00 a.m. Over considerable variety of bottoms. 9:10. He sees a large group of smalls. Near bottom, in 6-8 ft of water, over an extensive flat or bed of TG. He estimates that there are 100+ mids. in group when first seen. (NOTE: The young do prefer TG, at least extensive areas of TG, more than do adults. At least at a certain stage in their development. See also below.) By the time that I get in the water, the large group seems to have broken up into smaller sub-groups (scattering presumably due to our appearance).

We watch a small sub-group of approx. 30-40 mids. Largely composed of Sepiotenthis, but also including 3-4 mids. of another species!?! All mids 1-2 ft above bottom. The Sepiot enthis (which I shall call "Sepiots" from now on) range from smallish small to large small, almost sub-medium. None is really tiny. When first seen (by me), they are in double streak above (bellies invisible from our viewpoint). Then go into Ord & WS. Probably also ? in some, certainly not all, cases.

I am again struck by how much the display behavior of the young at this stage is like the "ordinary" behavior of adults.

The mids. of the other species are about the same size(s). Also some variation. Considerably thinner. With small terminal triangular fins. Either the young of some species of (more) open waters (Illex, Loligo, Ommastrephes ?), or adults of some species which I have no reference to. I shall call the species "X" for the time being.

When first seen, the X's are "Dull" in color. Sort of

pinkish medium neutral all over most of upper surface. Considerably pinker than Drd color of Sepiots. Possibly also slightly paler on the average. Only top of head, especially "eye brow ridges" dark, perhaps dark brown.

The most peculiar aspect of the X's is their relationships with the Sepiots. Just mixed in as full members of group. Sometimes near center, at other times near edge. Not consistently either leaders or followers. All mids. of both species range 6" to 18" apart most of the time. The X's are neither more nor less apart than are the Sepiots. The different X mids. may show some tendency to associate, insofar as they are often neighbors within the group or sub-group, but even this is not consistent. Many times the distribution seems to be random.

Once, as group retreats, an X flashes a white spot ("CL") near center of back. Apparently alarm signal. Flashed without any change in surrounding field.

Sub-group disappears briefly. Find it again 9:20. Now includes a small number (10-12?) of Sepiots and 3 X's. All mids of both species in V (arms upward). One X mi dull in V. Another X mi PH in V! Quite reminiscent of PH of Sepiot. Background less yellow, perhaps light dull neutral (not, I think, very pink). No Y; top of head still dark. The PH is marked by "bars" across back, in conventional style. At first I think that there are only 3 "bars". Then there seem to be 4.

All the mids. shoot away a few yards. The X with PH flashes a CL, between the two rear bars as it goes.

Catch up with some of the Sepiots a few minutes later.

9:32 Several do Ord, WS, with definite Y and Pale Arm. Some of the Pale Arms conspicuous. Entirely Pale, or Pale over whole base of arm mass.

Now see that there is an X in this sub-group. Dull with dark eye ridges. Then shows faint adumbration of PH "through" Dull. Then shoots away a few ft. Stays stationary. Retreats again. Stationary again. Etc. Etc. This mid. some-

Diagrammatic: 4 "band" PH ("bands" not really as even, clearly defined, or contrasting).

Fins less than ¼ length body. Body longer than head and arms and (retracted) tentacles combined

-times shows CL in Dull during retreat Sometimes traces of PH, with or without CL, when stationary.

Then all mids. approach us. Reports in Ord, WS, Y, Pale Arm. X's (now there seem to be 2 mids. with group) in semi-PH - Dull with conspicuous equivalent of Y. Brilliant

creamy silver spots center eye ridges. Silver spots still outlined by dark brown. (I shall call this pattern "Y" for the time being, even if it isn't very yellow-in actual fact.)

Stop observations 9:40.

COMMENTS:

(1) With their different shape and fins, X's can hardly prefer to travel at the same speed as Sepiots. Yet the group this morning seemed to be behaving in typical Sepiot fashion. I.E. the X's were adapting to the Sepiots rather than vice versa.

(2) There may be two social stages in the development of young Sepiots before they become medianus:

A. Juv's tend to be in small groups (3-15 typical?). Occasionally in shallows. More often semi-pelagic in or over deeps. Do lots of V's and Splits. Lots of PH's and Streak patterns.

B. Ordinary and larger smalls tend to be in larger groups (40-100 typical?). Preference for extensive TO beds near shore. Fewer V's, etc. Frequency of displays more as in adults.

The formation of these large groups must entail a willingness to accept strangers. Which may explain why mids. of other species can become incorporated in a group.

FURTHER COMMENT: Thinking over all my observations so far, it seems to me that our observations of Sepiot breeding behavior have been best at three different places: Piratupo, Egopukiy, and Piriatupo. What do these islands have in common? Small human populations, of course. But also some other things. A diversity of habitats, all mixed up together, in

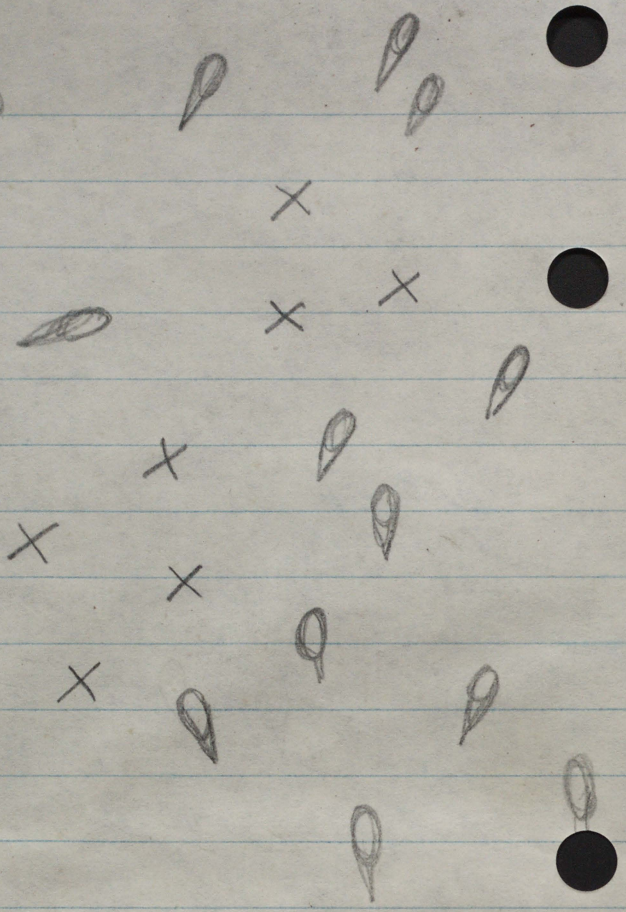
shore (on more or less sheltered side). Patches of TG, not necessarily very extensive. Patches of coral, etc. Isolated heads. And/or small reefs. Large barrier-type reefs may also be present, e.g. Ogojuekop, but they probably are largely irrelevant to the breeding of the squid.

Going back to Panetupo this afternoon, to area where mixed group was seen this morning. Start 12:30 p.m. Water (after rain) murkier than before. We swim back and forth over TG area, and fringes of adjacent sand and coral, for a long time without seeing anything of interest. Then, 12:55, Carlos sees a lot of smalls in real shallows, 3-4 ft of water. Arcadio and I try to track them down, but fail. Finally, 1:20, we see group of 50+. 2 ft up in 6-7 ft water, center of TG bed. Group includes 10+ X's. Rest all small Sepiots. Most of the Sepiots in Ord, WS, most of the time. Some assume streak-stripe patterns during brief retreats. From above, they look like Double Streaks plus Fin Stripe and/or Quintuple or Quadruple Streaks.

Most of the X's do CL in Dull during retreats. One turns Pale all or almost all over (can't see what happens to back of head). Quickly relaxes.

The social organization of the group now is a little different from what it was this morning. Many of the X's are "grouped" together, partly segregated in the same way as a Sepiot age or size class in a diverse group. But the space between X's is much the same as that between Sepiots. And also the same as that between an X at the edge of the X sub-group

and its nearest Sepiot neighbor(s)
Commence:



Whenever there is a retreat, all the vids. of both species retreat together, at the same speed and in the same direction.

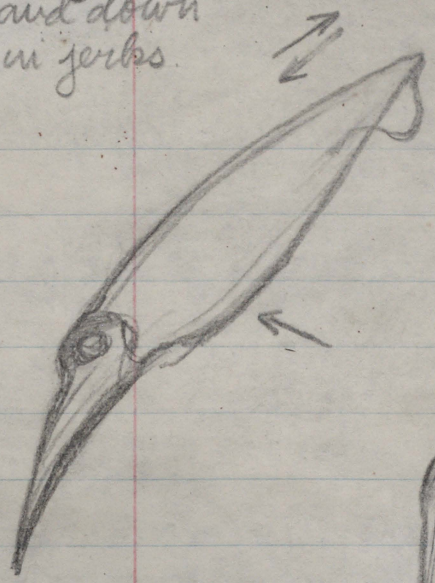
One X retreats in Dull with both CL and Y (the Y itself is sometimes difficult to distinguish because the eyeball is also very shiny — see below).

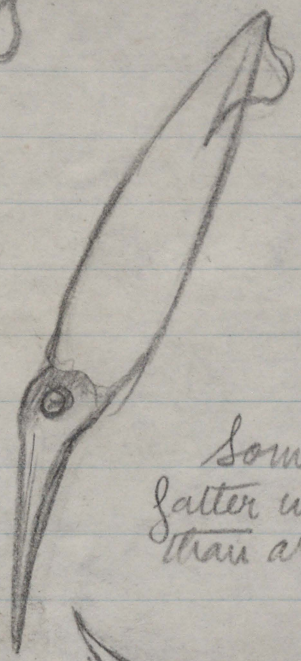
In one case at least, a mass retreat was both started and led by a Sepiot. One of the larger smalls, but by no means larger than some of the others around. It was followed as promptly by its X neighbors as by the other sepiots.

The X's tend to move in short jerks. At least when moving slowly. Certainly jerkier than the Sepiots. This probably means that the X's rely more upon jets from the funnel and less upon fin movements.

When more or less stationary, the X's often "hang" with the head lowered (I shall call this "Head-down" or "HD"). The posture may be purely functional in resting (it looks as if the animals were hanging from their fins), but it could also be a display, possibly homologous with = of Sepiots

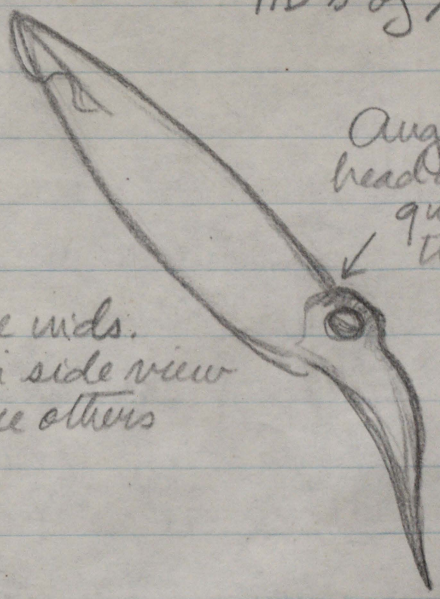
Body moves ups and down in jerks.





HD's of X

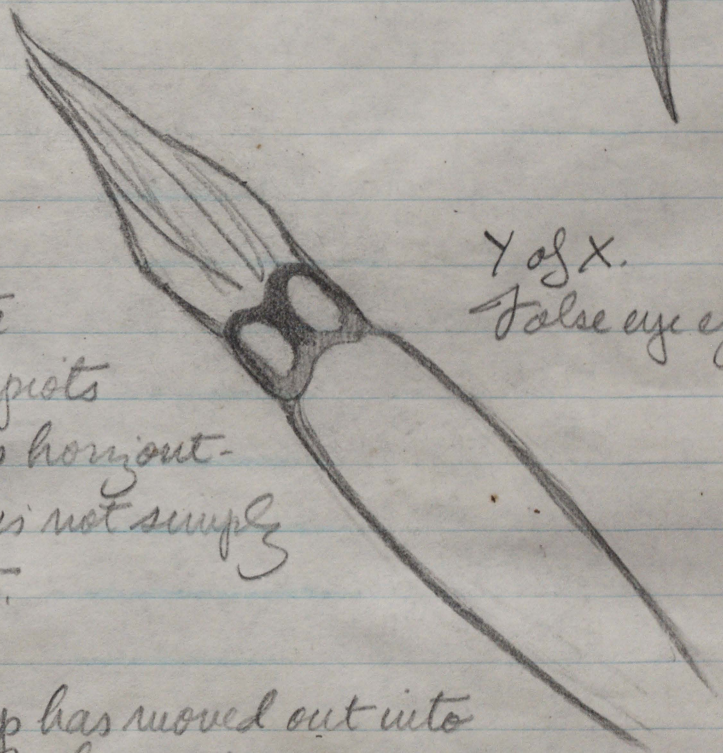
Angle between head and body quite typical



Some mds. latter in side view than are others

The HD's can be with Dull or Dull + CL.

NOTE: While the X's are in HD, the Sepiots have body more or less horizontal. I.E. HD position is not simply a reaction to current.



Y of X. False eye effect.

1:32. Group has moved out into deeper water now. Perhaps 10 ft. But the animals are still staying near the bottom.

There certainly are more than 10 X's here. Probably 25 or more (vs. 3 or 4 times that number of Sepiots).

Several X's in Dull + CL suddenly flash Y and retreat. The Y of this species really is very conspicuous indeed. When seen from above, the silver spots surrounded by dark are quite

good "false eyes." Quite probably effective in defense against predators.

Many of the mid. Sepiots in this group are larger than the largest X's.

Interrupt observations 1:42 - 1:48.

Sepiots behaving as before. But I am struck by the frequency of Pale Arms at the moment. X's also behaving much as before. One mid. retreats in Dull with Y but no CL. CL probably contains less escape than Y (???).

Both species of squid ignore several species of fish of approximately their own size swimming around and through group. The fish seem to ignore them in turn.

NOTE: We have not seen any feeding this morning or this afternoon. Do the X's really feed as infrequently as the Sepiots? Or do they feed at night?

One X swims first toward me and then away from me in Dull with both CL and Y. (Is CL homologous with WS of Sepiot? Or with RL-Pie complex?)

1:58. Several Sepiots do brief B's and E's. Possibly to us. In Ord, WS, Y, sometimes Pale Arm.

As far as I can tell, there is no temporal correlation between E's of Sepiots and HD's of X's.

Stop observations 2:05. Arcadio goes on shallow tow around most of the rest of Panetupo, adjacent reefs, and the nearby island of Morutupo. No squid. Does this suggest that all the young are gathered in one place?

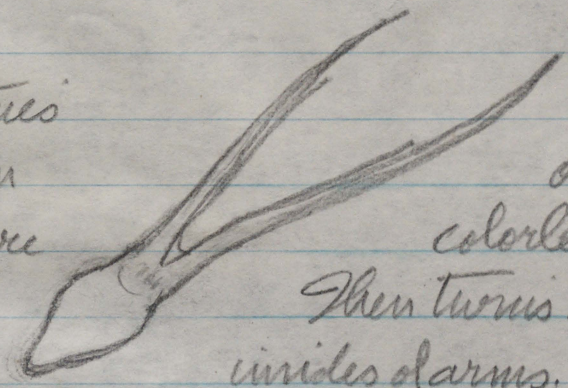
QUESTION: Is X the same species that we called

"Dorytenthis" last year ??? Seems to have same display patterns (CL, "4 bar" PH).

Going to run light again tonight. We have moved the Jettys close to Panetupo.

7:15 Single tiny Sepiot shows up. Brufly. Does split. Presumably not from group studied today.

7:58. Large octopus comes swimming along surface in V. Probably same species as other night (briareus). Long pointed tubercles (not raised to maximum extent now



V sometimes wider than shown here

One set of arms much longer than the other. Animal apparently colorless until it gets to light. Then turns medium orange except for insides of arms. Circles light, twice; then goes off

Going out in small boat 8:25 pm. Netting. Back 8:45.

ADDITION: Arcadio says that a single X went by light last night.

9:15 pm. A row of floating TG leaves goes drifting by near the light. Drifting with them, and looking very much like one of them, is a single small Sepiot (rather large for the class). In more or less Ord, WS. Suddenly shoots out arms, catches small prey (arthropod ?), turns PH, then returns to Ord. And continues drifting with leaves. Making absolutely no attempt to swim actively. I.E. it is certainly

Cephs; May 5, 1972, XI.

trading on its resemblance to a leaf to approach prey unawares And possibly also escape predator fish (There are a lot of predator fish, considerably larger than the squid, around the light at the moment.)

Stopping observations 9:35 pm.

May 6, 1972
John Blas

Notice a pelican flying around shores of Panetupo shortly after dawn.

We start work at Panetupo ourselves 7:38. Looking for large group seen yesterday. Arcadio does shallow tow. Continues for 20 mins. without seeing single squid. Do these animals spend the night in deeper waters? (Note: we covered this same area in boat last night without seeing the squid.) Are groups of small Sepiots particularly mobile? (We have not seen the group at Panetupo again.)

There are lots of jelly fish and at least 3 small Barracudas around here now.

8:06 Arcadio finally sees a large group of small Sepiots 1½ ft up in 4 ft of water over pure TG. Initial "alarm" reactions to us. Ord, WS, Y, some Pale center Arms, a trace of DM by one ind. General Paling by several inds during retreat. NOTE: Squids in these circumstances give very few P's and even fewer E's. This seems to be a general rule.

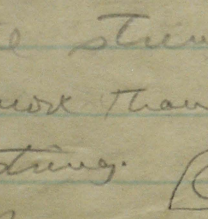
There must be 40+ inds. in this group or sub-group.

Tinaitepec San Blas
May 5, 1972

I

May 5 1972 Tinaitepec 745 am arrive at nest at 750 AM Donot see female everything is unchanged visibility 15-20 meters over shore. Start looking for eggs. After about 5 minutes see into cluster of 6-8 strings in Porites furcata crevice about 5 ft under surface bottom about 7 8 ft this new nest is about 50 yds away from other

don't see any squid nearby. The eggs are older than the ones we saw yesterday. They look slightly sedimented and not as transparent as the other, they looked as if they had a few scratches but I am not sure of this. Also the eggs seemed to be bulging inside the string.

There weren't any more than 2 or 3 eggs per string.  like so.

A little later I see a single squid (large) swimming near surface ORD & WS going mantle first then I loose sight of it again & again again & again. Then I find it again in deeper water and swimming arms first, I loose it and find it again near same area rocking back and forth doing E and P ORD & WS Then I loose sight of it when it goes into deeper water.

We move to Pandups, and I go in the water at 855 pm for tow at 915 I run into a group of 100 plus juveniles. I notice there are two species in this group Sepioteuthis being the predominant quantity wise. There may be about 5 to 10 of the other and they seem well integrated I see three individuals of Species X flickering writhing 2-3 ft from one another,

May 5 1972

111

but I also noticed several individuals
This specie surrounded by Sepiolinellus
with most of its kind nearby. This
specie swims with little jerks when
moving slowly. its transparent with
a PH similar to that of the Sepia
no eyes I could notice. Iridocytes
over the eyes and dark around
There.

May 5 72 Pan trap 12:26 pm some ink puff
and one barracuda at 12:35 at
1:20 pm I ran into juvenile squids
100+ again 2 species in group. This
same group I encountered this morning
there are about 15+ ino of the
other specie. When standing still,
This specie tends to hang vertically
in the water sort of hanging from
its fins at the end of its mantle.
arms and about one third the length of

the mantle. The bottom in this area is sandy completely covered with turtle grass. I go for tour around pauetupo at 2:05 see nothing of interest no ink puffs, no squid end of tour at 305 pm At 330 pm I go for a Sea-sled dive from Pauetupo Island to far end of Tiatupo and back. bottom is smooth sand at 45 ft. saw lots large ink puffs near the end of Tiatupo in 35 ft of water. I see one of the retreating individuals its Sepioteuthis there were about 8-10 ind. Go all the way to end of Island and turn around back to Pauetupo Go over sand bottom only closer to Island, some sparse coral and a lot of Debris and some TG but mostly smooth sand no squids or ink puffs. end of Dive at 4:05 pm Pauetupo April 6 1972 tour at 735 AM until 8:10 AM juvenile squids nothing but Sepioteuthis the group is of about 100 + shallow water and TG with sand.

Tiriatupo 855 AM check eggs on first nest. everything is alright, there is a small pomacentrus living in the sand.

V 4 May 5 1972

Crevice with the eggs. The eggs look untouched swaying back and forth with the current.
Swim to second nest. Still two squid nobody in residence. End of dive at 9 15 AM
Cirrquintups at 10.18 for tow until 10 36 two inkpuffs of squid. back to Pauletups same group of 100+ at 11:05 AM in shallow water over TG, There's a slight current, nothing but Sepioteuthis. Go for tow at 11:15 AM two other squids, end of dive at 11 40

Fairly well scattered most of the time.

Group seems to be pure Sepiot. No X's visible

8:10. Animals have moved into deeper (10 ft) water. Still low over pure TG

See a few cases of Double Streak and Fin Stripe. One vid. turns Dark all over. Then goes into Ord, WS, Y, Pale Arm, and DM. Then relaxes. Reverts to Ord, WS.

8:30. Now I see that there is a single X with group. I think that this X must have joined. Dull, with occasional traces of PH and/or CL, and with almost continuous Y (!). The vid. is quite close to me; I am probably the stimulus provoking the display. This X seems to be an absolutely full member of the group. Near center. Maintaining usual Sepiot-type individual distances. (At one point, all the animals "close up". Perhaps visibly frightened by something. X closes up with the others)

COMMENT: I am still amazed that there is so little hostility among the members of groups like this, among the Sepiots themselves or between the Sepiots and the X's.

Stopping observations 8:37 a.m.

Go over to Piriatupo. Arrive 8:52. Check both clusters of eggs. Both O.K. and apparently unchanged. (NOTE: There is a pomacentrid apparently living in crevice with first clutch of eggs!) Then we swim around coral and sand area. No sign of squid. More evidence that the larges have all died off here. Try to explore TG area, but there is a heavy swell and it is too murky. Stop observations 9:15

Then go on to Cinquintupo. Arcadio goes for shall-

our tow Part area where 21 mids. seen a few days ago and then all around island. Nothing of interest.

Back to Paretupo again. Arcadio 9:46. Sees one small Sepiot, then loses it. I start swimming around. Water is murkier and considerably colder than earlier. Group of 3 small Barracuda is still around.

10:10. Arcadio finds large group (100+) of small Sepiots several hundred yards away. Far out from island but still in shallows. Most mids. 1 ft up in 3 ft water over TG. Give usual low intensity hostile reactions.

Apparently no X's around. Association between the two species is not permanent.

Stop observations 10:25 a.m.

Going to Matupo this afternoon. 3 more or less large Sepiots in middle of channel when we arrive 2:06 p.m. Water is 20-30 ft deep here. Bottom sand and mixed coral, etc. The squid are near surface. I go in water, to try to observe them, but they have gone and I have trouble with my mask, etc. Arcadio goes out and sees a large group, plus miscellaneous others. SAN.

3:35 p.m. Go back to where Arcadio saw large group 20 ft of water over usual mixed bottom (this is well outside the small reef where we have done so much work on previous visits. Find group of 31 Sepiots, all stretched out in a line, approx. 3 ft below surface. Ranging from large (4 mids) gradually down to small medium. And neatly arranged according to size, largest on right flank, smallest

on left, in graded series. Fairly well spaced apart (most 2 to 4 ft from nearest neighbor, but see also below). All in Ord, WS, Y when we first approach.

The two largest annuals, on the right, show a tendency to "drift away" from the rest. Especially the end individual. This ind. also shows traces of Parlet. Once, when the two go off close together, one does definite Pie, but unfortunately I can't tell which.

3:55. This behavior continuing. Now the end ind. is c. 10 ft away from its partner (who is still more or less in line) most of the time. Doing a little low intensity Rocking by itself. Apparently "trying" to "lure" its partner away from the others. Suddenly the partner turns first Dark and then yellowish all over before reverting to Ord, WS. I can't see what provokes these changes.

COMMENT: This yellowish was quite like the usual background color of PH. But definitely without conspicuous mottling of any sort. Was it just an "int. mov." of PH? Or a qualitatively distinct pattern???

Then the next to the last ind. does Lateral Silver. Dark side toward the end ind., Silver side toward the rest of the group.

The two end inds are approximately the same size; but it would appear that the farthest is ♀ and the next ♂? If so, their behavior this afternoon probably represents the very first or almost first stage of "courtship". They are just starting to show signs of wanting to break away from the

group. And the ♂ is "defending" the ♀.

Now the end md. is showing more flushes of semi-Partial. Doesn't induce any obvious response

Suddenly the whole group drifts down toward the bottom. And I see that 3 or 4 of the Gray and Yellow fish have begun to graze on or near a patch of T & which seems to be the objective toward which the squid are aiming. The squid hang around the fish for a few minutes; then drift back to their original position.

What is the purpose of such behavior? Do the squid, by any chance, expect to catch small prey stirred up by the fish? If so, they must be often disappointed. I have never seen the squid actually catch anything in the vicinity of the fish. Certainly they did not do so this afternoon

Stop observations 4:05 p.m.

Running light tonight

7:05 p.m. Single large Sepiot shows up. In extreme conventional PH and E. Showing arms (writhing?) in E. Then drifts off, shoots away.

8:50. A single something which may have been a Dory [illegible] this type swims in outer edge of lighted area. 9:04 Single Dorytenthis - type (black) near light. Goes away almost turned [illegible].

COMMENT: The fact that we are seeing so few squids at lights must mean that the local forms are not primarily nocturnal.

Stopping observation 9:20 p.m.

May 7, 1972
San Blas

Still at Nialupo. Bad storm late last night and early this morning. Heavy rains. Strong winds. Winds still continuing when we start work, 7:30 a.m.

Arcadio does shallow tow along lee side of Nialupo Grande (this is the side where we have done only a little work so far). 7:35. He sees two large lepiotes. In 4 ft of water over coral and sand bottom. I go into water. We lose the animals momentarily, but then find them again. Still in approx. 4 ft of water, about half way up. Very pale in color. This may not be quite the same thing as the ritualized Pale during escape. It may be a "cryptic" response in the circumstances of today. The bottom is very light, and the water is "milky" with silt. The paleness of the animals makes them very difficult to see. In actual fact, at the moment, they both seem to be in a bleached version of Ord, WS (possibly Y?).

I get a very good close-up view of the eye, pupil, of one of the eels. Commerson's

The pupil is the most conspicuous part of the animal now.

This view is from slightly behind. When viewed from the front, the anterior "horn" would be more prominent.

Then there is some Rocking. The bleached Ord + probably replaced by Pastel. Apparently the 2 mids. are a pair. The ♀ does Pie. Mids both Pastel. No Fluttering or Flushing yet, as far as I can see. Both Fluttering and Flushing are not only sexual but probably also immediately "pre-cop". See also below.

Both mids. shoot away, and we lose them for a few seconds. Then I come upon one in very shallow water (2 ft at most) seems to have something large (3"?) and dark held in center arms. A fish??? Feeding during "courtship"?

Arcadio tells me that he sees one mid. investigating coral. Looking for nest site? SAN

Lose the mids and find them again. Now we see that there are 4 mids present. Obviously two pairs. 1 ft up in 6-7 ft. of water. In Bleached Ord, WS, 4. One ♂ does brief Spread with "Z" when another mid. (presumably the other ♂) comes too close. This "Z" is peculiar. The stripes have the usual form but are pale-medium grayish rather than really dark. A sort of "shadow Z". Presumably another adaptation to cypsis.

Difficult to follow actions of all 4 mids. ♀ of one pair showing definite tendency to "stray". Drifting away from group. Her mate, on the other hand, tends to stay nearer the others, presumably to make sure that they don't interfere with her.

One of the ♀'s does a

"Shadow-Pie." Dark markings body pale gray. Also another peculiarity. No dark at all center front upper edge mantle. But top of crown is brownish as usual.

One ♂ swims close by me. Assumes pure dark Fin Stripe on Shadow-Ord.

Then one ♂ swims by both us and his ♀ in Double Streak plus Fin Stripe. More or less dark. ♀ does Pie, more or less normal, but this time there is no dark on head!

I start to concentrate on one pair, while Arcadio concentrates on the other.

♂ and ♀ swim together. ♀ in Pie. Dark on both head and front mantle. ♂ in Double Streak (dark and strong), Fin Stripe (strong), and with two longitudinal Streaks below eyes (faint). ♀ E. in Quadruple Streak plus Fin Stripe.

Encounter between two pairs. The ♂ of one pair (A's) chases off both mds. of the other pair (mine). No display by the aggressive ♂ except for very slight Spread (no Z). Retreating ♀ does Pie. Retreating ♂ does Quadruple Streak plus Fin Stripe.

Now the two pairs are swimming about 4 ft apart. One pair displays (mine?), the other does not (A's?). The ♀ does Pie. The ♂ does Double Streak plus Fin Stripe.

All these Streaks and Stripes certainly are intra- as well as interspecific!

It looks very much as if the pair which is not doing much hostile display are the "owners" of this area. While the other pair are behaving as "intruders". Is this "intrusion"

quite "natural"? Or have the annuals been crowded together by our appearance and/or the storm?

Note: Arcadio says that his annuals are already making cop. attempts. SAW!

8:02 a.m. Now I see that there are 5 inds. present. Newcomer presumably ♂. Immediately "attaches" himself to one pair. Can't see display, if any. Then he disappears.

Still watching "my" pair. More ♀ Pic. ♂ does Double Streak (I think without Fin Stripe). All the annuals seem to have stopped Shadow patterns now. Dark markings are really dark. Presumably the annuals are getting used to us. But they are still maintaining the bleached background color in Ord. (Automatic when the ground is as light as it is here?)

I wonder if these are some of the annuals which we saw on the other side of the island yesterday. And/or if their sexual behavior has been "triggered" by last night's rain? (Via the presumed general correlation between the principal breeding season and the beginning of the rainy season.)

Note: Arcadio says that the ♀ of his pair is still investigating corals as if looking for nest sites. He has not yet seen a successful copulation this morning. Does this mean that ♀'s start "prospecting" before cop., while still in a "courting" party??? (Certainly A's ♀ looks very "fat", as if full of — presumably unfertilized — eggs.)

We lose sight of the annuals briefly, then catch up with them again 8:10 a.m.

Now my pair is showing sex! Rocking together.

♂ turns Pastel, advances forward toward ♀ with rapid and conspicuous Fluttering and Flushing. She immediately Pies. He immediately retreats with brief slight Double Streak. Then they Rock together again, and then go through the whole advance-retreat performance again, with the same displays in the same order.

Throughout this period, A's pair is out a few (4-5?) yds away, also showing cop behavior S/A

Addition. Arcadio notices one interesting aspect of Pie display. Pie usually combined with unilateral Fin Stripe. On side away from ♂? Presumably more silver on side toward ♂? Is Silver hostile (aggressive) in this species. Viz Lateral Silver of ♂'s defending ♀'s.

Lose vids. again. Find a single pair (I don't know which one) again 8:12. ♂, close to ♀, in Pastel with Flushing and Fluttering. The 2 animals Rock together. ♀ in more or less "neutral", light, coloration. ♂ advances forward toward ♀. ♀ Pies. ♂ darts forward, alongside and partly ahead of ♀. Then turns around and shoots arms at her head area or at the base of her arms. Obviously a cop. attempt. Certainly with contact. But possibly unsuccessful? The ♂ "slips" back a foot or so. ♂ still in Pastel with exaggerated Flushing and Fluttering. ♀ in Pie. I notice that she has her center arms slightly raised.

But she makes no attempt to "arrange" anything in the forehead area. Then she appears

to throw something forward !!! A spermatophore ??? The two animals continue to Rock together for some seconds more. The ♀ gradually drifts further away from the ♂ And both ends. Resume "Normal" Bleached Ord.

Animals gone again 8:22 a.m. We stop observations a few minutes later.

ADDITIONS:

I certainly bet the ♂ and ♀ in rather extreme Pastel, with little or no Flushing or Fluttering, while swimming together at some (early ?) stage in this morning's proceedings.

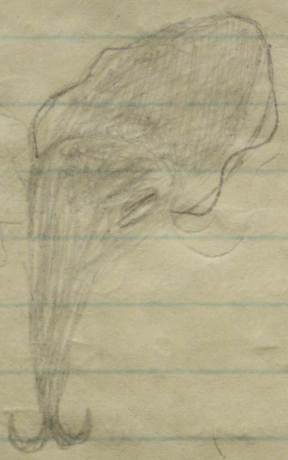
Arcadio says that when a ♂ retreats from a ♀ after a cop. attempt he is apt to assume Fin Stripe as well as Double Stripe.

SAN

May 6 1972 2:20 pm start dive at Nicatypos at 2:40 pm see into group of 35 ind. large to small small, all in line Dark ORD with faint WS all about 5 ft from each other. The depth here is 25 ft or so and the group is about 6 ft under surface. As coming forward, the youngest and smallest are last all in general very quiet. One med.

does a funny looking E, like so all dark without a WS.

Group brakes up and almost immediately regroups on deeper water all in PH with WS then no WS Then all ind near me in PH & WS while the ones farther away in Dark some DM close to me



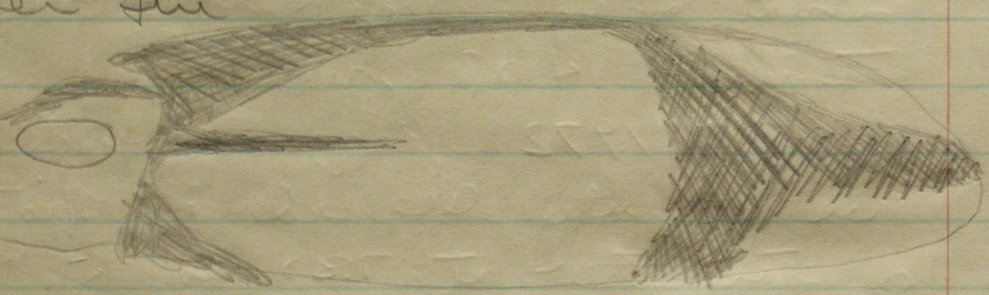
A large Barracuda approaches, some dark and pale and retreat others just pale and break their formation all dark facing the barracuda They reform again in ORD with W.S. and all is quiet again. They are all about 12 ft under surface with bottom at depth of 25-30 ft. The bottom is sparse coral and TG on a slope.

3:36 pm Same area nothing at 3:40 Same group as before missing in ORD & WS They all Darken and come closer when they noticed me. They are in Deep water about 35 ft and about 10 ft under surface. Their undersides are very pale d drop down to bottom to get a look of group from under. With the

surface of the water for a background they are very hard to see. I surface and they all swim under me in a very pale PH. A Barracuda appears and they all pale and retreat some ink. Then they all stop about twenty feet from where they started their mad dash. Then they all return to where they were in OPD & WS They all retreat again and I lose sight of them at 4 08 pm.

May 7 1972 Grey windy and rain we go into lee side of Miatupo and I start tow at 7:30 am at 7:35 I spot two large ind very pale with WS almost blending with their surroundings (the water is not very clear) all quiet, no displays. a fish goes by and as usual they dive away, I catch up with them and all one ind go into a clump of Agaricia agaricites then retreats & look but see no eggs. Three more ogids join the two and I've been watching. They are all pale with faint WS.

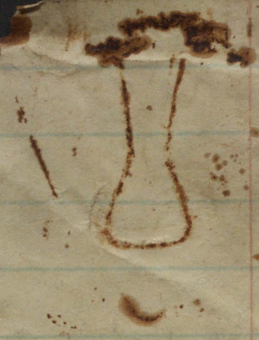
Then I notice one has something in its arms, it's close to the eyes end of arms and makes it bulge a little. Eggs? This ind looks a little thicker than the others. Then there's a display of extreme anger from one of the fins ind. One has disappeared and I only see him together with the other four, twice or three times. One copulation attempt directed at thick individual, male flutters and approaches female, then goes under her, female goes pale and pales, also shows a dark thin line over fin



opposite from side from which male may be approaching her. male switched side of approach and female paled that side and another line appeared on other side. As for male when rejected, darkened both sides of w.s. and showed two thin dark lines under fins. This goes on for quite a while. Male is relentless and female rejects him over and over. There is one successful copulation

V

Male approached female flutteringly and under female remained pale. Then very rapidly male turned around and pounced. Female retracts moving her middle arms as if arranging spermatophores.



IV

Indexed for displays.

June 21, 1972
San Blas

Going to work at Nalunega. Weather is clear and hot. Water very calm but slightly murky in spots

Arcadio starts to explore I and II areas ca. 9:00 a.m. Apparently no squids (perhaps driven out by fish? sardines are enormously abundant here now). Then goes on to III area. Still no squids.

9:40, past III area (away from I-II), Carlos and Lucho find group of squids. I go into water. Group includes 14 mds. Ranging smoothly from small to medium. About half way up in 2 ft water, mixed TG, sand, Diadema bottom. All mds. quite close together, 3"-6" apart. At first in Ord, WS, Y. Several mds. make brief retreats. Tend to adopt Double Streak + Fin Stripe during retreat. Double Streak and Fin Stripe combined with partial or complete DM in one or two cases. One md. does downward V (in Ord+, I think). Then some mds. do more or less slight E in Ord+. Then group gradually relaxes. All in Ord, WS, Y, without further display.

Then the group darts away a few yards. Arcadio follows them, but I go exploring. Come back 9:50. Group behaving as before. Rather dull.

A few minutes later, Carlos notices large mds. Only about 20 ft away from the group of smalls and mediums but apparently not socially integrated with them at the moment

Cephs., June 21, 1972, II.

There are 3 larges present when I first arrive on the scene. Obviously a "courting" trio. One pair plus one "escort" or "outrider". Inds. of pair swimming, usually backward side by side, close (a "-1") together. Escort swimming parallel, usually behind, facing same direction, 2-3 or more ft. away.

2 or perhaps all 3 inds. go Dark, apparently as reaction to me. Then do some E in Dark and/or Ord, WS, Y.

Then the escort disappears. And it is then that one of the inds. of the pair begins to do Lateral Selver!!!

I presume that the ind. which does Lateral Selver is the ♂. But it is certainly the larger, longer and perhaps plumper, of the two!!! (This could conceivably be a homosexual pair. But I will call the ind. which does Lateral Selver "♂" in the following account, and the other ind "♀", simply for the sake of clarity and convenience, without prejudice.)

The 2 inds. of the pair swim about together for some minutes. The presumed ♂ does repeated Lateral Selvers. The other ind. does nothing at all in the way of color changes. Just in ordinary Ord, usually or always with WS, possibly some Y for some or all of the time.

The interesting thing about this Lateral Selver behavior is the problem of releasing stimuli. As far as I can tell, there is no other squid around, closely, at any time during the performance. Nor do the Lateral Selvers seem to be released by or directed toward me (no "broadsides" presented). If so, then the Lateral Selvers are provoked by the presumed ♂

Again if so, it is remarkable that the conspicuous part of the display, the silver side, is directed away from the releasing stimulus. Presumably as a "precaution" against possible "intruders" (rather than a reaction to actual "intruders".

While the mds. of the pair are swimming together, they pass over a variety of mixed sand and scattered coral etc. bottoms. Very little TG. (N.E. egg laying type habitats?). Usually halfway up in 2-4 ft water.)

The Lateral Silver comes and goes, or, at least, sometimes much stronger than at other times. At its weakest, it is confined to little more than one side of the arms plus a trace of RL. At its strongest, it is quite uniform along whole side of body. Eye brow ridges are particularly brilliant. Quite pure silver, much brighter than in Y, and without yellowish tinge.

At one point during the summ, one md., probably the presumed ♂, does long spread. Probably without Z!

Then one or both mds. eject(s) ink. Both dart off and disappear immediately. I can't see any predator in immediate neighborhood. Is this hostility intraspecific? Is this pair at a particularly early stage of courtship?

Then Carlos and Lucho find a large group of small and medium squids. Ca. 60 mds. In 2-3 ft water over TG. Not far from where group of 14 seen earlier. Quite probably incorporates 14. All mds. close together. Behaving as usual. Eyed, WS, Y. 2 escape with Double Streak and Fin Stripe.

I shall call the area of this group "IV", and the area of the cavorting pair (trio) "V".

Ceph., June 21, 1972, IV.

Stop observations 10:10 a.m.

Go back to IV area 2:35 p.m. Still hot and calm. Swam around IV and V areas for some minutes without seeing anything of interest. Then come across pair of largest 2:50. About 20 ft from where V's seen this morning. Possibly same V pair, although I rather doubt it. Certainly the "size sex role differentiation" is "normal" in this pair now. The animal playing the ♂ role is the smaller of the two.

When first seen, the animals are in 3 ft water over mixed sand coral bottom. No TG in very immediate vicinity. Just swimming about calmly, very close together, in usual way, i.e. backward, facing in same direction. Almost united. ♂ stops, swims forward rapidly, and "strikes" at arm-head area of ♀. Obviously copulation. Definite contact. Can't tell if successful or not. No immediate visible rearrangement of spermatophores, but some rather suggestive arm movements later on (see below). The ♂ appears to be in Ord + WS throughout the period immediately before and during the cop! Certainly no extreme Pastel. The ♀ also in Ord + WS at first. Shows Brief RL as ♂ starts to advance. Then flushes Pastel immediately before and during contact. Then goes Pie immediately after cop. ♂ shows trace of Double Streak and Fin Stripe immediately after cop. Then the 2 animals "relax". Go back into Ord + WS and resume swimming together as before. Going rather rapidly. "Meandering" over fairly large area (100 m. in diameter?)

After some minutes, ♂ starts to "Bend" toward ♀

occasionally. She also assumes brief Pies from time to time, probably in response to ♂ Bends and/or other int. movs. of approach. Once she does quite elaborate writhing, then drifts with arms stretched out in semi-V. Could this have anything to do with spermatophore ???

Then I happen to drift too close to animals. Both E in rather pale Ord, WS, Y.

Then they swim off into slightly deeper water. Around 8 ft. Usually 2-4 ft down. Bottom Cargel, sand. And sex recurs. 2 cop attempts within a minute! Preceded by very fast, "tight" (short arc) Rocking in Ord, WS. ♂ Bends during Rocking. Then ♂ shoots forward to ♀. This time he is in Pastel, with Flushing and Fluttering. ♀ does not change color. ♂ "strikes"; definite contact ♀ Pies briefly. ♂ retreats a foot or so. Comes forward again. Still or again in Pastel, Fluttering, Flushing. ♂ back to normal color (?). ♂ strikes again. ♀ Pies again. Both relax. Continue swimming together again.

Obviously there is some considerable variation in coloring associated with copulations. Especially as regards Pastel + (or the absence thereof).

Stop observations 3:10 p.m.

All the time, I was watching this pair, Arcadio was observing a very large group (or combination of 2 semi-distinct semi-groups) a few hundred feet away. Over 120 inds. Group IV plus additions? SAN.

COMMENT: The population would certainly appear to

be "up" here now. And active and sexual. Apparently very different from early May.

Back into water 5:35 p.m. Can't find anything in V area. But then find very large group of many medium, a few smalls, one large, and one semi-large in V area 5:45. 1-2 ft up in 3-4 ft water over essentially pure TG. In Ord with WS and Y and (in most cases) Pale Center Arms ("PCA"). Several mds. do slight P toward us without change of color.

This presumably is largely same as large group seen earlier today. Apparently divided into 2-3 subgroups. Clusters of mds. separated by a few ft or yds much of the time.

There are quite a lot of medium small sardines in the neighborhood, but they tend to keep yds. away from the squid. Apparently conscious.

All the squid shoot away when a 2-ft Barracuda approaches. Come back as soon as the Barracuda leaves.

Behave as before. Medium small sardines also still (again) milling around. Now the squid are beginning to show an interest in them. Several of the medium and larguish medium squid advance slowly, swimming forward, toward the sardines (and also toward us as we are "behind" the fish). These squid assume Double Streak — Fin Stripe as they approach. Probably also some trace P. Then stop, retreat backward, reassume Ord +.

5:55. The squid seem to have relaxed, in the sense of not worrying about us anymore. And their color has chan

ged somewhat. Ord stuff is comparatively pale or light. WS is comparatively thin and inconspicuous. Usually no Y or PCA. Ord becomes darker, WS wider, and Y and PCA reappear only when Arcadio or I come particularly close.

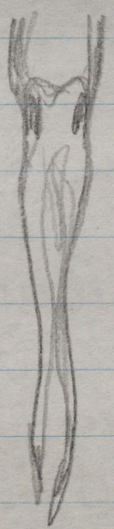
The sardines are still around. Possibly also other small animals. And the interest of the squid in feeding is increasing even more. We begin to see a lot of apparently successful feeding strikes.

6:02. One medusa strikes at prey without changing color at all. Prey is so small that I can't identify it. Probably tiny sardine, but could be small crustacean instead.

The adult seems to have disappeared now. Perhaps gone off into deeper water.

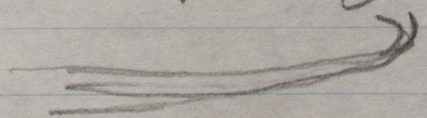
One rather large medusa does definite RL!

Now I notice that many of the medusae kids are floating with their tentacles extended. Sometimes also slightly spread.



Tips of tentacles often whitish.

Is this extension a "feeding intention movement" and/or indication of hunger? Probably yes. And some of the kids are making brief advances toward the sardines. Sometimes tentacles are curled up at very tips during advances



All or most of these advances in light Ord with WS. Someti

mes also Y by cuds. near me.

Now I see several cuds. make feeding strikes at small prey in what appears to be Pastel !!! Sort of medium lavender all over. No WS. No Y. Strikes seem to be successful.

What can this mean? Is the "feeding Pastel" really the same as the "copulatory Pastel"? Is Pastel simply an indication that all fear, all inhibitions, have been lost?

NOTE: All feeding strikes seen today have been forward, arms and head first.

COMMENT: Arcadio says that this group did little or no feeding earlier in the afternoon. It is beginning to look as if the species is primarily a crepuscular (at least evening) feeder. Why? Reduced visibility? (Compare terrestrial carnivores!)

I stop observations ca. 6:15 p.m. Arcadio continues ca. 5 mins. more.

SAN.

Run light behind boat at night.

7:15 p.m. Not quite night yet. Several medium sized squid show up near light. All apparently Sepioteuthis. One makes feeding strike at something near near light. Successful? In any case, it shows conspicuous behavior as it "lingers" by light for a few seconds afterwards (possibly burned by contact?) At first very pale all over, except for conspicuous dark streak down center of back. Then "bars" of "barred PH" superimposed crossways over long

I

Nabuniega, San Blas
June 20 1972

Night light observations
7:15 pm Placed light in water.
very clear and calm water.
I can see the bottom quite well
sandy and rubble on east side
of Dock at Nabuniga. Organisms
start gathering around the light
in the usual sequence, Copepods
and other micro organisms, then
sardines etc. At 7:25 pm a
Jonny squid makes a brief
appearance swimming on the
surface (ORD & WS) then pales and
captures a small shrimp? and
starts sinking as it swims away
into deeper water away from the
island. Carlos and Jim porter
believe that the squid population
has increased a lot in the last
few weeks. Carlos saw a group
of about 40 (assorted sizes) in
front of his house, this morning.
and a group of 20+ by the Dock
on Friday. He has also seen large

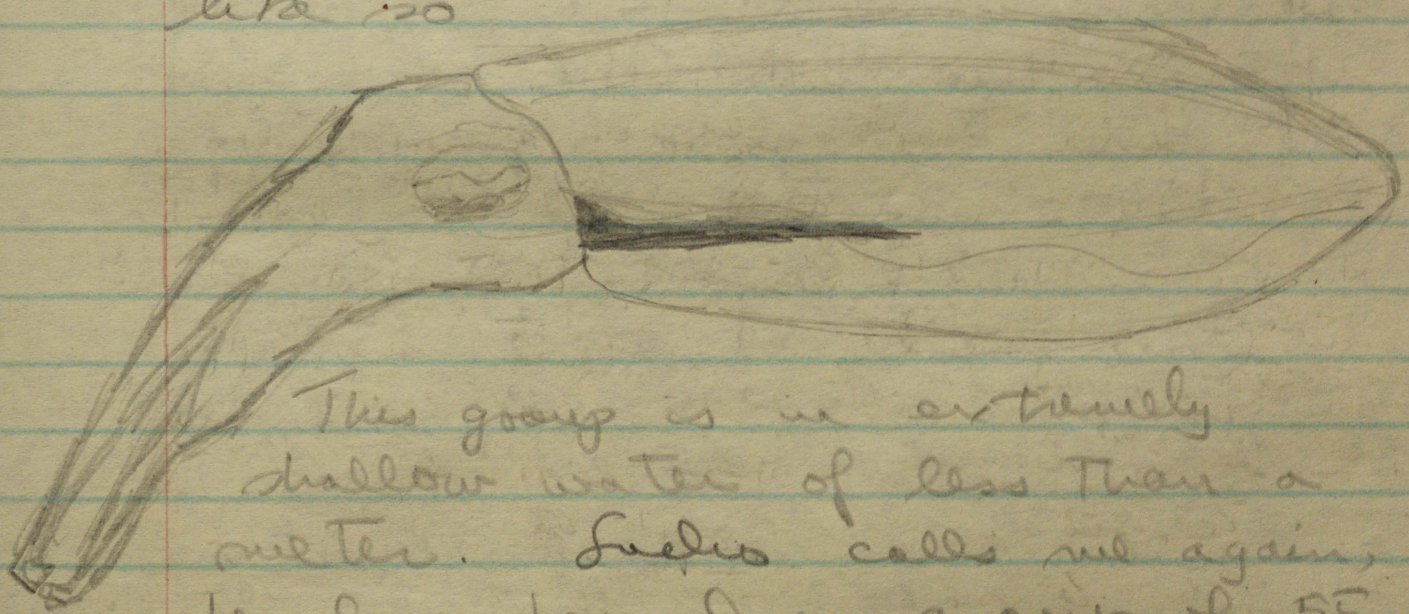
groups at Las Bleas point by the small beach where he goes for his drinking water. This last was last wednesday and it was a group of about twenty large. Jim Porter has encountered them at night in about eighty feet of water. He mentioned a group of about 4 or 5 large ones. He gave me the idea that he was encountering them more often than he has in the past. I wonder if we are not approaching a peak population and whether it will be in all the islands or just localized. The variety in sizes seems to indicate that this spend spawns throughout the year. Also could it be that several groups have recently migrated into this area? I am almost certain that they avoid artificial lights at night. Ended observations at 10 pm, no more sqids.

6/21/72 Malmeya 8.55 AM Begin dive on shallows it's hard to see at any distance because of the high concentration of sardines. I swim all the way to the eastside of the islands but see nothing. I turn back and

II

Malaneza, San Blas
June 21, 1972

swim past the dock, & notice a few fairly large banner mds and some sea angels & the clouds of sardines. At 9:35 am I hear Lucio & Carlos calling They have spotted a group of 14 young individuals. They are over solid dead corals & some T.G. There is a lot of diadema in the water. & see some PH & WS and notice a couple ind. do a Thin red & ossel fin stripe like so



This group is in extremely shallow water of less than a meter. Lucio calls me again, he has found a group of 55 young squid over turtle grass and sand and in that area of the island where bottom slopes

steeply into deeper water. When I find them they are in their usual leports formation but they break up and form like so. They start filing past me one by one, following the largest of the group towards deep water, but then their leader changes its mind (why?) and returns into the shallows. He DM over PH & WS with wide fin stripes as he swims past and some of his followers follow suit. Everything is quiet again. They all assume a dark ORD pattern with mostly no WS. except for a few. There are 5 or 6 very young ones in this group all at the end opposite the largest one. There is no sign order However and they have not resumed their usual leports formation. I saw one large squid earlier by the dead coral. He swam past me in a pale pattern with vestiges of a WS. I only saw him briefly then lost him.
I noticed another large squid coming up from the deep. He too is pale and

III Malenega, San Blas
June 21, 1972

rather monodescript. He DNs briefly as he swims past me, then turns around and goes back into deeper water at about 15 ft under he stops and hovers close to the bottom. Then starts moving back to the shallows arms first, he goes past a school of abudefduf and inks while moving arms first he does not darken or pale before or after inking nor did he increase his speed it seems to me he went through the aforesaid sequence in a very bored fashion. This is the first time I see one of these animals DnK while moving arms first. end of dive at 10:35 AM Start dive at 2:40 pm head to area west of dock at Malenega. Swimming against mild current at 2:46 pm I find the group of 50+ in same place except that now it has become a group of 120+ They go from young to 5 or 6 inches I can detect two different groups

in the formation. This morning's group is keeping a lepanto formation and are medium small, the newcomers are slightly larger and are keeping no formation. The two groups did not integrate while I stayed with them. There is a large pair detached from main group. At first I think it is a courting pair, but see no signs of courting. When I approach an individual or a group of them he or they go into a PH & WS with fin stripes in the young this display is more pronounced and held for longer periods of time than in the older crowds. I also noticed that if I press my pursuit after an individual he will immediately display PH & WS with fin stripes and he will keep this pattern dark as long as I am coming closer to him but once he starts to outdistance me this pattern will start to fade gradually as we become farther and farther apart and finally give way to a pure pastel throughout the underside of the mantle. I have only seen this done by the young,

IV Mulatupo, San Blas
June 21, 1972

The mated specimens held this pattern briefly then go into a pale pastel as they move away from one.

I just saw a beautiful display of collective mimicry. A garfish swam directly over the group. The whole group, as a unit immediately sank vertically to the bottom mantle first and turned into a light green P.H. & W.S very much like the color of surrounding turtle grass. It was uncanny because a moment before the garfish swam over them they were all in dark ORD & W.S in a horizontal position to the bottom, all very conspicuous and the next the whole group seemed to disappear in this water. It took a trained eye to detect them in the grass. I could see their arms waving slowly with a sway not unlike that of turtle grass waving with

the current, and their bodies rotating gradually watching the passage of the garfish over them. The depth was no more than 3½ feet so the gar must have been less than 3 feet from those directly under. They never lost their cool.
One of the large indian boats started its engine about 50 meters away. The whole group reacted by fading and those of the larger individuals started for deeper water pale PH & DM Then they changed their mind and rejoined the group. Are they susceptible to vibrations? end of observations at 3.45 pm. Went for deep tour around d'aloud no squids except the group that' d'd been observing earlier in same area end of tour at 4:15 pm.
Begin another dive at 5:39 pm arrive at study area (same as previous dive) at 5:44 pm The same group of 120+ is still there. They are feeding too. I see one attack, he comes towards me arms first with his tentacles extended, he fails and retreats almost immediately. I notice

Malcolm, San Blas
June 21, 1972

he is displaying fin stripes, then I see another and another attack at the same school of minnows, they are all displaying fin streaks. I see one in DM pattern as he goes for its prey. All these are young squid. I have never noticed these displays on the mature individuals. So far they have all been unsuccessful. A great number of them, if not all keep their tentacles extended while in the group whether preying or not is this a typical prior to feeding posture? I think so. I see another young individual attack, it goes along the bottom and under the school of minnows in a clear pattern with DM then shoots up and fails to catch anything, goes back down to the bottom and works its way back to the group without changing pattern until it has joined with the others, then ORP & as and clear. Suddenly a small fish (corongid?)

about the same size as the young squids runs into the group and makes a very disinterested and unsuccessful attack upon one of the young squids. The squid reacts by moving away a few inches and turning gold brown yellow at the end of the mantle. This wave of color moved the length of the mantle and on to the arms to disappear at the tips. The fish repeated its attacks on other young squids and they all reacted in exactly the same way. end of dive at 6:18 pm.

Night light observations:
7:00 pm At 7:15 pm a group of 5 or 6 young squids darted into the light one made an attack on the nearest night next to the light, flared its arms right after and went into a reddish zebra pattern, like so

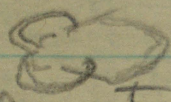
VI

Nalunega, San Blas
June 21, 1972

Is dusk their feeding time? We have never watched them at this time before.

Night light observations resumed. At 8:27 5 young squid come under the light. They are in a dark area very in the dark and become barred and very one in the light. I think their tendency to posture becomes more pronounced at night than in the daytime. One member of the I noticed 3 or 4 large Dory fish at the edge of the light, but only briefly. They are the largest I have seen so far, as long as this page is wide. The squids in general seem to be afraid of the artificial light but the presence of minnows under the light is sometimes too strong a temptation.

9:15 pm I rowed on the boat with Carlos to the area which I'd encountered the 1204 group. Some of them where still there, a few inches under the surface and in the curl up position

The group as a whole has disappeared. The different individuals seem to be spread out all over the area. as far as the east side of the Island. All of them floating a few inches under the surface and curling  and more times than not close to a ball of sargassum of about their same size which they resemble. Do they do this all the time while young? I did not see any mated specimens are they in deeper water? some of the young (medium) do that (Porter in conversation). a large percentage of the young are certainly gone, probably in deeper water. I did see some extremely young ones drifting with the sargassum. They were not plentiful in the daytime, yet I see more of them than I do the larger and more plentiful. Could it be that only some of the young and the very young remain on the surface minnowing the debries and the sargassum? While the older retreat into deeper waters? End of observations at 945 pm.

itudinal center stripe. All of this (stripe alone, and stripe plus PH) accompanied by very extreme spread. Arms actually "curled back". Probably some dark markings on arms. But probably (?) not full Z.

More medium sepiots show up at light during next 3/4 hour. Do a lot of feeding. Lenger (more or less in line) on outskirts of illuminated area, then dart in to take fish nearer light stuff. The squids usually remain dark, i.e. Ord. 2, unless and until they get very close to the bulb. SAN

Arcadio goes out by boat, and finds that at least some sepiots have remained in IV area.

The species is perhaps more active at night than I originally thought. A real 24-hours a day organism!

June 22, 1972
San Blas

Still at Malunega. Rather windier and more cloud today than yesterday.

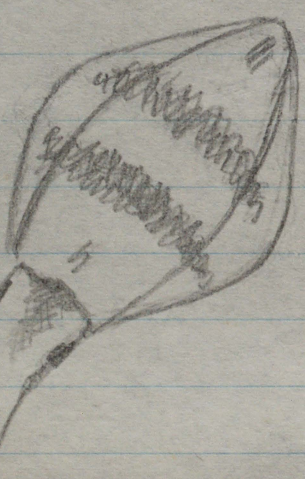
8:35 a.m. A group of 24 mediums shows up by ship. In fairly shallow water in III area. Quite near surface.

COMMENT: This may well be a "sub-group" of the enormous IV assemblage seen yesterday. I would rather expect these animals to rejoin the IV later in the day. The appearance of these animals now is further evidence that large assemblages break up at night. And this sort of cycle may be evi

dence that night is the period of greatest activity. The assemblages during the middle of the day may be "resting."

The scattering at night may take different forms. Trichonius breaks up into small-ish groups. But other age classes may behave differently. Arcadio saw lots of smalls near shore last night. Very scattered. Perhaps essentially single? He did not see any larges. Had the larges gone into deeper waters? (Vis Arcadio's notes on Jan Porter's observations.)

The group of 24 this morning is very closely integrated and coordinated. Inds. only a very few inches apart. Alternating periods of Ord, WS, Y, and PCA with rather more interesting color patterns. Latter essentially the same as patterns often seen at night, which I have called by various names or paraphrases (e.g. "light PH", p. 158, or "extremely barred form of PH" etc.). Doubtless it is closely related to "Real PH", but it probably deserves a name of its own. I shall use "Bar". The Bars seen this morning are more or less like the one sketched on p. 158. Can be summarized diagrammatically somewhat as follows:



The bars themselves are dark red or reddish brown. Areas between bars on body and fins essentially transparent.

The annuals this morning are doing lots of V's. Sometimes straight forward. Frequently upward. Often with extreme curl. Occasionally downward. Most of the V's occur during Bar, but there also are some with Ord+.

All or most of Bars also combined with extreme Y.

I can't see what is provoking changes from Ord+ to Bar+ or vice versa. But nothing precludes interpreting Bar+ as an alarm and/or a feeding reaction.

Does Bar+ tend to occur at night largely because annuals are more active, more often highly stimulated, then?

Is Bar cryptic and/or disruptive? Does it mislead potential prey?

One of the annuals is clutching rather large sardine when first seen this morning.

Go into water 8:10 a.m. Explore IV area. Find group of 60-70 smalls and mediums exactly where large group seen yesterday afternoon. 1-2 ft up in 2-5 ft of water over FG. All closely packed together, in Ord, WS, Y and PCA. Apparently not feeding. Perhaps not surprising as there are no sardines around at the moment.

One medium suddenly turns more or less yellow all over. Then dark all over (definitely no WS). Then re-assumes Ord+.

Now a medium red fish (common blue and green thing) starts to swim around and through group of squid (just quit feeding on plankton?). Movements sometimes force one or more individual squid(s) to retreat a few inches.

Cephs., June 22, 1972, IV.

The squid tend to turn yellow buff, during retreat. Thus "general yellow" might be intermediate between Pale and PH (i.e. PH without blotches).

One mid particularly close to us does brief Quadruple streak. Presumably as a reaction to us.

8:25. More brief retreats in "general yellow"

Then I swim over to V area. Water rough and murky. There also is a small Barracuda around. No signs of squid. So I go back to IV group, which Arcadio has been watching all the time. Much as before. Arcadio says that they have not been feeding even when potential prey present.

Stop observations 9:15 a.m.

Arcadio watches small group of smalls and mediums in I area on way back. SAN.

Go on to Panetupo area. Arrive in heavy rain. Arcadio finally starts shallow tow, 12:25 p.m., after rain stops. Explores area where mixed group found in early May. Weather is cool, overcast.

12:35. Comes across blobs of ink. In 5 ft of water over TG. I go into water. Swim around for some time without seeing anything of interest. 12:55 Carlos sees 4 small (tiny) squid near boat. They disappear. A few minutes later, we finally find group. Includes 40+ mids. Ranging from rather large-ish small (perhaps even small medium) down to tiny 3½ ft up in 5 ft of water over pure thick TG. All or most mids. in Ord, WS, Y, PCA at first. Very shy and mobile. There do not seem to be any X around. A few mids. have

tentacles rather extended. But I don't see any actual feeding.

All of a sudden, one of the largest of the mids. (Medium or almost so) Rocks with a small. And Loses RL very briefly! Premature ejac ???

1:08. Animals seem to be less shy now. Have drifted into shallower waters. I sit up in 3 ft of water. They also are showing a tendency to break up into smaller groups or subgroups (Presumably "scattering" is a sign of relaxation — during the daytime.) Suddenly they all shoot off and disappear. Probably scared off by a Red Snapper.

COMMENTS: It is my impression that the mids here now are approximately the same size as the ones seen in the same area in early May. Considering how fast squid grow, this must mean that there has been a complete turnover of population in the interim.

Obviously this area is ideal for young squid of an appreciable range of sizes (and presumably ranges). It is the nearest thing to a full-scale "nursery" that we have seen. Why is it so ideal? Possibly because it is a really immense flat of TC. And yet it is perhaps surprising to find the young assembled in an environment which provides so few hiding places, nooks and crannies. (I have never seen a squid actually go down into the TC itself.) The water is not particularly clear. And the area is not lacking in predators or overflowing with prey. It is, however, relatively very well protected from strong wave action. Is this the answer.

After the squid leave, Arcadio goes for another sha

Ceph., June 22, 1972, VI.

Slow tour. Stops 1:25 pm.

Then we go over to Piriatupo. Arrive 1:30 and go in to water immediately. Arcadio inspects site of first egg cluster found in May. Nothing visible. (Hole perhaps damaged).

I go swimming for a while over mixed coral. Then over TG flat. No squid. (If the absence of young squid over TG here is real, it suggests that any young which may have hatched recently may have gone over to Piriatupo. Much might be evidence, confirmation, of an initial "pelagic" stage.)

I go back to coral and stop observations 2:10. In the meantime, however, Arcadio has found a group. So I go to join him. Group includes 44 mids. Ranging smoothly from medium to large (at least 6 mids.). 3 ft down in 10 ft of water over mixed bottom (sand, coral etc., TG).

Most of the mids. are in Ord, WS, Y, and PCA when I arrive. But there is also some courtship in progress. Two ♀'s are Pic-ing frequently when attended by 1 or 2 ♂'s (each).

CORRECTION: Perhaps the situation is not so simple. Certainly the ♀'s who are involved in courtship frequently are no more than 2. But the ♂'s may be more numerous than I originally supposed. Each of the courted ♀'s may be accompanied by 1 or 2 ♂'s at any given moment, but ♂'s may also be "relaying" one another. Perhaps 6 or 7 ♂'s involved in total.

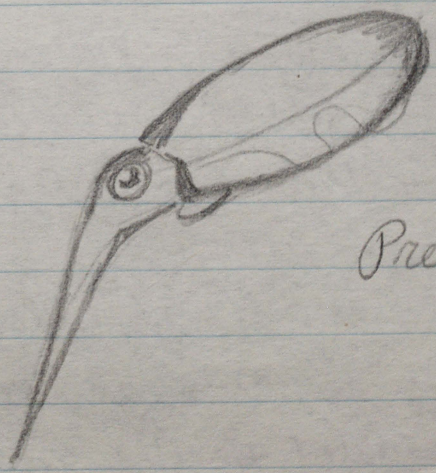
My general impression is that the sex today was unsuccessful, on the whole or in the short run, but also quite high intensity, see also comments below.

The ♀'s would Rock with ♂'s quite frequently. And ♂'s would make forward approaches quite frequently. But none of the approaches I saw led to actual contact. The ♀'s always assumed Pie as the ♂'s came in. And the ♂'s "broke off" at the last moment. (Arcadio saw one ♂ apparently ejaculate into the water.) Again I was struck by how effective Pie is as a repellent!!!

When a ♂ "broke off" after an approach which was frustrated by a Pie by a ♀, he usually "dropped back" behind her. At least one ♂ did a brief low intensity Pie himself as he dropped back!

As would be expected, the animals also reacted to us from time to time, whenever we got too close. Several cases of extreme Dark. Once, a medium or medium-large did Pie advancing backward to me!

COMMENT: Is Pie an expression of high intensity hostility rather than sexuality? If so, is it produced when an individual is not frightened but still not willing to attack?



Notice appearance of "swollen" rear end. Presumably due to eggs?

I noticed one peculiar aspect of ♀ Pies today. The arms are often pointed downward during Pie (as sketched on previous page). This can be reminiscent of E. But the connection is probably only indirect. In the case of ♀ Pies, the downward pointing may well be unritualized ♀. Still nothing more than an "after effect" of locomotion. ♀'s tend to rise, backward and diagonally, when Pie-ing in response to a ♂. (I think that I may have seen such downward pointing many times before without paying much attention to it.)

There were some even more obvious hostile encounters between some inds. this afternoon. Spreads. Usually with some form(s) of Z (sometimes, perhaps, as elaborate as at Ogupu Kyi on May 1, but not well seen). Most of these spread encounters must have been between ♂'s. Once, however, I saw a Spread performed by a presumed ♀, directed toward a ♂, after he had approached her, just after she had assumed Pie, perhaps even superimposed upon or combined with the Pie.

I stop observations 2:30. Arcadio continues until 2:50. SEE HIS NOTES (he has more data than I do).

ADDITION: While the squid were counting, there were the "usual" Gray and Yellow Fishes (Yellow Goatfish) feeding in TG below them. Are these fishes using the squids as "sentinels"???

GENERAL COMMENT: One problem has just occurred to me. We have seen two "forms" of apparently high intensity copulatory and/or paracopulatory behavior. In large groups, with young looking on. Or in isolated pairs (with or without

VII

Malenga San Blas
June 22, 1972

8:11 AM Reach sand area as yesterday at 8:20 AM It's a group of 57+ Young in ORD WS-½PCA The leader DM & PH quickly when a small fish approaches him but does not retreat, the little fish goes after other squids and they all reach in similar fashion except no DM. Every now and then an individual in the group turns velvet dark, like this ink for no apparent reason at all. I notice a young squid in ORD-WS with fin stripes which originate at the tip of the arms and extends fin into the mantle and sometimes all the way to the end of the mantle. I try to scare him into becoming a little darker but instead it inks, shoots to the surface arm first and immediately reverses and comes back to the same place in PH-WS-½ and fin stripes, its fins fluttering nervously I photograph him a few times and he allows me to come closer. I go back to

ship and I run into a group of 17 young all reacting to the presence of the boat by Barring and displaying their whole repertoire of postures, it all looks very hilarious. I photograph them. End of Observation at 9:15 AM

Puntapo, Las Blas
June 22, 1972

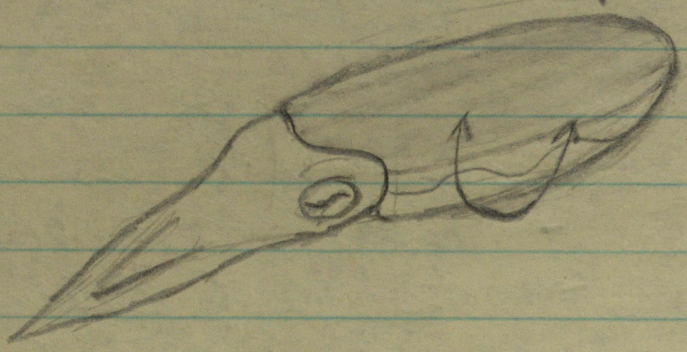
12:15 Tow on T.G. area of I island. After 20 minutes or so run into group of 14 who go on and join several other groups to form a group of 50+ they are as young as the group we encountered in this same area last trip. There are no signs of any larger squids. It seems to me that when young the Sepiots favor shallow turtlegrass areas more so than any other. End of observations at 1:25 pm
PIRIATUPO 1:35 p.m. The nest is empty and it looks as if the coral had broken up some. It certainly has deteriorated some. I try searching for the second nest but I am not sure where it is. Then I run into a group of 4 or 7 large squids. Immediately I notice a courting pair at the end of the

VIII

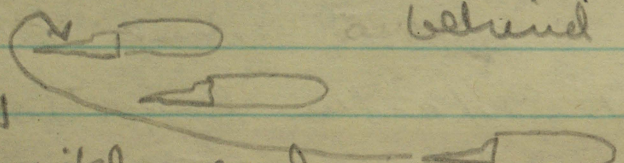
Pina Tupo, San Blas
June 22, 1972

bird. I notice some more courting within the groups. Several females "pie" at least three excluding the female at the end. There is some low key courting and a couple of quarrels over a female I see no successful couplings. Then Martin comes in the water and starts watching. I go on to see if I run into other groups. Nothing. I go back to group. They are still at it Martin hasn't seen any successful cop. either. At one time I noticed a female start fluttering fast as the male did, Then the male followed suit and the female flagrantly pied. I saw this done at least twice more, once by another female. Could she be enticing him? in all three cases it seemed that way for the males reacted by fluttering and an attempt to copulate. In all three cases the females "pied" I have also noticed that the male when fluttering and very close to the

female starts a sideways rocking motion like so. do it part of the pre-copulatory display or is it simply trying to find a way past the female's defences to copulate?



After an unsuccessful copulation attempt between a female and its partner, a third squid which had been following this couple moved forward from its position behind the courting party



passed very quickly and positioned itself under the "jilted" female and attempted copulation. It seems to me that the male was successful in passing spermatophores to the female, but she did not accept it and immediately ejected them as she rapidly swam away, paling as she went. All throughout my observations, a group of large "yellow goatfishes" "Mulloidichthys martinicus" (cuvier) grazed directly under the group of squids and moved with them along

IX

Piriatapu, San Blas
June 22, 1952

The reef. We first noticed this at Ogopukip during our last trip here but have found no reason for this behavior from part of the goatfishes (They certainly follow the squid groups wherever They go in the shallows of the reef, from 20 ft and less.) The only reason I can offer is that perhaps the yellow goatfish is using the squids as lookouts. When They frighten, the goatfish runs for cover.

accessory, third, ♂'s), and much Lateral Silver (absent in groups?). What is the difference. Group copulatory reactions must occur before and/or after "isolated" ones. Perhaps the group reactions are preliminary. In this connection, I should note that the 2 ♀'s being counted most actively this afternoon did show some slight tendency to drift away, with their escorts, from the main body of the group. But they always came back after a few seconds.)

This evening we run the light from before dark until past 8:30 p.m. without seeing a single cephalopod. Is this because the boat is fairly far from shore (several hundred yards?) Are Sepioteuthis and its associates (x) only near shore at night?

NOTE: I have seen a number of pelicans here and at Nalunega this trip. Apparently the pelican breeding season is over, or at least coming to an end.

June 23 1972
San Blas

There was heavy rain and lightning early this morning, before dawn. Gradually decreasing. Lightning stops. Gentle rain continues. We finally go over to Piniatupo. To area where counting group seen yesterday. Into water 9:45 a.m. Calm. Cool. Rather murky.

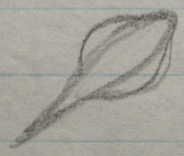
Find 3 larges 9:48. 3 ft up in 10 ft of water, over TG and sand with a little bit of coral. Obviously a "counting

trio". A ♀; a ♂ (♂1) closely associated with her, swimming close to her all the time; and another ♂ (♂2) "following behind", always on side of ♂1 opposite to the ♀ (i.e. ♂1 is always between ♂2 and the ♀).

All three mids. are in more or less ordinary Ord with WS most of the time. Sometimes with some trace of T and/or PCA, but never very extreme. The ♀'s Ord is usually somewhat more pinkish or lavender-ish than those of the ♂'s. A low intensity indication of Pastel? She also has a rather golden blob visible inside her, toward rear of body, probably more conspicuous on her left side than on her right. Ovary?

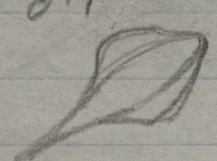
Both ♂'s have trace of RL all or most of the time. Usually or always more conspicuous in ♂2 than in ♂1.

All three mids. swim gently back and forth. In position commune:



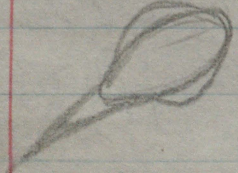
♂2

Very little obvious ly ritualized Rocking. ♀ certainly in lead when group is going forward ♂'s obviously in lead when group is going backward (♂1 "setting the tone", at least for changes in direction ????)



♂1

The ♀ and ♂1 are always facing in the same direction. But ♂2, the "secondary consort" — see also below — occasionally faces in opposite direction, even while continuing to move with the



♀

others almost as closely as before.

3 or 4 times, the ♀ suddenly rises in extreme typical Pie, letting the arms "trail" in "Downward Pointing". Rise always backward. ♂1 rises right behind her. Usually or always he assumes Double Streak and Fan Stripe, body, as he does so. ♂2 usually rises behind, without change in coloration.

Now the ♀ is swimming in semi-Pastel. Upon which are superimposed the dark (head and body) markings of typical Pie.

Then ♀ rises in complete Pie with Downward Pointing again. ♂1 follows in Double Streak and Fan Stripe. And ♂2 follows in Slight PH with Spread (and probably also slight Z on arms). All this may be provoked by appearance of a 4th ind. Another ♂?

The 4th stays around for a few seconds. Then disappears again 10:02. The other three resume behavior as before all very calm. Movements generally slow and relaxed. Some slight, slow Rocking. No more Pies, for the moment.

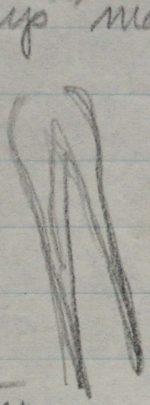
Why is there no Lateral Silver? Aren't the ♂'s (or ♂1) excited enough? If not, why not? See also below.

Every once in a while, when the whole group is going backward, ♂1 accelerates toward ♂2. Presumably hostile at which point, the Ord of ♂1 tends to become darker, more sharply differentiated, a little more Double Streak-like. ♂2 doesn't react very strongly.

Behavior still continuing as before 10:10 a.m.

Ceph., June 23, 1972, IV.

I notice that all 3 mids. have bases of arms slightly spread in usual "courtship" manner: Then ♂1 suddenly does semi-V; without change in coloration. Why?



By 10:13, everything is so calm as to be thoroughly dull. I notice that there is a Yellow Hogfish swimming around, in mid-water, quite near the squid. Little or nothing in the way of interesting interspecific behavior. Only the squid tend to retreat a little if the fish comes too near.

Arcadio swims off to look for more mids. 10:16. I remain behind. Suddenly the (a?) 4th mid. (re) appears. This provokes a sudden outburst of rapid activity. Rapid swimming, back and forth and also irregular circling. Lots of Pcis, most with rises and downward pointing. Pcis by at least 2, and probably 3, of the mids. (Further evidence that Pcis are hostile, not purely female sexual.) At least once, an mid., presumably ♂, rises after another in Pcé, and does "usual" Double Streak and Fin Stripe as "Be" does so.

Then the 4th leaves. Everything goes calm again. 4th back within a few minutes. Another outburst of activity. As before. Lots of Pcis, etc. 10:20 Then 4th goes again. And there is calm again.

COMMENT: The outbursts of activity in response to the 4th mid. have their implications. They suggest that both the ♀ and ♂1 have, in some sense, "accepted" ♂2 as an integr

al member of the "family". It is only the 4th who is "disturbing".

Then the 4th comes back for the 3rd or 4th time, 10:20. Now he is more or less accepted. The three others continue swimming as before. Only the ♀ has dark Pie marks superimposed upon semi-Pastel!

A few minutes later, I lose the annuals (I think that they swam away). So I go over to join Arcadio, 100-150 ft away, 10:30. He is watching group. I see 14 mediums. 4 ft high in 10 ft of water over TC. In Ord, WS, Y, PCA. Arcadio says that group includes approximately 23 mids. in total, including one pair of large-mediums or small-larges which are showing courtship behavior. And one large who comes and goes. This latter may well be the 4th of the group that I have been watching. Presumably "shuttling" back and forth.

COMMENT: This group of 23 may well be "remnant" of groups of 44 seen yesterday, most of the "courting" adults have left, to go on their own. Probably the trio observed today is one of these separated units. So far so good. The general sequence confirms the hypothesis that pairs (and trios) are formed within large groups and then segregate out. But it is remarkable that the trio observed this morning were much less active, sexually, than the courting adults of the group observed yesterday. This in spite of the fact that they presumably are more advanced. Why? Possibly the ♂'s who were most active yesterday went off with other pairs or trios? Or is the general relaxation, presumably temporary, simply due to the re

moval of intense crowding and consequent competition, an almost inevitable after-effect or by-product of separation, a characteristic of the initial phase of segregation???

12:45 p.m. Back on Station. See 5 small (tiny) Sepiots clustered around anchor rope. Very near surface. Anchor rope very taut (very diagonal). All in Ord, WS, Y. Staying, as usual, with rear ends toward rope, heads and arms pointing outward. One ind. turns entirely Dark (no WS) briefly. Then reverts to "normal"

After some minutes, slips swings around, so that rope becomes more nearly vertical. At which point, the animals swim away! I.E. they want horizontal rather than vertical extension for protection. Viz work of Wells, etc.

Go out again in the afternoon. Again to Piriatupo It is still overcast, but the rain has stopped. Arcadio does a shallow tow, 2:25 p.m., as we approach the island. Nothing of interest. Reach approximate group area and both go in to water, 2:32. The water is colder but clearer than this morning. We swim about, exploring.

2:50 p.m. Come across group of 7 squid. 4 ft. up in 8 ft. of water, over mixed TC, sand, coral, bottom. All inds. are large-ish medium or small-ish large. In Ord, WS, Y, and PCA. Retreat before us. Not very fast. But all inds. close together and assume semi-Pastel as they go.

What really is motivation of Pastel?

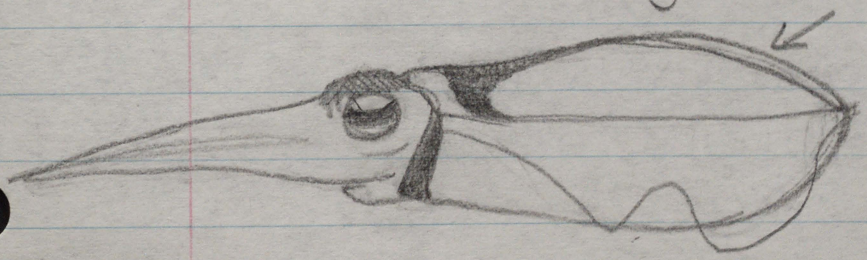
One ind., presumably ♀, does rise, Pie, Downward Pointing during retreat.

Then ♂ of the mids. disappear. Leaving one behind. This latter swims away into deeper water and over coral. In Ord+. Then it too disappears.

I catch a brief glimpse of what may be same mid. a few minutes later, 3:01 p.m. In E with Ord+. Disappears

3:12. Arcadio finds group of 16 larges half way up in 10 ft of water, over very mixed bottom. The two largest seem to be a courting pair. ♀ does Pie without rise or Downward Pointing. Again. Again. Then with rise and Downward Pointing ("DP"). Then without rise or DP. Then with both again. Then without either again. At least once (perhaps always?) ♀ does Flutter with Pie (is this typical? SAN). The attached ♂ follows the ♀ closely throughout. Sometimes in Ord and WS. At other times in Double Streak. Some Double Streaks with Fin Stripe. Some without. All following with Flutters!!! Flutter an expression of "conflict"?

The Pie patterns of this ♀ are rather characteristic



White stripe down midline of rear half of back (very conspicuous against silver). Black line along midline of front half of body. Note peculiar arrangement of black near front of mantle.

Also NOTE that fin is attached high upon body (this is characteristic of all mids., ♂ and ♀, large or medium — and presumably also smalls).

Several large ♀'s are much more rounded, in profile, toward rear than are ♂'s. Presumably, swollen with eggs. (Do they also "swell" in Pic ???)

At least one other ind. in group does at least one Pic. Very brief.

Several inds. do P in Ord+ to us.

Then the (principal) courting ♀ is followed by 2 ♂'s for some minutes. There is a hostile encounter between the 2 ♂'s. Spreads, with PH on back, probably some Z on arms. Followed by sudden flurry of activity by the ♀ and one or both ♂'s. Darting about rapidly, in Pastel and/or semi-Pastel. Sex? Hostility? Both? Then relax.

A few minutes later, several inds. turn entirely Dark. Apparently as reaction to our approach.

There are both Yellow and Spotted Goatfishes swimming nearby. Coincidence? SAN.

All courtship seems to have stopped 3:25 p.m.

But the ♂ and ♀ which were courting earlier, the largest inds. in the group, are still swimming together, at one end of the "line" which is the usual (and typical) formation of the group.

All inds. in Ord+. Then one turns first "yellow" and then all Dark, apparently in response to nearby fish. Relaxes immediately. Now I see that several inds. have tentacles slightly extended. The group as a whole is also lower in water. Are the animals getting ready to feed? Is this why courtship has stopped? Note. It is so cloudy, and

dark this afternoon that the animals might think that it is already evening.)

Then suddenly all the vids. turn Pale and dart off. Back again almost immediately. Quite calm. Ord + etc.

The largest vids., the fawn, are maintaining their relative position vis à vis the others. (This sort of "positional stability", for short but not fugitive periods, seems to be typical of all groups.)

Everything very dull 3:32 pm.

COMMENT: Why are the animals here doing so few E's toward us? Are they particularly tame? And/or is this an insular peculiarity? And, again, why so few (no) Lateral Delivers??? Another insular quirk?????

A Yellow Goatfish swims through groups, provoking more "yellow" - Dark responses.

I stop observations 3:40.

COMMENT: Are the animals less active sexually today than yesterday simply because the weather is less good today? Is it a temperature and/or light effect?

Arcadio stays in water until 3:45. Shoots a medusa. I sketch and he photographs specimen.

Then we go on to Mialupo. Run light from before dark. Without attracting any cephalopod.

Nothing by 9:15 pm.

June 24, 1972
San Blas.

Working at Matupo. Generally sunny. Into water 7:45 a.m. Usual small reef area. Water calm, clear, cool. We swim around usual areas. No squid. There are lots of small sardines, in dispersed formation. But also a substantial Barracuda. Finally stop 8:08 a.m.

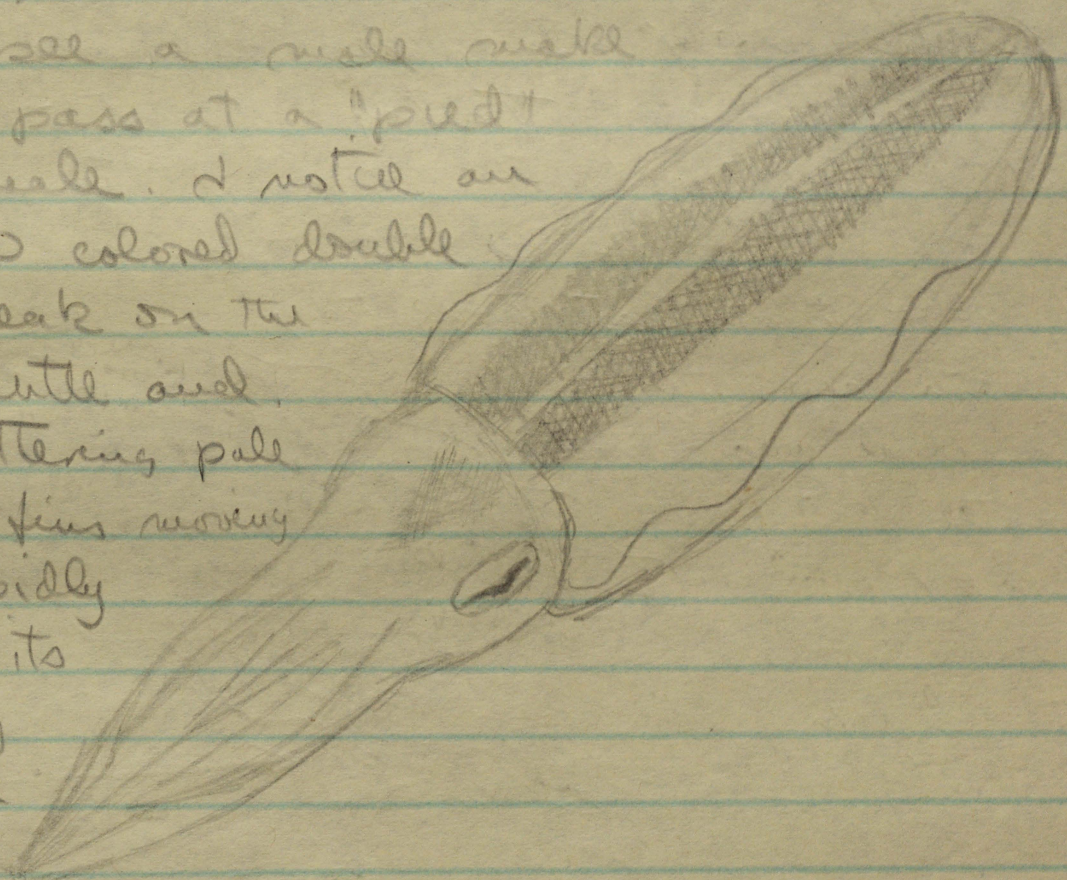
Arcadio goes for shallow tow. 8:12. He sees 7 mediums along edge of TC flat and channel. Loses them. 8:23. Reach area where counting pairs and cops seen during last visit. Lots of goatfish grazing in shallows, which are therefore murky, but water is clearer further out. Lots of small sardines in tight formation. 8:30. See pair of larges. 2 ft up in 6 ft of water over sand and coral. ♀ in Ord +. ♂ in Double Streak and Tri Stripe. Tri Stripe is comparatively broad. I.E. whole pattern is reminiscent of Quadruple Streak. The animals seem to be very shy. Start retreating immediately. Into deep water, over TC and sand, to an offshore reef. ♂ in lead during retreat (as would be expected of an animal in Double Streak Tri Stripe?). Both disappear. Arcadio says that there are Barracudas, a Sand Shark, and lots of jacks in area. Not surprising that squid are nervous.

I come out of water 8:43. Arcadio goes for shallow tow along channel and wreck, then over to near shore of "Little Matupo" (Achutupo???). Finds squid,

X

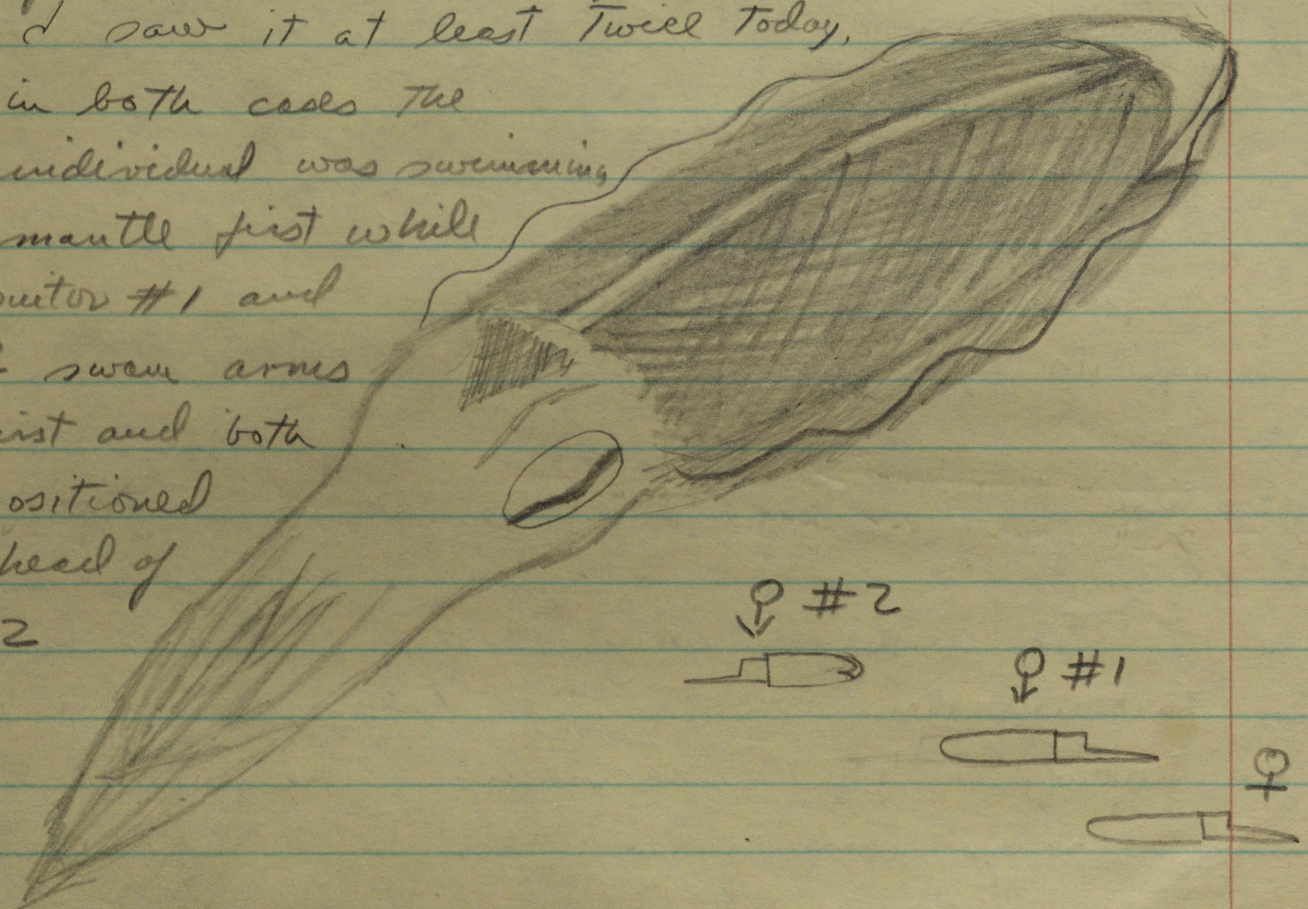
Piratypo. San Blas
June 23 1972

Rainy & gray not windy at all. very calm sea. We get in the water at 9:40 AM. At 9:55 AM I see a group of 5 large coming from deeper water
I see a male make a pass at a "puff" female. I noted an ORD colored double streak on the mantle and fluttering pale his fins moving rapidly and its body half to



rotates when its very close to the female. The female shoots up near the surface keeping it "pit" coloration. The male gives up, and goes back to ORD & WS.
I noted a young spotted goatfish "Pseudupeneus Maculatus" (Bloch)

feeding directly under the group of 3 squids that I'd been observing. Once the squids became frightened and moved rapidly for about 15 ft. The goatfish watched them, then looked around and went on to feed under the squids new location. I have only seen this once. I noticed the female of this group flattening in a very low keyed, her entourage of 2 males remained quiet and very cool. Today I noticed a white point at the end of the mantle of suitor #2 of the trio I saw it at least twice today, in both cases the individual was swimming mantle first while suitor #1 and ♀ swam arms first and both positioned ahead of #2



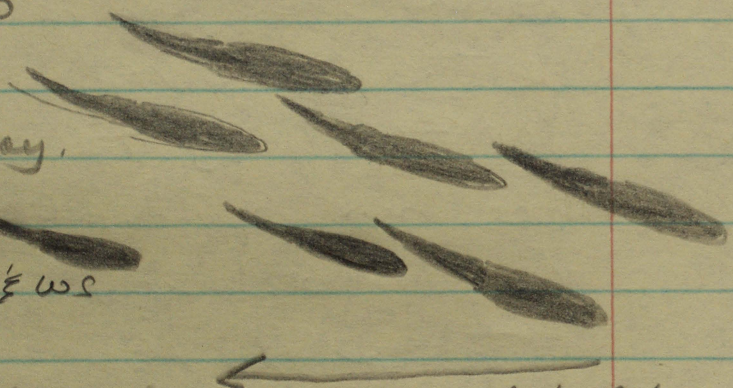
Today's group seems to me like part of yesterday's

group. most of them were medium (~3 cm) except for 3 or 4 who were fairly large.

Pirisurgo grey, no sun, or rain or wind. very calm water. I start with a Tow from the beginning of the reef that extends east from the Island. It's 2:27 pm The water is extremely clear There, about 100 ft visibility. We are headed to our study area. I see no squid along this reef. We arrive at study area at 2:35 The water here is a little murky but better than this morning. I swim all the way to nest #1 area, but see no squid. We swim around but I see no squid until 3:15 pm a group of 16 large & some medium two males are quarreling over a female. Some courtship. I see no succesful copulation. The water here is about 7 feet deep and bottom is coral and some TG. There are a couple of goatfishes yellow & spotted grazing under the squids I watch them a while. Suddenly

The squid bolt, The goatfishes do not follow the squids, but run in every direction, usually opposite from the squid. Everything calms down, and the squid returns to the sand area, The goatfish all return and resume grazing directly under The squid. It occurs to me That The goatfish are using the squid not only as sentinels, but also as decoy. When The squid return after being frightened, They do it moving arms first and very straight but Tilting there entire body up like so.

I observed them do This at least Three times Today. I Think They were in scale ORDERS with PCA.



← Moving in This direction.

8:55. Mixed group of 19 Sepiots and 8 X's. (These X's are almost certainly Doryteuthis. But I shall continue to call them X.) All the Sepiots are more or less large. 6 of the X's also are large (as large as any of the specimens seen by Arcadio in Washington), two are smaller, probably should be classed as mediums. When group is seen first, it is in 10 ft of water, over sand and coral bottom. It moves out to deeper water (15 ft), over sand and TG. Inds. remain 1-2 ft above bottom.

Some of the Sepiots are courting at first (2-3 pairs). Whole group, even the pairs, rather tightly integrated. But the X's form a definite sub-group. Tend to stick together in a unispecific cluster. But not necessarily closer to one another than the outlying members of the subgroup are to the nearest Sepiot.

Most of the Sepiots are in Ord + all or most of the time. Some go Dark from time to time, presumably as reaction to us.

Several of the ♀ Sepiots do conventional nice, Pie, DP performances. There also is at least one elaborate Z Spread Eagle counter, as at Ogupuluip (darker mid. above, lighter mid. below — surely these can't all be "rape" attempts!)

The X's are usually in Dull.

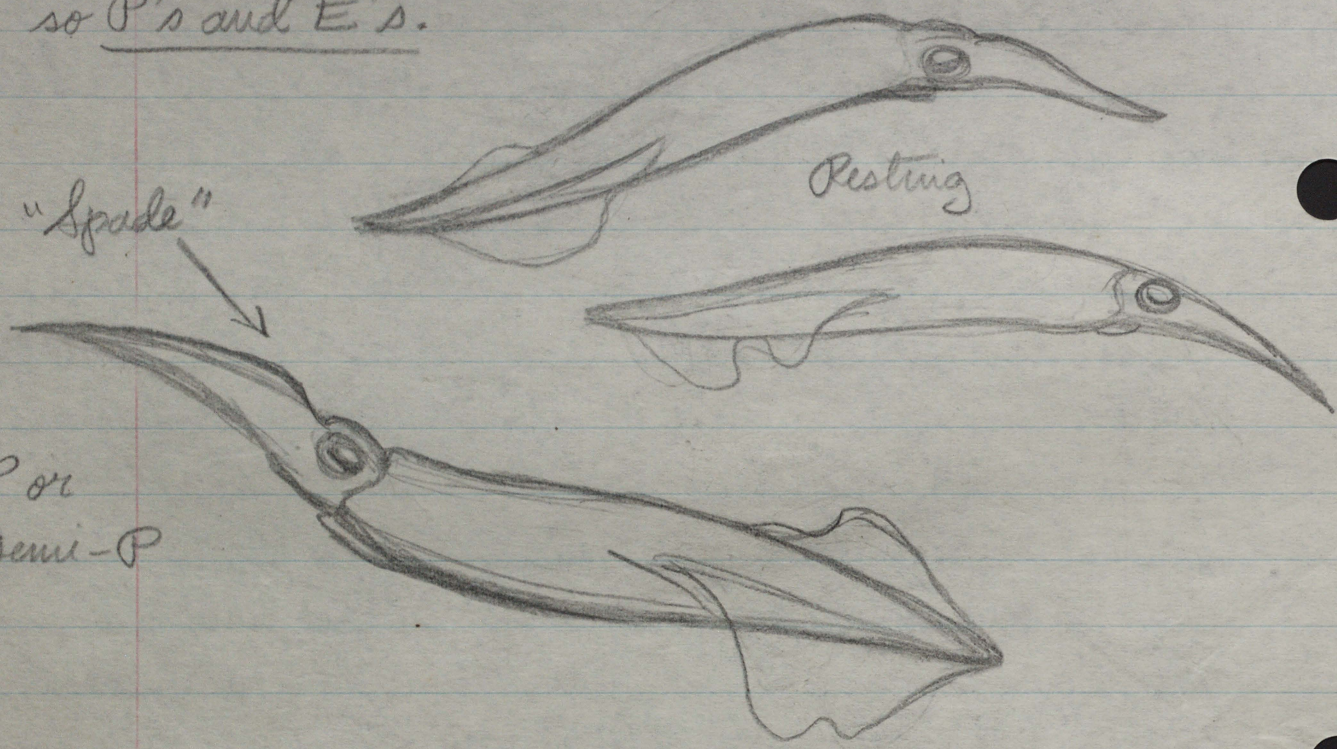
There are Spotted Goatfish feeding in the neighborhood.

Suddenly everyone, both Sepiots and X's, turn Pale, retreat a few yards. Then stop. Resume Ords and Dulls.

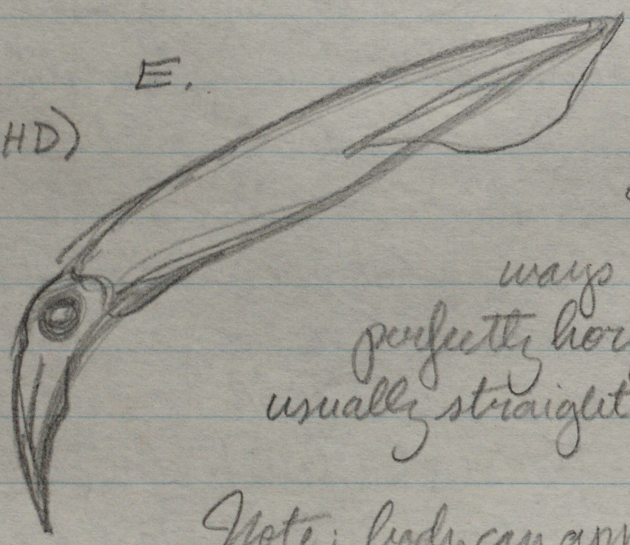
Notice that X's have characteristic postures. HD's as seen before. Also some "curved" semi-horizontal postures. All

Ceph., June 24, 1972. III.

so P's and E's.



One X does E and CL.
9:02 Sepiots do E and dark, to us.
One X does E without CL.



Note: Body is not always tilted in E. Can be perfectly horizontal. Perhaps usually straight.

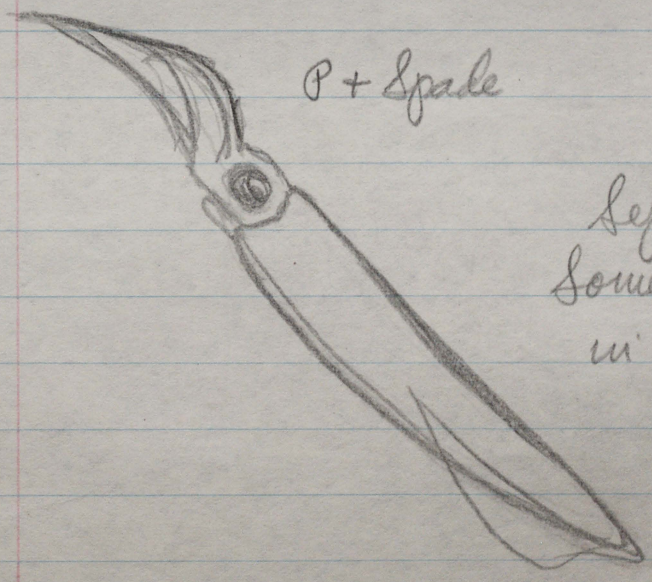
Note: body can appear to be slightly S-shaped in a variety of postures. I am not sure if this is "real" or not. It certainly is exaggerated, in effect, by fins.

The Sepiots seem to be courting less frequently now. Many mids. are quite Dark. This is perhaps surprising, bec as the bottom is very light! They are not cryptic now. Is their Darkness related to the presence of X's? Is it provoked by and directed toward the X's ???

Now most of the X's are in HD. Then they start to alternate P's and E's (again). All in Dull, at least most of time. Notice that tentacles seem to be spread at base during all or most P's and E's. Also during at least some simple HD's. I shall call this pattern "Spade".

Spade
View from above.

Spade seems to be more extreme with E's than with P's or HD's, on the average (probably a fair amount of variation).



P + Spade

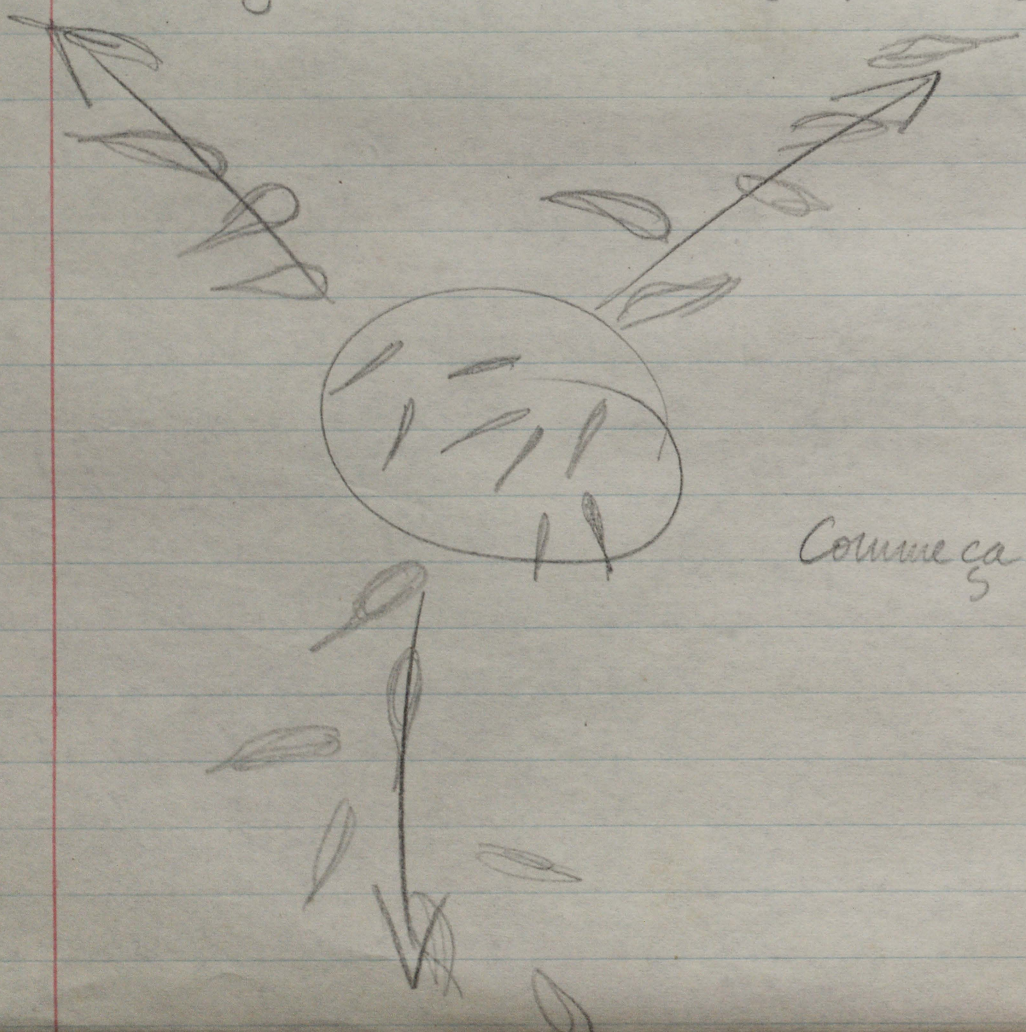
Sepiots are also E'ing now. Sometimes in Dark. Sometimes in Ord+. 9:08. Apparently the E's of Sepiots are not direct responses to X's. Nor are the E's (or P's) of X's direct responses to Sepiots. But I wonder if there could be an "indirect" connection? Are Sepiots doing more

more E's than they would otherwise because the X's are doing E's? Or vice versa? How close or complex is interspecific communication? (Certainly the 2 forms understand one another's alarm signals.)

X P's and E's continue. Most in dull. Just a few with CL. E's more likely to be accompanied by CL than are P's.

My impression is that CL's are more common when we are far away than when we are near. Is CL "inhibited" by fear? What sort of signal is it, what function does it subserve?

The spatial organization of the group is remarkable. A "nucleus" of X's, with 3 radiating "spokes" of Sepiots



Comme ça:
5

All inds. turn Pale and dart off again. Back in Dell and Ord + 9:14.

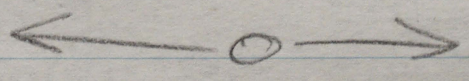
The X's do not seem to be courting. And even the Lep iots seem to have stopped for the moment. (There are still 18 individual Lepiots present. I.E. the "pairs" that were courtin g earlier have not left. They have simply subsided.)

Then some of the Lepiots start to Rock again. With little or no color changes. The Lepiots are still P'ing and E'ing from time to time. Presumably all due to us.

NOTE: The X's are also still active. Alternation of HD's and/or E's with P's or unritualized horizontal postures is quite reminiscent of Lepiot Rocking in physical form. But I doubt if it is a display per se. Perhaps normal "resting"? Response to wave action? I may add, however, that the HD phase is usually longer than any "contrary" horizontal or up ward phase. Is HD the "sleeping" position?

I get out of water 9:15 a.m. Go back 9:27. Arcadio has been photographing in the interim. (He has a snap of Q+ RL with or Lateral Pelver. SAN.)

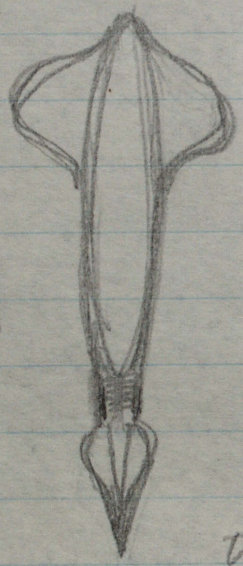
Now X's are a nucleus between 2 wings of Lepiots



One or more X's does CL. Without either E or P. Then more HD by X's. HD by one of the melanins is almost ver tical. X's still alternating P's and E's from time to time. E's in either horizontal or HD.

Ceyl., June 24, 1972, VII.

All X's turn Pale and retreat. Back relaxed again. One mid. does Spade in HD without E:



Just exaggerated

Body is relatively very long.

I suppose that HD and E are quite closely related, but it may be convenient to continue to treat them separately for the time being.

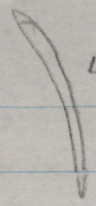
COMMENT: It is really very remarkable that there is absolutely no sign of inter-specific hostility in this group. Is it because the animals are "resting"??? Still CL's occasionally, in horizontal, HD, and E or semi-E positions. I can't tell what, if anything, is provoking them.

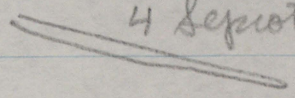
Stop observations 9:40 a.m.

Going back to same area in afternoon. Still sunny but with more wind. Into water 1:20 p.m. Mixed group is still there, but considerably reduced in size. Now includes 8 large Sepiots and 5 large X's. Sepiots in Ord+. Some do E in Ord+. Then some do P in Dark.

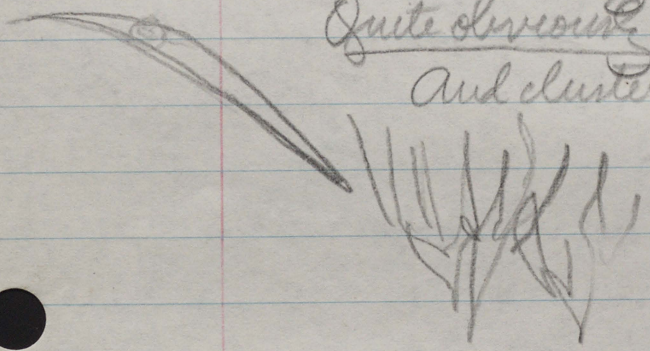
All the animals are very low. 1 ft or less above bottom (in 15-20 ft. of water), still over TG (or algae) and sand. Still segregated, but not quite in same way as earlier. See diagram on next page.

Ceph., June 24, 1972, VIII.





All the x's are very close together. Tilted upward. Quite obviously "asleep". At least relaxing in siesta. And clustered quite close to patch of little "bushes" Presumably cryptic?
(Addition: the X mids cannot be more than 2"-3" apart)



The Sepiots are somewhat more dispersed. No closer than 1' at their closest. Now 4 are in E, 3 in P (1 apparently gone). Postures maintained for a long time. Are these animals also semi-asleep? (Are P and E characteristic of animals which are "disturbed" but still reluctant to move?)

Stop observations 1:35. Arcadio goes for shallow tow. In channel. Investigates floating Sargassum. Nothing. Goes around Little Miatupo. Completes circuit. As boat returns to group area, the squid inks, retreat, return. Then we go on to offshore reef. Arcadio sees blobs of ink 2:05. Then 12 small Sepiots, 5 ft below surface in 30 ft of water over sand. Disappear immediately. We stop 2:15.

Out again later in afternoon. To mixed group site (after French yacht has passed over). Into water 3:40 p.m.

Ceph., June 24, 1972, IX

Find 6 large X's and 23 Sepiots (20 large, 3 medium)
COMMENT: This reassemblage would suggest that the Sepiots, at least, disperse into relatively small groups when they "sleep" during the hottest part of the day. Perhaps the diurnal social cycle is: small groups at night, large groups in morning, small groups at noon, large groups in afternoon ???

There are some Z-Spread encounters among the Sepiots. Dark above, light below, as usual and as at Ogupuko-jo. One of the inds. involved in such an encounter swims away in PH. I notice that the fins are transparent with dark brownish borders in this PH. Quite conspicuous.

The X's are in HD. Some with CL from time to time.

Sepiots also (still) doing lots of P's and E's.

Spacing of animals is still distinctive. Horizontal spread shown in diagram on next page. The X's are still very close to bottom. The large Sepiots have come up, to mid-water or only a few feet below surface. (They also are showing a tendency to move inshore, nearer to larger clumps of coral, etc.) The medium Sepiots are lower than the larges of the same species, but not as low as the X's. There are Spotted Goatfish below the large Sepiots.

Ceph., June 24, 1972, V.

x's

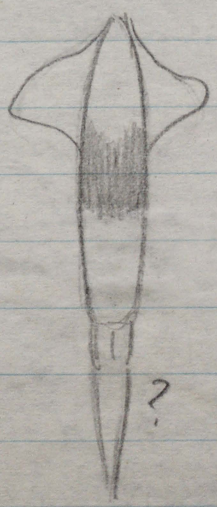
Medium Sepiots

Line of large Sepiots

The X's are often in HD. And the HD's are often very steep, nearly vertical.

3:55. There seem to be only 4 X's around now. Apparently scattering as afternoon wears on. But see below.

The X farthest from us does E in Dull, body horizontal. Then goes into HD as I approach. Still in Dull. Is HD an alarm, "hiding", cryptic reaction? (If so, just the reverse of cryptic upward P of Sepiots)? Then this X goes horizontal and assumes distinctive color pattern. The first of a series which I shall call "Neapolitan" ("Neap"). More or less common as:



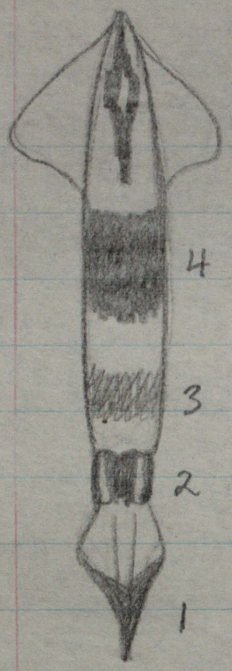
Spade?

Then relaxes back into Dull.

The 3 medium Sepiots are now at least 20ft away from the others. In constant E and P in Ord +. Turn Pale as I approach.

One X also turns entirely Pale (apparently essentially completely transparent — internal organs almost invisible). Then another mid. X goes entirely Pale except for mid-body band and "crown". Then gradually goes darker in other regions, to form a very complicated Neap indeed:

Ceph., June 24, 1972, XI.



Light spot in center rear seems to be CL.

Note numbers

Slightly exaggerated contrast (all dark is more or less brown or red?)

With "Y" (Silver)

With Spade.

Background is entirely Pale, perhaps transparent.

Presumably this is not PH???

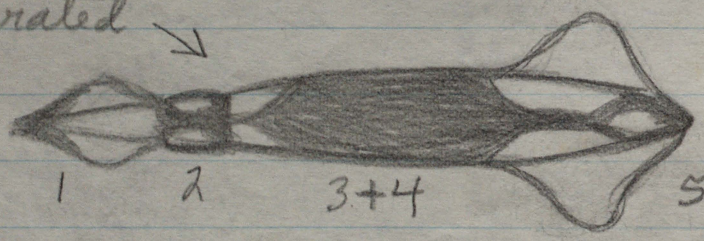
I can't tell what releases this performance. Perhaps a fish (not Goatfish) swimming nearby.

4:02 p.m. Suddenly this animal turns entirely Pale and retreats. Then returns. Resumes complex Heap as before; all 5 areas dark and distinct from one another.

There seem to be only 3 X's now.

One X assumes still another version of Heap.

Again exaggerated ↘



Then another mid does same (1-2-3+4-5)

One of the Spades with Heap "expands" a little to form what might be called a low-intensity Spread with "semi-Z" (conspicuous dark flecks, if not complete stripes, on arms)

Ceph., June 24, 1972, XII.

4:10 p.m. The X's are still near the bottom, still at the same site, but the Sepiots have drifted slightly farther away. Now there are Yellow Goatfish under the Sepiots.

There also are more Z encounters among the Sepiots. And some Rocking of pairs. A ♀ of one pair turns Pastel and Rocks with a ♂ in Ord+. Then the ♀ reassumes Ord+ and the ♂ does Lateral Silver, while Rocking continues. This pair is "at end of the line" of Sepiots, but not really detached.

The ♂ Sepiot goes Dark when fish approaches. Dark combined with PCA. And also Spade. (Obviously the "spreading of the bases of the arms" which I have seen in Sepiots before is the exact equivalent of the Spade of X.)

Then the ♀ of this pair goes Pastel. The ♂ accelerates and approaches her in a very Brown version of Ord+. Then the ♀ reverts to Ord+. ♂ immediately falls back. Does this suggest that Pastel is an "invitation" display?

There seem to be other pairs of Sepiots doing low intensity courtship some distance away from me. But it is my impression that courtship in general is not yet far advanced in this group (which may explain why it is still a group).

Lateral Silver presumably is not high intensity, at least not advanced, as a sexual pattern.

I go out of water 4:12 p.m. Go back in 4:20.

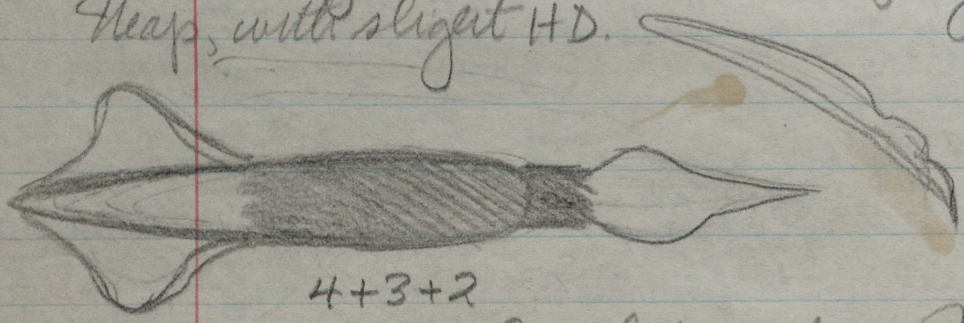
One Sepiot does Dark Z-PH with Z spread to an mid. in Ord+ immediately above.

Ceph, June 24, 1972, XIII

There seems to be a counting pair in center of Sepiot group. ♀ does Pie. ♂ remains in Ord+.

There are 3 X's still around. Still in same place. (The species is very sedentary during the daytime!) One mid. is (still or again) in complex Heap as in top figure on page 239 but without Y (or silver) over eyes. The second is Pale throughout. The third is in yet another version of Heap, with slight HD.

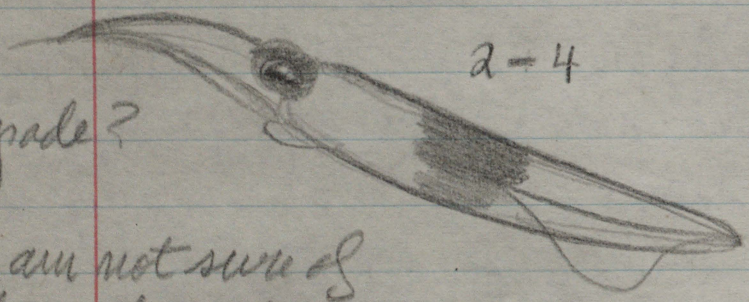
And Spade



4+3+2

4:30. One of the mids. in Heap (the "twist") suddenly also turns entirely Pale as a fish passes by.

Then one mid. does Heap in P.



2-4

Spade?

I am not sure of the underside

All of the X's disappear 4:32. Due to appearance of jacks?

I stop observations.

But Arcadio tells me that all 8 X's come back a few minutes later.

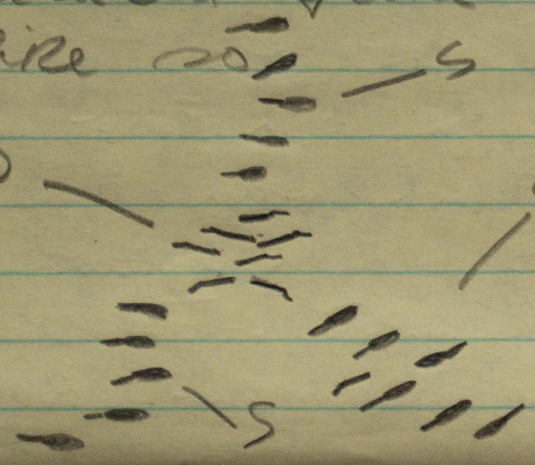
SIAN.

XII

Miatupo, San Blas
June 24 1972

7:44 a.m. The usual area, d swim out into deep area of reef, lots of grazers, water is very clear but see no squid. d cover the whole area and see nothing, Then d run into Martin and he points a large barracuda, d chase it away. Then d swim along the shallows and see two large brown sting rays & another barracuda smaller than the first but still quite large. This may explain the absence of squid.
d go for Tow at 8:05 a.m. d run into 7 medium squids, when d see them they are moving parallel to me but in the opposite direction. They are all in PH with fins striped d follow them but they never stop moving. d loose them in deep water.
d go on with Tow over deep slope of Island water there is murky with a lot of minnows as usual.
Then d get into corally area & sand where we saw 2 courting pairs

last time here. There are a lot of grazers and the water is clear but a little murky in clouds near the shore. Probably from the grazers. I see a sand shark 6-7 feet in length come over the sand on the deep fringe of the reef. It stays around the reef briefly, then goes on to deeper water, I notice a remora on back of its dorsal fin. A few minutes later I see Martin following Two large sepiots. He loses them a few moments later. I go for tow around small Miatupo at 8:53 AM I run into 26 ind. its a mixed group of large Sepiots and 8 Dory Ten This. The group is not well integrated. The Dorys stayed in a group in the center of the flock and the Sepiots out in Two or three ragged lines which radiated from the group of Dorys like so

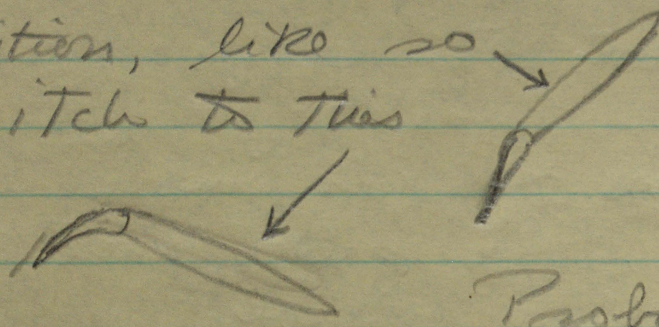


XIII

Wiatapo San Blas
June 24 1972

Like The Sepias, The Dorys also pale when frightened, also they'll go into a light brown reddish embroidery like pattern over pale when they are approached slowly by me (fear?) Their movements are clumsy and quite jerky, also very stiff when turning around on center. I noticed some rocking (courting?) but nothing came of it. Once I saw them switch to a barred pattern over pale (why?) They seem less concerned with our presence than The Sepias, but they keep their distance. their CL (center light) seems a little chronic. at one time I saw one approach another its CL very bright as if to attempt copulation. The ind that was being approached simply retreated without any change in color pattern End of observations at 940 am

1:12 pm On small M. calyx I found same group as this morning. ORD WS PEA When I see the Dorys, they are in an almost vertical arms down position, like so ↘ and then switch to this ↙



Probably to watch us better, I am too far away to notice any change in color pattern, but I don't think they did. There are some spotted goatfish in vicinity of group. Squids are close to the bottom just like this morning and less than 30 ft away from where we originally found them. I count 16 individuals, including 8 dorys, one of the dorys is well integrated in the Sepiots group; the other seven are keeping pretty much to themselves next to a group of green calcareous HALIMEDA OPUNTIA algae. The bottom is sandy and the depth about 15 to 17 ft and near the deep slope, there's a slight current due east or so and it's a very sunny day. The formation

deteriorates probably due to our vicinity. The Dorys remain in the sandy area, the Sepiots go brown over the coral in shallower water. Martin thinks They (The Dorys) are waiting for Dark to get active. He's probably right, the times that we have seen them was at night and they were awfully active. At 1:33 pm I go for tow around Island. Some Ink puffs, very small (PICKFORDICTEUTHYS Pulchella?) later on I see some larger ink puffs, probably Sepiots. I head Towards our Study area in large Miatyo There are a lot of predators, one barracuda among them. Shark on other side of Island 5-6 ft. Seemed interested in trap set there by the Indians. Just around Island, on lee side I run into group of 15-20 med & large Sepiots. I come upon them rather suddenly. They ink and bolt. They'll probably be back to same place. end of Tow 3:15 pm

3:45 pm Back to small Mataso
the Sepiots are still over the reef
and the Dogs over the sand by the
calcareous algae. They don't seem
too well integrated. The Sepiots
seem to be paired off, not much
sexual activity, but RL-ORD-WS pattern
Sepiots ♀? were paired to a generally
PH WS spotted ARMS ♀? I noticed a Sepiot go
slowly from an ORD & WS pattern into
a Zebra with flaring of arms, fluttering
of body etc for no apparent reason
at all. Then it went back to ORD very
slow. I see 18 sepiots in the group
now. I also noticed that RL-ORD-WS Sepiots
keep flashing their neon light on the half
of the body facing their partner, even
though this one may not be displaying
a flutter or copulatory advances.
The male was usually in a dark PH-WS
with spotted arms. 7:15 pm Dive & Tour
on Small Mataso. Spotted Dogs in
a group of 8 in same place I left
them earlier, but started moving away
as soon as the light hit them. Did
not see any sepiots. Covered the lukile
lee side and some deep water to
30-35 ft but no sepiots. Do They

XV

Niatupo, San Blas
June 24 1972

go into deeper water at night or does the group disperses and then regroups in the morning?

Cepl., June 24, 1972, XIV.

Running light at night.
8:15 p.m. Two Sepiots show up. Larges. Pair? Stay low. In Ord (+) and/or Dark.

June 25, 1972
San Blas

Still at Huatupo. Lots of rain last night and at dawn. Also local fishermen. But everything calm and clear now. Go to nuvid group area. Into water 8:00 a.m. Cold. Moderately clear.

Find group ca. 25 Sepiots almost immediately. 3 ft up in 8 ft water over coral and sand bottom. Group mds. range from large to medium. Include at least 3 courting pairs.

Lots of Pies by ♀'s, correlated with Double Streaks + Fwi Stripes, or Double Streaks alone by ♂'s. It is my impression that ♀'s tend to assume Pies before ♂'s get their Streak-Stripe patterns. But it also seems likely that the Pies are in response to approach movs. or int. movs. by the ♂'s.

One mid. suddenly retreats a few feet in PH + DM.

When not in sexual or high intensity hostile display, most mids. are in Ord, WS, Y, PCA. Two mids. retreat before a fish in Dark. But Darks seem rather less common now than during observations yesterday. Why? Could it have something to do with T° regulation during periods of repose???

♀ in Pie. ♂ follows in Ord +. Both Rock
♀ in Pie. ♂ follows in Double Streak. Both rock.
There are Spotted Goatfish swimming below the squid

All the squid are more or less in line. Rather surprisingly, the two most active, courting pairs are at the same end of the line, next to (but not interfering with) one another. (It is more common to see courting pairs at opposite ends of a line.)

♀ of one pair goes Pie as ♂ approaches. He is in Double Streak - Fin Stripe. The ♀ does not rise, but rather shoots away more or less horizontally. The ♂ shoots after her. There is a very fast twisting chase, extending for 10 yds or so and several seconds. Both mids. turn Pastel or an intermediate between Pastel and Pale. Then chase stops. ♀ resumes Ord+. ♂ goes PH and then Ord+.

Another fast twisting chase between a ♀ and a ♂ (don't know if same mids. or not). Both mids. in intermediate between Pastel and Ord. And both fluttering in extremely exaggerated manner. The chase attracts a 3rd mid., presumably another ♂? This 3rd displays to the other two. Does PH with Spread facing them. PH, not Σ, markings on arms. This seems to subdue the pair. They move on more slowly in Ord+. 3rd mid. does not follow. Also resumes Ord+.

Same pair a few minutes later. ♀ does Pie, rises DB, as ♂ approaches in Double Streak (and Fin Stripe?). Fast twisting chase with extreme fluttering. Both mids. again assume intermediate between Pastel and Ord. A 3rd mid. (again?) approaches in PH. Chase stops. All relax.

8:17. Same pair starts again. ♀ Pie, ♂ follows in Double Streak. Fast twisting, fluttering chase develops. ♀ rem

arms in Pie throughout, but ♂ goes into Pastel. Then (again) 3rd mid. approaches in PH. The ♂ who has been following the ♀ does PH, with Spread, Z pattern on arms, back. All relax.

Several rather large fish swimming through and around group don't seem to disturb squid at all.

More Roching and chasing. ♀ always in Pie, ♂ always in Double Streak, with or without Fin Stripe.

Then there is a conspicuous hostile encounter. Presumably between 2 ♂'s (?). One mid. does PH. The other does PH with Spread, Z markings on arms. This latter definitely has belly light at the time, almost certainly also Fin Stripe.

Now there is a trio going. ♀ in Pie, followed by ♂1 in Double Streak and Fin Stripe, followed by ♂2 in Dark.

Courtship behavior is nearly continuous this morning. So far it does not appear (to me) to be very high intensity, but see also below.

8:30. Going to look for X's. No sign of them. Definitely not at site preferred yesterday. COMMENT: X's must be much more mobile than Sepiots. Is this because they hunt their prey actively? What can their prey be? Which brings up another subject. X's must be largely nocturnal. And at least some Sepiots also are at least sometimes active at night. Why are most cephalopods nocturnal? Is this true of relatively large predators in general? Even on land?

Out of water 8:35. Back in 8:45.

Sepiots still there. Behaving as before.

Then the main bulk of the group shifts off. Leaving

3 pairs of larger behind. The pairs are still courting, apparently mutely. Each pair about 6 ft from its neighbor. Now I see that the others, the bulk of the group, are approximately 20 ft. away.

A motor starts up ca. 50 ft away. Loud to me. The squid do not react in any very conspicuous or abrupt manner. But the main body of the group gradually drifts back to the three pairs, away from the course of the boat and motor. Is this really significant?

Go to look for X's again, 8:55 a.m. Still no sign.

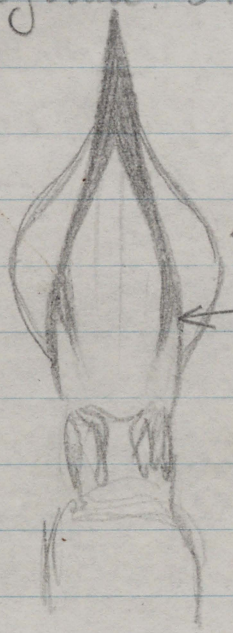
Back to Sepiots. More or less as before. Perhaps somewhat less active. (But Arcadio tells me that there was a cop. a few minutes earlier. At edge group. SAN.)

Out of water 9:05 a.m.

Going to visit some other islands this afternoon, further out toward algal ridge. Start with Orgitupo. Hot, calm, oppressive. Get into water 12:50 p.m. Nice reef. Floating Sargassum. Lots of small sardines in dispersed formations. No squid. 1:15. Stop. Then out to Huichutupo. Arrive 1:30. Arcadio does shallow tow. Over large TG flat, then sand, then more TG again, more sand, and finally more TG in very sheltered bay. No squid. Why? (The whole area is very reminiscent of the "nursery" on Panetupo.) Stop 1:55 p.m.

Back to area of mixed group near Huichutupo. 2:15. 9 large Sepiots still there. In exactly same place as this morning. Ord, WS, Y, RCA. One mid. does E in Ord + to us. Another does PH with spread, Z on arms, presumably also to us (?)

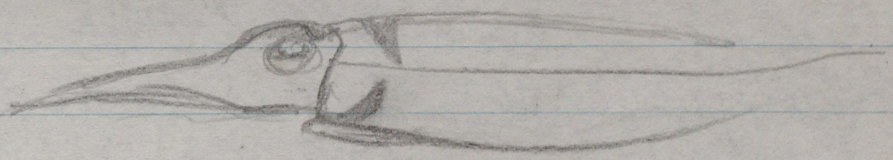
Go to look for X's. No success.
Back to Lepiots 2:23. Inds still in Ord, WS, Y, PCA most of time. One ind. has extreme PCA with Spade. Commune ca. 5



Presumably tentacles. Quite transparent.

Indication of arms

Then several of the animals, presumably pairs, go into semi-Pastel. One presumed ♀ combines semi-Pastel with dark marbles of Pic.

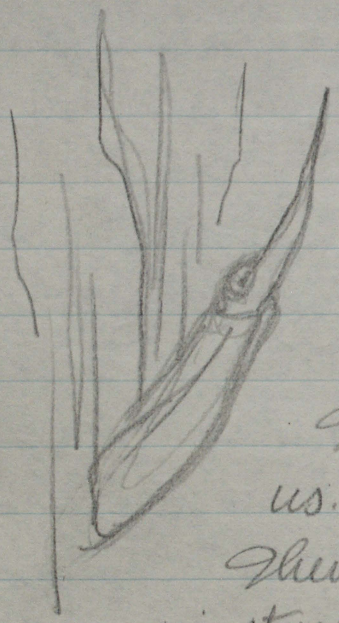


Then several inds. go Dark. One ind. does extreme Curl in Dark.

2:30 p.m. Two inds, presumably pair, suddenly go into (what I suppose) is cryptic pattern. P with body mainly vertical, with Ord, WS, PCA, and possibly Spade (with tentacles brown, not transparent). Low in water. Just beside and slightly above gorgonian. See sketch next page.

Then one of these P-vertical-cryptic animals does PH and Spread Z pattern on arms, when 3rd ind. approaches with

in one foot. 3rd retreats. The other resumes crypsis.



I swim around to try to see underside of animal. Certainly dark below fin. Probably Quadruple Streak

Then one mid. does E in Ord+ to us.

Then pair goes P-cryptic again. Now in staghorn coral. Is this posture a resting posture? Then another pair does same thing. Can see bottoms of all four. Entirely dark (medium brown) below, except for funnel, which is transparent.

Another mid. is supplanted by a fish. Twice. Each time it retreats a few feet in semi-Pale. Then, when fish stops (goes away), the squid advances again in Ord+ and Curl. What does this tell us about Curl? A "relief" pattern? A "Training Display"???

There are Spotted Goatfish around (still).

Courtship is still continuing, at a not very high rate. Not among the mids. being cryptic near the bottom. But among the others, who are swimming higher up. I see one female approached by 2 ♂'s, at about 1 minute interval. Each time she rises, Pres, DP's. The first ♂ is in Double Streak - Fin Stripe during approach. Gives up as ♀ rises. Resumes Ord+. The second ♂ is in Quadruple (perhaps even

Quintuple — I can't see belly) streak plus fair stripe during approach. Also resumes Ord+ when ♀ doesn't respond pos dwdy. (Note: As far as I can tell, this is not an established trio. The 2 ♂'s did not seem to be associating with one another, or even with the ♀, beforehand.)

Stop observations 2:45 p.m.

Go on to "Salar" Islands. Into water near shore 3:55 p.m. Warm. Murky. This inshore environment is characteristic: extensive TG, some coral, a fair amount of sand, huge numbers of Diadema, many holothurians, many starfish. We swim around until 4:20. Then Arcadio goes for shallow tow until 4:50 p.m. No squid.

This is not perhaps surprising. The concentration of detritus feeders is so great here, inshore, as to suggest that there is too much debris for squid. Irrespective of the TG.

It does not, however, mean that adjacent habitats are unfavorable. To whit: the offshore open waters.

The Settuja is anchored quite far off shore here. In fairly deep water. And small (tiny) squid start to appear by the ship fairly soon.

6:14 p.m. 3 smalls near surface. In more or less Ord + . Rather scattered, 5-20 ft apart. Soon swim off.

7:15. Running light. 4 smalls (tinies) appear at surface. Not very close together. More or less Ord + at first. Then the arms and tentacles of one mid. turn entirely white or transparent. A few seconds later, same mid. does upward V and Curl (arms still white or transparent?). Then another

mid. does V-Cord.

The mids. drift off but soon come back (or are replaced by others of similar size). Arcadio watches while I am writing. Sees feeding on both copepods and fish (one fish almost as large as the squid itself). Inds. usually darkish (Ord + ?) when far out, Barely light. SAN

More Sepiots, mostly small but also 2 mediums, come in later. SAN. Going to bed 9:00 pm.

June 26 1972
San Blas

Still at Salar Group. Somewhat cloudy. Very windy. Water rough. Go over to (another) island called "Orgitupo II" (no. II on "Orgitupo de Salar"). Arcadio starts shallow tow 7:45. Goes all the way around island. Then on to adjacent island of Ukupsui 8:02. Tows all around island. On to adjacent small islet ("Yantupo") No squid anywhere. (Note: the islands here are rather scattered. They do enclose a "lagoon" but only very partially. I.E. the rough weather is having full effect here.)

We go on to another larger island (name unknown) 8:35. Almost immediately, Arcadio sees puff of ink. Near surface in approx. 20 ft of water. I go in. We swim around until 8:55. Find more puffs ink. All small, black, near surface, in deep water. I.E. probably emitted by small Sepiots. But the animals themselves remain invisible (Young in the open are almost always shy!)

XVI

Maitupo San Blas
June 25 1972

8:01 AM Resume diving in same area as yesterday at Small Maitupo. 28 mid 6 med. ORD-WS-PCA I notice 2 or 3 counting groups still low keyed counting. They are in a Separata formation, they are in 7-8 ft of water over coral, sea fan Gorgonians and sand. Grazers everywhere, every now and then one darts through the group, the squid nearest to the passing grazer PH-WS but does not retreat much. I notice one of the paired females flutter without the RL first male seems a little excited in PH-WS. with dark motley arms but does not make any advances. Second male cuts in with no fluttering also in PH-WS. DMA but does not press on everything cools again. Every now and then I notice a female pic and a little bit of fluttering from the males, but not much everything seems quite dull.

Most times are beginning to pick up two males display zebra & flatten and flare, depending male under attacker, preventing attacker from approaching ♀ then depending ♀ shoots away from attacker goes light very light lavender and flutters as he approaches "pied" ♀. the attacker follows behind in a Z pattern. Defending ♀ attempts cop. but fails. attacking ♂ again approaches and depending ♀ hits him with arms rapidly as in copolation. attacker ♀ pales and retreats rapidly. At this point thinks really start picking up there's at least 3 pairs attempting cop. at the same time and they are darting in and out of the group in all directions. The ♀ are all pied RL, their RL moving from one side of the body to the other always to the side from which the ♀ may be making its advances. The males are fluttering and lavender everything is moving rapidly. There's at least two second males, each following a courting pair and they are in Z & DF and also very excited, for

Miatupo, San Blas
June 25 1972

a while it looks like a free for all. I cannot take notes and watch. There is one (I think) successful coupling. I see the female in light ORD-ws bunching up her small arms as if arranging spermatophors. Everything cools off again. 4 moments later, I see 2 juveniles approaching the main group, they are close to the surface and travelling arms first like so in Boxed pattern. I approach them and they start to swim towards open sea I photograph them and they change their postures several times. I go back to group and a few minutes later about 15-18 of them leave moving arms first as if to investigate some occurrence that has called their attention. They all are in very light ORD pattern I do not detect a ws. 9 ind are left behind. Before the group moved away to investigate? these 9 ind were all below the group that left. I noticed 3 pairs

and perhaps a fourth group + 1 cleftsided male? PH-WS. I watch them a while but everything is pretty dull. I move on to observe the other group and immediately notice a TWO counting. Their movements are terribly fast and violent. both males and in ♀ most of the time except when either is approaching the female to attempt copulation. both males are large and equal size. This is real competition, though one seems to have already established supremacy. The female is almost constantly in "PIE" & RL moving very fast and parrying one advance after another, her RL switching rapidly from one half of her body to the other always to the side from which she was being approached. She is almost always swimming rapidly and darting in every direction. Every now and then the males will flare & ♀ at each other, then the female will stand by sort of waiting the outcome, then first ♀ would resume the chase while second ♀ attempted to beat him to it. Fluttering males seem to display a dark inner line on the lower section of their mantle

XVIII

Nia Tupo, San Blas
June 25 1972

its not conspicuous but fairly easy to detect once noticed. Finally first male succeeds in coupling with the female. The second male following behind in 2 row but on action decreased gradually. They were still at it when I left them, but all very low keyed. end of observations, at 9:15 AM.
9:45 resume observations at sand area, all very dull. Then went for tour around small Nia tupo, no other groups. end of tour & deep tour at 10:45 AM.
ORGITUPO, Lemon Keys NOT FAR FROM Nia tupo 12:50 pm we explore the area The bottom is coraly big heads of coral and large clumps NO squids we stop observations at 1:20 pm. Then go on to HUICHUTUPO and explore, the area lots of TC rone sand areas with starfish no squid we stop at 1:55 pm The area looks interesting, ideal habitat for young as well as large squid.

Small Wiatupo 2:15 pm 5 large ind. 12 ft deep sand near coral ORD-WS-PCA very light. I see one approach the group arms first, does a and & Turns around joins the group and Z Then goes ORD-WS and does an E and rocks. Then a ♀ parts from the group and heads to sea and meets an approaching ♀ she "pies" and ♀ flutters as he turns around and goes parallel with her to the group. More squid come in from deeper water. I go investigate but find no more squids. The water is not very clear and the squids are behaving very dull. I see Two ind almost vertical and parallel to a gorgonian. They are in Dark PH & WS PCA with wide fin stripes and a wide ventral stripe. At 2:41 pm there are 10 ind. in the group. They are all in PH & WS It occurs to me that when they are all in a uniform pattern, There will be no action. End of observations 2:45 pm Salon 3.56 pm I swim and tour over T.G. areas, sand, and coral, lots of sea urchins spread all over the place, also sea stars no squids. end of observations at 4:55 pm

XIX

Salen, San Blas
June 25 1972

Nightlight observations 7.15 pm.
4 juveniles in dark reddish and
barred pattern, and dark reddish
with WS. One takes a minnow
about 3/4 the length of its mantle.
It swims away struggling with
its catch and stops by the light
of the light and goes on struggling.
The others dart in very close to the
light, and dart right out they seem
to capture something then go on
into the dark to swallow it. Probably
copepods. There's a high concentration
of them in the immediacy of
the light. I notice two more
squids, extremely small. So there
must be about 6 squids in the vicinity
of the light. Another takes a minnow
about the same size as the first and
then a third follows suit. This last
one caught a smaller minnow than
its predecessors. Again another attack,
this time upon a very small organism, and
probably a small coelenterate, for

an instant later the squid lets go of it and darts away pale and shaking its arms, probably was stung. Another successful attack. The squid stops brushes its arms then moves away slowly mantle first with its tentacles trailing long.

Now a medium size squid joins the show darts in in dark reddish barred pattern grabs a small organism and darts away in same pattern plus MD. Now I see a juvenile attack, its in dark reddish but patterned as "pie"? It succeeds, and darts out again without changing pattern.

End of observations, at 9:30 pm.

Then we go on to Porvenir. Weather more sunny now but still windy. Go into water 10:50. Swim over very wide areas, TG flats and coral. See lots of sardines, Goatfish, Needlefish But no squid. Stop 11:35

Still at Porvenir at beginning of afternoon Sunnier but less wind than in morning. Go into water 1:25 pm. Warm but not very clear. Swim over extensive area another side of island. Usual variety of habitats. 1:45. Find black ink in 5 ft of water over TG. A few minutes later, find more ink in deeper water. But we can't see the squid themselves. Finally stop at 2:00 pm. NOTE: It is interesting that the squid of this island are much rarer, shier, and/or at a different stage of the annual cycle from the squid of Halimeda which is so close by.

Then Arcadio goes for shallow tow along reefs between Porvenir and Michumdla (?) and around the latter. No squid by 2:45. So we stop.

I go into water to inspect anchor rope of Tethys by Porvenir. (Still) no squid.

We move on to Ogupekip. Arrive 5:45 pm. I go into water, in shallows by boat 6:00 pm. Visibility poor. Several small Barracuda around. No squid. Also inspect anchor rope. No squid. Arcadio goes for shallow tow. No squid. Out of water 6:15 pm

Run lights at night. Nothing by 8:30 pm.

ADDITION. According to Arcadio, nothing came in later either

June 27, 1972
San Blas

Ogupukip. Cloudy. Very windy. Arcadio goes for shallow tow along side of island where squid observed last trip (and earlier), 7:45-8:05. This is windy side now. No squid.

Then we turn point into lee. Find squid almost immediately. Group of 6 larges and 8 meds. at first (see also below). Size classes rather distinct. The 6 larges seem to be 3 pairs. Approximately 8 ft down in ca 30 ft water (shelf slopin very steeply here). Over coral clumps and sand.

All mds in Ord + most of time. But pairs of larges certainly counting. ♀ doing Pie +.

The pair of largest larges is at the end of the "line", and courting most intensively. ♀ goes Pie, runs with DP. ♂ follows, Fluttering, in Ord + with perhaps faint trace of Double Streak and Fin Stripe. Then there is a brief twisting chase. Both mds. in Ord + with perhaps trace of Pastel or semi-Pastel, perhaps stronger in ♀ than in ♂? Then the 2 mds. swim more slowly side by side. ♀ does a little writhing (not extreme, mostly tips of arms and tentacles) from time to time. Has she already been copulated with? Both mds. in Ord +. ♀ shows trace RL Diamonds (not correlated with writhing). Then the ♀ shoots backward. The ♂ shoots backward after her. Both in Ord + at least above. But ♀ also has "Speckled Belly" below (small dark spots on light ground, as in some Z performances). As the ♀ continues to shoot backward, the ♂ still follows but

XX Salon, San Blas
June 26, 1972

ORCHIDEA (Salon) 7:51 AM Tour around Island, TG + coral areas, flat with corals + sloping down corals to 35-40. The TG area is flat and shallow, looks like a good nursery for juvenile squids 8:05 AM.
ORQUIDEA (SAN BLAS) 8:07 AM coral sloping down steeply and deep bare sandy bottom with occasional coral and gorgonians, plenty of ink puffs but no squids are sighted. 8:55 AM
PORVENIR 10.58 AM In front of Jungle Jim's hotel slight current due west, lots of jelly fish. Bottom is shallow TG enclosed by coral reef, some rubble. There are lots of striped blue jacks. Head towards dock side of Island, water There is murky with churned sand, no squid ends of observation 11.42 AM, 1:21 PM Go for swim along west side reef (PORVENIR) some ink puffs

but no squids 2:03 pm Then go for Tour along reefs in front of dock at Pomwin and all the way to Wichub Inala, around Twin Island and back to Pomwin some like puffs but no squid 2:55 pm

Ogopukip: 5:50 pm down the anchor line to about 65 ft depth, sandy bottom and murky past 65 no squid 6:00 pm then go on shallow Tour along west side of Island and back to ship lots of large snappers, groupers and jacks, one large barracuda, no squids. Bottom TG and shallow with occasional heads of coral and sponges. End at 6:30 pm.

Night observations: 6:30 pm Sardines and copepods, no squids end of observation 9:15 pm

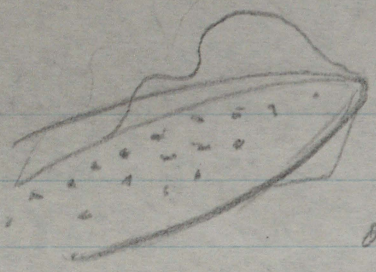
suddenly turns around to face her, shoots his arms and tentacles out to touch her forehead or adjacent area. Definite contact. Definite copulation. Apparently successful. As soon as cop. occ wis, ♂ turns around, to swim backward by ♀ again. Whole process very rapid. ♀ rearranges spermatophore(s) with shor t arms in usual way. Prusumably also loses Speckled Belly. ♂ turns PH buff when a 3rd ind. approaches. Latter retreats, ♂ resumes Ord +. ♂ and ♀ swim together calmly, both in Ord + NOTE: There was no Pastel in immediate association with this cop. Nor, probably, Fluttering. As cop. was simple, direct, and apparently successful, does this suggest that Pastel and Flutt ering are partly hostile, at least indications of "conflict"

Counting continues after I scrubble my notes. Now watching 2 pairs. Close together at one end of "line", but not really separated from rest of group. ♀'s Pie + in usual way from time to time. ♂'s usually stay in Ord +. Do occasional Fluttering. Why is there less Double Streak and Fin Stripe in this group now than in some other groups seen earlier and elsewhere? Are the pairs particularly well adjust here? Particularly advanced?) One or both ♀'s do(es) brief writhing from time to time. (This cannot be coincidental. Is it "anticipatory?) At one time, the 2 ♂'s come within a foot of one another. Probably accidentally. The upper ♂ immed. assumes Speckled Belly without other col or change. The 2 ♂'s separate. Speckled Belly lost.

Speckled Belly should be recognized as a distinct dis play. See sketch next page

1 Medium turns Dark Brick

Cepha., June 27, 1972, III.



Prelim. sketch Speckled Belly.
NOTE: I have not yet seen center of underside in this pattern.

8:20 a.m. All the squid swim away at moderate speed without turning Pale. Frightened by Leopard Ray? Back again immed.

2 Mediums go Dark. Relax. Then yellow-Dark. Relax.

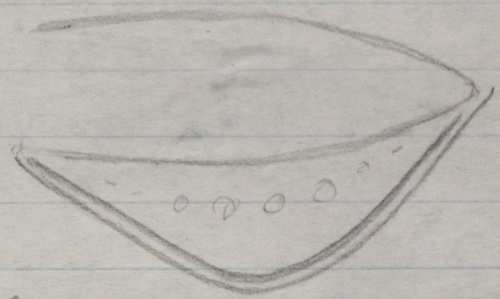
Now I notice that ♂'s of pairs swimming and Rocking with their ♀'s often (not always) have rather conspicuous light (white or light blue) borders to their fins. Extend whole length of fins. Combined with usual ocelli. Net effect is to make fin movements more conspicuous than usual. Obviously with deliberate. I shall call this "WB". NOTE: the animals with WB that I am watching now seem to be using their fins normally, not fluttering.

The ♂ of one courting pair does brief, slight PH with Z spread when a 3rd mid. approaches pair. Latter retreats. ♂ relaxes.

NOTE: There do not seem to be any real "trios" in this group now. Is this another indication that pairs are comparatively well adjusted and advanced? Probably yes.

Watching one pair rather intensively now. Interesting size relationship. The presumed ♂ seems to be slightly longer than the presumed ♀. Certainly not shorter. But the presumed ♀ is noticeably plumper. Presumed ♀ does occasional Pie, usually without mic and DP, as the 2 animals swim together. Also at least 1 brief Pastel or semi-Pastel. Otherwise in more or less Ord+

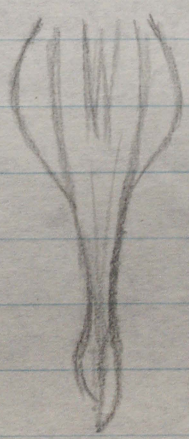
Sometimes with dark markings of Pic superimposed upon Ord or Pastel. Always, at least in Ords, with very conspicuous PCA (see also below). Presumed ♂ always in "Oriental Ord+", but with a brown stripe just inside border of Fw. Ocelli as usual.



Area outside brown stripe is transparent, not white or light blue as in WB. (Although transparent area may well correspond exactly to the light stripe of WB.) I shall call this dark stripe "BB".) Like the WB's seen earlier, this BB was combined with apparently unritualized fw movements.

What are the functions of WB and BB???

Both the ♂ and the ♀ have "Spade" all or most of the time. Equally developed in both (i.e. not modified by extreme PCA of ♀). I get a particularly good view of it. And will, therefore, have to modify my earlier descriptions. The bulge is definitely due to "outer" arms. Not tentacles. Probably outer arms of upper row all the others, "Spades" of this at time.

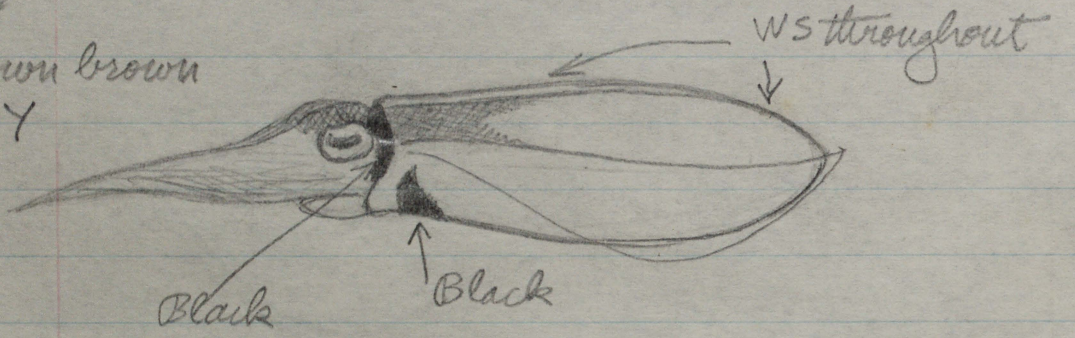


These outer arms, unlike are quite transparent, in the particular pair at this particul

NOTE: The "Spade" is difficult to see, or, at least, to notice. I am not sure that it is ritualized in Lepidoptera. And I can't

tell if it is rare or common.

Set out below is a sketch of a moderate-high Pic ly a ♀ (at intensity at which some of the back remains dark, Dr L and/or semi-Pastel)



Courtship seems to be becoming less intense 8:37 a.m. Group has become larger (as would be expected as the morning wears on). There is now one more medium. And 2 smalls have appeared 10 ft away.

Group is also showing a tendency to drift into shallower water. A sign of relaxation?

One medium does what looks like Bar on under-side! With Pt above ???

Smalls do DF without color change during brief retreat

Stop observations 8:40. Arcadio tows back to boat without seeing anything more.

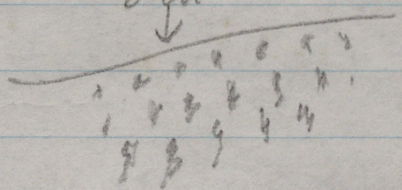
Go back to same place 11:00 a.m. Sunny, still windy. Find 18 squid at almost exactly same place as last. 2 ft down in 10 ft. of water over staghorn coral. (The increase in group seems to be due to addition of 1 more medium.)

Squid retreat before large group. surgeonfishes (Ac antheus) But not far and without changing color.

Ceph., June 27, 1972, VI.

There is still some courting in progress. Some Pies + One pair of larges is semi-detached at end of line.

Watching another pair, less detailed, at other end. Both ♂ and ♀ in Ord +. Swimming and Rocking together, ♂ usually slightly behind. Now see that ♀ has BB. She retains this BB throughout the whole of the following performance. ♂ has no B of any kind at any time. ♀ does several Pies, with mic and DP (and of course BB). ♂ follows every time. ♀ resumes Ord + between Pies. The ♂ seems quite excited. He makes many accelerated approaches to ♀. Also does lots of Bending. He does not change color. Each time he gets close, however, the ♀ (in either Ord + or Pie, whatever she happens to be in at the time) the ♀ (also) assumes Speckled Belly. This pattern is more complex, morphologically, than I thought. Spots over whole lower surface of body. Small and roundish on sides, below fins. Larger, more bar-like near center of belly.



Crude approximation

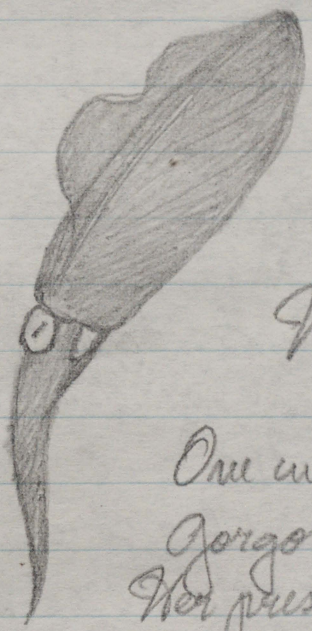
This behavior continues for several minutes. Pies and Ords with BB, retreats, occasional Speckles by ♀. Ords, approaches, and bends by ♂. Twice the ♂ shows trace of Double Streak - Fin Stripe during approaches But these patterns are not very extreme, more or less superimposed upon Ord +. Both mds. may show brief flash of semi-Pastel on Ord + from time to time. But this is difficult to be sure of. Now both mds

swimming head forward. And ♂ suddenly shoots forward, gets ahead of ♀, turns toward her, darts his arms and tentacles at her forehead, turns back, and falls behind her again. He does all this without any color change or flutter. The ♀ seems to be in Ord + before and during Cop., at least above (I can't see her belly). The ♂ tentacle made contact, but I am not sure that the cop. was successful. The ♀ immediately does E!, still in Ord + (BB etc) after contact. Then fumbles with small arms as if arranging spermatophore(s). But the ♂ certainly does not seem to be very "relieved". He resumes courtship as before after only a very few seconds. He resumes approaches and bends in Ord + and occasional semi-Pastels. ♀ resumes retreats and runs in Ord +, Pie +, BB, also with occasional semi-Pastels. She still usually does Speckled Belly when ♂ gets close. But then the ♂ gradually calms down after 2-3 mins. The 2 animals resume swimming more or less quietly, still together.

11:17 a.m. Groups seems to have shrunk to 15. Smallest gone?

Most of the remaining mids. have gone Dark. Notice that Iris are dark in Dark. Ocelli on back and Iris run ani. 2-3 mds. have kept a trace of WS, but the others have lost it completely. Most of the animals are still fairly near the surface, but it looks as if they are beginning to rest, to take their mid-day "siesta". Some mids. are floating more or less horizontally. More are in a "HD", very much like the HD of X!!! 3 or 4 are in P with body oblique. These P animals are near a

gorgonian. I.E. they are being cryptic



HD of medium Sepiot
Only eyes & funnel light

Moderately extreme.

One mid., large, apparently ♀, near Gorgonian, assumes extreme E in Dark. Her presumed mate and several neighbors continue P in dark. Then I look away for an instant. Turn back to find presumed mate of ♀ in Lateral Silver (usual orientation, Silver side away from ♀). The ♀ comes out of her Dark E, changes color. Goes "Bar" underneath (Ord + above ???). Is this reaction to approach of neighbor? Then both animals relax (?). ♀ resumes E + Dark. ♂ goes Dark in more or less horizontal position.

I go further away from these animals. ♀ stops E (i.e., her E was a reaction to my presence). Then assumes "cryptic" P with upward pointing body. Still Dark. ♂ also assumes P with upward pointing body.

Dark must be resting color (among other things). Resting postures can take 2 forms. I. P with upward body. This is most characteristic of animals near gorgonians, corals, etc. II. HD. This probably is most characteristic of animals in more

open water. I may be cryptic because it resembles branch of a coelenterate or plant. II may be cryptic because it resembles detached floating leaf or blade of TG.

Stop observations 11:30 a.m.

NOTE: One of the mediums in Dark had conspicuous light marks or streaks toward tips and/or on undersides of arms and tentacles. Due to injury? Display? In any case, SAN.

Back to same place 3:10 p.m. Windy and cloudy. Group of squid exactly where we left them. 15 larges and mediums. No longer dark. Most in Ord+.

Some counting. Watch 2 pairs at some length. Call them X and Y.

Y. ♂ and ♀ swimming together. A little Rocking. ♂ in Ord+, RL, and WB. ♀ in Ord+, occasional Pie, occasional dark marks of Pie superimposed upon Ord+.

X. Also swimming together ♂ in Ord+ with RL, but no WB (definite) ♀ in Pie, then in Ord+. ♂ suddenly does Spread, with Z pattern on arms, but rest of body still in Ord+. Provoked by and directed toward neighbor? Then ♀ advances in Pie+. ♂ follows in Ord+, then does sudden Speckled Belly (again toward neighbor?) ♀ resumes Ord+ and moves backward. ♂ follows, loses Speckle, retains Ord+. Both calm for the moment.

NOTE: the medium cited above still has white on under arms and tentacles. Also tends to separate arms and tentacles in what looks like forward V. I am now fairly convinced that it is injured or sick in some way. Another medium

has conspicuous scars at base of center arms. This group should be easy to recognize again!)

As far as I can tell, all the counting mids. tend to have "Spade" lilie this morning.

3:15 X Pair. ♂ suddenly does Spread, Z-marks on arms, Ord+ on head and body. Then advances on ♀ in Double Streak - Tri-Stripe. ♀ Ries, rises, DP. Then both Rock together ♀ in Pie+, ♂ in Ord+.

Y Pair. ♂ and ♀ Rock together. Both in Ord+ with RL. ♂'s RL is more extreme than is that of the ♀. He also (still) has continuous WB.

One medium, who has been in Ord+, goes Pale with DM as I pass over. Then relaxes into Ord+ again.

Another medium does E in Ord+ as counting pair passes by. (This E [illegible] certainly intraspecific.)

Y Pair ♂ and ♀ Rocking together. ♀ in Ord+ with dark markings of Pie. Shoots forward. Assumes extreme Pie. ♂ follows. Pair passes through center of group. ♂ suddenly assumes PH on back and does Spread, Z markings on arms, in E!!! Then relaxes. Both mids of pair retreat.

3:26. Y's continuing to Rock, ♀ in Pie almost all the time. Is this why ♂ is so irritable??? Is this characteristically post-copulatory???

Everything calm 3:30 p.m. So we go off to explore. Swim along steep slope coral reef. Nothing. Get out of water 3:40. Arcadia continues with shallow tow. Around island, outer edge reef.

Cepl., June 27, 1972, XL

4:05 p.m. Windward side. Water rough and muddy. Arcadio sees 4 medmins. In Bar. Do V Curls and some other arm movements. All new, reminiscent of Sargassum (which is fairly thick in the water here now).

Then see 3 sharks. Stop observations.

Running light at night. Nothing up to 8:30 p.m.

June 28, 1972
San Blas

Still Ogupuku. Overcast. Still muddy. Go to area where group seen yesterday. Into water 7:00 a.m. Find squid almost immediately. 3 larges, approximately 30 ft from where we left them yesterday afternoon. 3 ft up in 8 ft water. Over sand of sand-coral bottom. All in Ord, WS, Y, PCA.

One, presumably ♀, assumes dark marks of Pic ("DM") in Ord +. Then loses DM, retains Ord +, then does RL in Ord +

Perhaps all 3 mds. are doing some "Spade". As yesterday. I am now fairly convinced that this pattern is not ritualized in this species

7:05. 4th individual arrives. Coming from deep water, further out. Slightly smaller than the others. Small to large or largish medmin. By comparison, it seems obvious that original group of 3 is a trio, composed of one ♀ and two ♂'s in the usual way (♂2 slightly smaller than ♂1). Both ♂'s of trio do RL as 4th arrives. Then stop RL, back into ordinary Ord +, when the 4th comes closer and seems to

XXI

Ogopukip, SanBlas
June 27 1972

7:45 AM Tow along west side of island. This is windward side and it's slightly choppy. We start along coral reef & sloping gently into sand. Water fairly clear, about 50 ft. Then go into shallow TG area along shore of island. depth about 20-25 on coral and 5-7 on TG. We go around island and into lee side. At 8:10 AM I see group of 14 Sepiots in about 20 ft of water 6 large & 8 medium ORD-WS and looking quite elated they are over coral right on edge of vertical drop. there's a lot of small fish around them. I noticed one male in mild Z all sitting in ORD-WS Then ♀ next to ♀ Z goes pie. a courtship chase follows with male fluttering. There's a medium ♀ following this pair, but it's not trying very hard. probably because #1 ♀ is much larger. courtship chase is repeated about twice then ♀ went ORD-WS (pale) with a speckled belly & ♀ fluttering and a successful

copulation occurred. There movements at this point were not as rapid as usual. The ♀ coupled and then the ♀ retreated mantle first her arms arranging the spermatophore, this last took her a while. When coupling occurred second ♀ went Z wildly and moved towards couple but stopped and went back to ORD & WS There's some mild courtship from medium pair. some "pie" & fluttering but its all low keyed. also from large pair at opposite end of line from first couple but its also low keyed. Suddenly something frightens them and they all disappear. A few moments later they all crawl back to same spot. (Note: when I first found them, the group was at edge of drop and about 20 ft from surface, After we'd been there a while the group rose to about 5-6 ft from surface and positioned themselves over shallower section of the reef.) When they return, the coupling pair is showing a difference in patterns ♀ is in ORD-WS while ♀ is in PH-WS I see another ♀ pie in middle of group a courtship chase follows but nothing happens. coupling pair again in Pie and fluttering then same ♀ switches To wild Z and comes from behind ♀ and

XXII

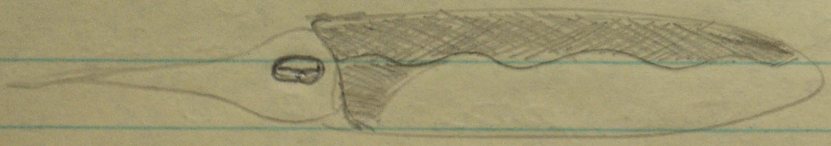
WB White Border on fins Ogopuhip, San Blas
BB Brown border on fins June 27, 1932

bits ♀ with arms in back of mantle. ♀ does not react to this in any way. A medium gets light PH and MD for no apparent reason. Now all in ORD-WS some rocking and counting dresses in "Pre" & mild 2 or shuttering. Then leopard ray appears swimming in about 35 ft of water and quite a ways from them, They all bolt, but not far. A few moments later they are all back. More courtship from coupling pair and two other pairs but all mild. Now I count 15 ind. another medium has joined group. I also noticed one medium has captured something and is working its arms. Probably squid I noticed a few moments earlier with tentacles extended. It's in ORD & WS very pale. Now I see 2 juveniles approach the group, that raises the group to 17 ind (NOTE: during courtship I noticed the male to display a thin white border on the fins.) End of observations at 8:45 am I towed back, and when

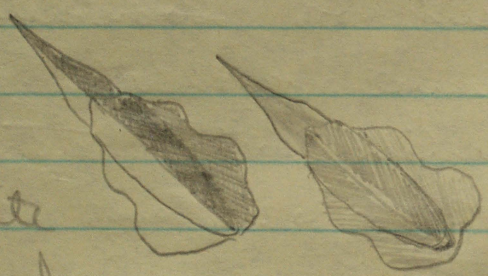
I started towing I noticed 19 large puffs of ink near the group we had been watching. Further on I noticed another large puff of ink but did not see any other squids. End of shallow tow 8:55 am

11:05 small spot on the reef, there are now 18 and they are 4 ft under the surface with an acropora & agaricia coral bottom at about 7 ft depth.

Typical lepards formation without size-order one large pair comes towards me slowly in ORD-WS ♀ with dark dotted bottom & ♂ in ORD-WS also with a slightly pr. underside



both approach at about 1 ft from my waist (I am hanging vertical to surface) ♀ is closest to me and it pales the half of its mantle closest to me

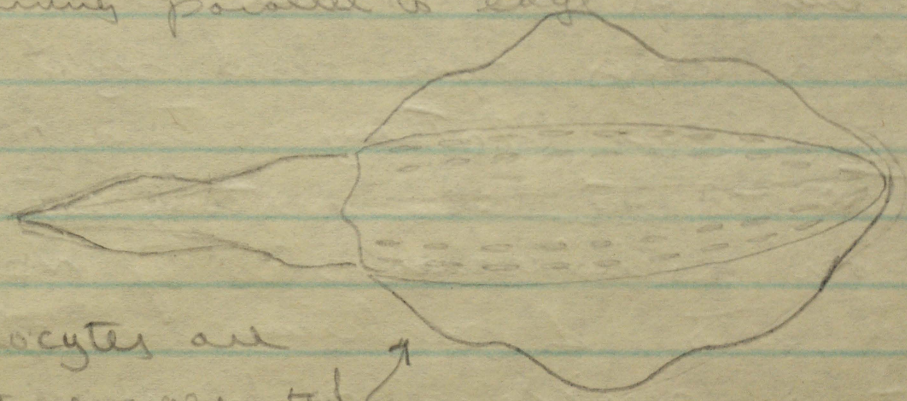


They do not go into PH or any fear pattern but proceed past me quite sedately. Its sunny and I can see quite clearly a beautiful iridescent blue tonality along the edge of the mantle next to the fins. I in the group, and fourth from one end I noticed a medium sized

XXIII

Ogojaskip, San Blas
June 27, 1972

squid is a velvety dark color with just a vestige of WS. The sucker section of the arms is white (not pale) its iridocytes look elongated. and in two bands on each half of the mantle running parallel to edge



iridocytes are quite exaggerated

Martin thinks it may be sleeping. Now they all seem to be doing it, but not to the extreme of the one I described. Two large ones have gone cryptic over a gorgonian, they are velvet dark throughout and have positioned themselves in a vertical attitude. I leave them and they all remain this way. The group has broken up in three sections, the sleeping group, all in dark, and closed to the gorgonian, three juveniles in ORD-WS and a third group over the steep drop who look active and

counting. End of observations at 11:45 pm.
3:11 pm Returned observatory. Large barracuda in study area, but squids are still there. Down near the acropora. Once the barracuda is out of sight, they all rise to the surface again. Some behavior as late this morning, some low keyed courtship etc. Martin decides to go exploring and we swim around the Island a ways over coral right on edge of drop. Nothing. Then I go for low but see nothing either. Once on windward side of Island I see urts & medium sized with a lot of swirling sargassum. When I see them they are all in board display they are all facing me from below me and they are doing a split with the ends curled up, they look like like almost exact replicas of the sargassum surrounding them. Especially since their mantles are out of my line of vision and all I see are their arms more or less like so

Then I notice 3 sharks, Two large 7-9 and one small 3-4 cruising slowly below. End of observations 4:15 pm.

join group. But then 4th leaves again immediately, back out into deeper water.

Leaving trio. ♂2 does RL in Ord+ again.

Then 4th comes back, 7:07. It stays slightly apart from the others. All 3 members of trio facing in same direction. 4th spends most of time facing in opposite direction. Everybody in Ord+. Both ♂'s of trio do occasional RL.

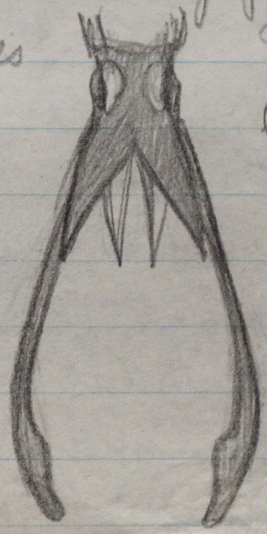
♂1 suddenly "flares", spreads arms (rather V-like, but less extreme than in either obviously ritualized V or Spread) Also writhes arms. Again with RL. All this done while backing toward ♂2. Then does it again. Arms are PCA, not Z. Then both relax. Back to Ord+ alone.

None of the mids is showing, or has shown, any trace of either WB or BB. Are these B patterns only high intensity?

4th mid. goes again 7:12.

♀ of trio goes into lighter, brighter color (probably intermediate between PH and semi-Pastel). WS greatly reduced (Chevroned) but still visible. At same time, shoots out tentacles. Feeding? If so, prey is very small. Copepod?

♂1 flares and writhes



With RL in Ord+, backing toward ♂2 as before. Again.

Upper arms (at least 2-3) flared together. Appear dark (Ord color). Tentacles also appear dark. Lower arms (5) appear light (probably simply because we see their

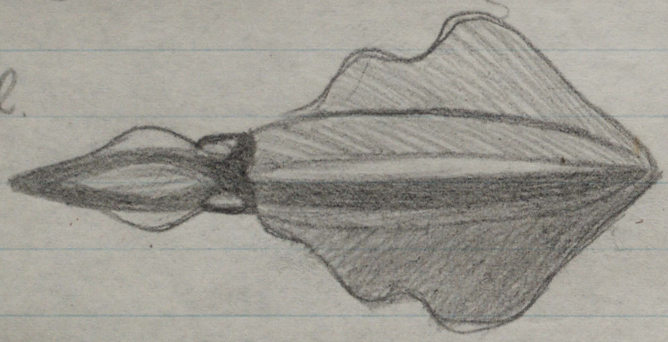
inner surface).

I suppose that this "flaring" probably is nothing more than a low intensity "int. mov." of more extreme and obviously ritualized spread (+Z etc.).

During the last "flare" performance, the ♂1 showed a trace of PH on back at climax. But still no Z on arms.

7:15 a.m. Still only 3 mds. Rather calm. Then ♀ does DM in Ord+ again. ♂1 immediately assumes peculiar color pattern. "Unstreak". Obviously intermediate between Double Streak and Lateral Silver. And Ord+. Starting from Ord+, the side of the back toward the ♀ goes slightly paler than usual, without becoming noticeably iridescent or even shiny. At the same time, part of the other side of the back becomes darker than usual, in a faint "adumbration" of ½ of Double Streak. In diagrammatic form, more or less comme ça:

Ocelli maintained.



Then all relax again. For the first time this morning, ♂2 of the trio is facing away from ♂1 and the ♀. ♀ suddenly does Pre ♀. ♂1 does real, if low intensity, Lateral Silver. This may be provoked by approach by ♂2. ♂2 retreats (Lateral Silver apparently effective as threat!). All calm again.

COMMENT: ♂'s may use Lateral Silver only when ♀

or 2 rivals present. When and if rivals become more numerous, it may not be "worthwhile", i.e. proper orientation may become impossible.

♂1 does RL in Ord+. Then ♂2 comes closer again. The two ♂'s swim side by side, backward, facing in same direction. Both in Ord+ and RL. Then both spread, with Z marks on arms, without changing rest of Ord+. Then both separate and relax. Relapse into Ord+ alone.

7:21. Now the 4th ind. has come back.

♀ does DM in Ord+. ♂1 does "Unistreak".

A few seconds later, ♂2 tries to "get around" ♂1, apparently to approach ♀ more closely. ♀ immediately goes Pale (sic!), retreats. ♂1 assumes Double Streak and advances to interpose himself. ♂2 retreats. ♀ does DM in Ord+. All relax. Swim together for some seconds.

7:25. ♀ does DM in Ord again. No response.

It would seem that high intensity courtship takes some considerable time to develop in the morning. (NOTE: The 4th individual does not appear to be interested in sex at the moment. Too young? Trio is not a quatuor.)

Both ♂1 and ♂2 do RL in Ord+ again.

♂1 suddenly turns Pale. Shoots downward, head and arms first, to look at bottom. Looking for food? (If so, this is, I think, the first indication of Sepia-like bottom feeding that I have seen.) Comes up again. Resumes Ord+.

Everything calm again 7:31 a.m.

♀ does brief trace of RL-Pie. Then back to Ord+.

Ceph., June 28, 1972, V

Now I notice that the ♀ seems to have a "belly band" across middle of underside of body. A broad medium-dark transverse stripe or bar. Could this be a form of Neap ??? Or just some internal organ "showing through" in poor light ?

♀ suddenly starts writhing. Then very rapidly does first extreme Bar (at last above), then Quadruple Streak, then shoots away. Some or all of this may be provoked by my approach. As soon as I retreat, ♀ returns in usual Ord+.

Stop observations 7:48 a.m.

XXIV

Ogopuki Pipi, San Blas
June 28 1972

6.58 AM, go in water. Spot 4 squids at 7.04 AM in sand plain as yesterday they are in usual formation and diminishing in size from large to small. First 1 two are obviously a pair. The fourth is not integrated. It keeps swimming off and coming back. Second and third are probably males they are both displaying a white spot on the tip of their mantle. A display I noticed a few days back among courting males.

♀ goes on first stripe when a grazer approaches her and φ_1 goes PH-WS-Y Then ♀ goes "Pie" & "RL" and φ_1 in double streak φ_2 goes on mild 2 it remains in this pattern after φ_1 has gone back to ORP-WS-Y with speckled arms. Then φ_2 approaches φ_1 in this pattern but φ_1 does not react. ♀ reacts to close proximity of φ_1 by going "Pie" and "RL" suddenly ♀ is frightened and goes into banned display end of observations at 7:45 AM.