The Ecology of *Onchidella borealis* Dall

Vicki Jones

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Introduction:

The genus Onchidella is classified in the family Onchidiidae. There is much controversy whether this family beglongs with the class Opisthobranchiata or Pulmonata. According to Fretter (1943) This family has features of both. For example the Onchidiidae have a lung which is a characteristic in common with Pulmonates while the loss of the shell and heart structure are Opisthobranch characteristics. She suggests that Onchidiidae separated from the Opisthobranch stem at the same time as Pulmonates. From this origin, however, the Onchidiidae have evolved along different lines from the Pulmonates, retaining more Opisthobranch characters. Owing to the adaptation to similiar habitat they have acquired a superficial resemblance to the nudibranchs. The features they share with the Pulmonates may be attributed to the close origin of the two groups. The presence of the lung makes them better adapted to a habitat which is closed to littoral gastropods.

Onchidella borealis is the member of this family found along the west coast of the United Stated. According to Marcus (1961) it ranges from the Aleution Islands down the coast of Alaska and U. S. as far south as Tomales Bay. There are other members of this genus and related genera found all over the world, mostly in the tropics. Onchidella is a small animal ranging in size from 1 to 10 mm. in length and looks much like a nudibranch. Coloration varies from brown to grey to yellow and grey mottled. The mantle is smooth to rough and its margin has evenly spaced papillae which are glands referred to by Arey and Crozier (1921) as repugnatory glands. They have a foot, two sensory oral lappets located anteriorly on both sides of the mouth and two tentacles with eyes. These animals can be found in the intertidal region creeping about on rocks and algae during low tide.

The behavior of Onchidella and related genera has been the subject of many sudies. Dakin (1952) in a study on Onchidella damelii on the Australian coast reported migrations related to the tides and definite homing behavior. Arey and Crozier (1921) in their study of Onchidella floridanum Dall on the Bermuda coast reported a similiar migration timed with the tides. They also pointed out that the animals exhibit homing behavior. Work has also been done with thermal reaction, photo responses, function of marginal glands and of tentacular eyes.

The purpose of this project was to study the behavior of Onchidella borealis and try to determine if this species also has the migrations and homing behavior reported by workers on other species. Also the distribution and habitat in the Newpprt area was studied with Yaquina Head, Yaquina Bay, and Seal Rock being sampled. Reaction to light, function of marginal glands and thermal resistance were also investigated.

Materials and Methods:

Sampling was conducted at Yaquina Head, Yaquina Bay and Seal Rock to determine the vertical limits of the animals and their habitats. Sampling areas with different exposures to wave shock and sunlight were chosen. The areas were carefully checked from upper to lower limits for the presence of animals. The holdfasts of various algae were dislodged and inspected for animals.

Rocks and mussel beds were also checked. The animals were found in clumps or colonies, most commonly in the holdfasts of the brown algae Hedophyllum sessile or in rock crevices.

During the observation of habitats it was noticed that sometimes the animals were quite easily located on algae and rocks while at other times they could only be found by dislodging the Hedophyllum. An attempt was then made to determine tidal rhythms. Trips at various times during the tidal cycle and under differing weather conditions were made to determine the characteristics of the tidal rhythms. Several holdfasts with populations of Onchidella were taken back to lab and placed in a sea table to see if the tidal rhythms would be continued in artifical conditions. One group of holdfasts were kept under water and one group was removed from the water in correlation with the tides. One migration experiment was run with two holdfasts taken out of water at low tide, one left in the well lit lab and the other placed in the dark room in dim light. Migrations occured equally well in both cases.

Experiments on other aspects of behavior of Onchidella were conducted. The margin of the mantle has evenly spaced papillae that secrete a white substance when irritated. Arey and Crozier (1921) refer to these structures as repugnatory glands and state that crabs and anemones will not eat small pieces of meat smeared with this substance. Various possible predators of Onchidella such as Thais snails and Pisaster were collected. Onchidella was irritated until the secretion was released and then smeared on the animals. The Onchidella was then touched to the tube feet of Pisaster and Lepasterias and to the foot of the snails. The only response illicited was the same as could be brought forth by a tactile stimulation. There was no avoidance reaction to the subsatance by the predator.

Reactions to light was tested. The animals were placed on a flat plastic plate and floated in 13 degree C sea water to maintan a constant temperature. A beam of light was focused on the upper end of the set up. Animals were placed at four inch intervals from the light.

The temperature tolerance of animals both submerged in water and in a saturated humid chamber, was tested. Eight 500 ml beakers were filled with sea water at 13 degrees Centigrade and eight animals were placed in each. The beakers were then placed in a 19 degree water bath and the temperature was allowed to stabilize. The temperature was then raised at the rate of one degree every five minutes. When the temperature reach 30 degrees C a beaker was removed. With each subsequent rise of one degree a jar was removed until the last jar reach 38 degrees. The beakers were then allowed to return to room temperature. Sea water was added gradually to bring the temperature down to the original 13°. The animals were then removed and the number dead were counted. Animals were kept overnight and checked for further mortalities. The same proceedure was used with humidity chambers. These were screw cap jars with a soaked paper towel in the bottom. A piece of screen was inserted to prevent the animals from directly touching the toweling. The jars were sealed with vaseline to make them water tight and were completely submerged in the water. A jar with a rubber cork and thermometer provided a similiar chamber to take temperature readings.

Stomach contents were examined to determine the type and variety of food eaten. The animals were dissected and the digestive tract cut open. The tract consists of an esophagus, crop, stomach, gizzard filled with sand and an intestine. The material found consisted of a great variety of diatoms, bacteria, algae and foraminiferans. The radula is evidently used to scrape food from the rocks and algae.

The animals in the field were mostly found on *Odonthallia liali* and *Hedophyllum*. An experiment was set up where the animals were given a choice of algae. 32 and 24 animals were placed in (a) large flat pans with clumps of various algae spaced around the edges. At the end of twelve hours the algae were removed and the animals counted in each clump. No significant species preference could be demonstrated (table I and II).

Discussion

distribution

The distribution of *Onchidella* at Yaquina Head ranges from the mussel beds to almost the level of sea water in the tide pools. This would consist of zones two and three in Ricketts and Calvins scheme of zonation. *Iridophycus, Egregia, Laminaria, Ulva, Odonthallia liali* and *flocosa,* and *Halosaccion* holdfasts were examined. The only place the animals were found was in the hold-fasts of *Hedophyllum*. The Hedophyllum holdfasts is well suited to give protection. Along with *Onchidella* was found Nemertean worms, samll mussels, and flat worms. The exposure to wave shock seemed to have little bearing on their distribution as they were found in both exposed and protected areas. The south jetty of of Yaquina Bay has lines of rocks that protude in to the mouth of the bay. These are covered with various algae and again the animals were found in large numbers in the holfasts of Hedophyllum. Populations ranging as high as 39 were found. At Seal Rock, seven miles south of Newport, an almost vertical face was sampled. Here the animals were again found ranging from the mussel beds down to the water level of the tide pools. The front face ~~was~~ exposed to the waves and covered with mussle beds yeilded animals in a density of four per sq. foot. There was no Hedophyllum present.

Population sizes.

Population sizes varied in the holdfasts and ranged from five to 60 individuals. The average size of population was 25 to 30. Sizes of the individuals making up the population range from 1 mm to 10 mm in length. Below are listed the sized of Hedophyllum holdfasts and the numbers of animals in each. These were taken at Yaquina Head.

3'' at longes point	by 3'' at widest part.	pop 3
4''	3''	69
4''	3	29
3''	3''	39
2''	3''	11

Tidal rhythms

Tidal rhythms were identified both in the field and in lab. The animals have an activity period of about two hours beginning approximately one half hour before the lowest point of the tide. During this period the animals creep out from the crevices and graze.

At the end of this period they migrate back into the holdfast and none can be found. The rhythms appear to be inherent and not triggered by the lowering of the water. Migrations occured on both the holdfast kept submerged and on those removed from the water. Tables five to 19 show the tidal rhythms observed in lab. Tables IX - XIX are for the same group of holdfasts that exhibited the migrations, for four consecutive low tides (lower low tides and higher low tides). With each successive migration the numbers became smaller and finally on the fifth tide no migration was observed. Migrations in the higher low tides were not observed in the field. Possibly the wave action prevented the animals from emerging. Most of the Hedophyllum was under water at the time of the higher low tides.

Migrations occured in dim light as well as in bright light and were of the same duration. (table XXII and XXIII). Populations were checked at Yaquina Head at low tide at 4:00 A.M. Aug 13. The animals were found out in the usual numbers as in daytime. The weather conditions seem to have little affect on the migration as populations could be found on both cloudy, foggy, and sunny days. Onchidella reactions to light in lab were tested and found to be photonegative. However, this reaction does not seem to be strong enough to discourage migration out during the dark hours or on cloudy days. Arey and Corzier(1921) reported that Onchidella floridanum behaves as a negatively helotropic animals and in nature it will creep out to feed in the daylight hours only.

Temperature tolerance was taken under water and in humidity chambers. Table III and IV is a chart of the temperature and vapor pressure the animals were subjected to. A large number of deaths occured at 39°C in the humidity chambers. These immediate deathes were the only ones which occured, for the animals were kept overnight and checked agin. In the absence of water in the chamber the lungs are functiong alone and probably cannot meet the demands for extra oxygen. As the temperature was raised no change in behavior was noted. According to Arey and Crozier (1921) there is no change in behavior of Onchidella floridanum from 17° - 36°C. When the temperature is raised to 45° the animals undergo violent contraction.

Homing behavior was observed both in the field and lab. Animals were marked in the field and observed to return to the same holdfast. In lab the animals were tested to see if migrateons were due to a geotaxic response or to homing. Onchidella were allowed to migrate and home with the holdfast in an upright position then in an upside down position. Return to the holdfast occured in both cases signifying the movements are homing. A pan was set up with rocks placed in the bottom. Onchidella were removed from a holdfast and added to the set up. The animals would migrate out from beneath the rocks but would not return.

Conclusions

Onchidella borealis Dall is classified as an Opisthobranch or Pulmonate. It occurs along the western coast of North America. Observations reveal it undergoes migrations very similiar to other species reported by Crozier and Arey on the Bermuda coast and Eakin on the coast of Australia. The activity period is about two hours and is correlated to the tides. Definite homing Behavio was also noted. Although photonegative activity was observed, it does not affect the migration to the point they come out only on cloudy days. Temperature tolerance is high with death occuring approximate at 38°. No reaction of possible predators to the repugnatory glands was noted.

Table I Algae choice by Onchidella

Algae	No of Onchidella
Odonthallia liali	7
Hedophyllum sessile	2
Iridophycus	11
Odonthallia flocosa	12

Table II Algae choice by Onchidella

Algae	No. of Onchidella
Iridophycus	7
Odonthallia flocosa	2
Endocladia	9
Hedophyllum	0
Odonthallia liali	6

Table III Temperature and mortality rate in humid chamber

Temp °C	Vapor pressure	No. dead	No. alive
36	42.175	1	7
37	47.067	1	7
38	49.692	0	8
39	52.442	9	7
40	55.324	7	1

Table LV Temperature and mortality rate -- animals submerged

Temp °C	No. dead	No. alive
30	1	7
31	0	8

Table LV cont.

Temp °C	No. dead	No. alive
32	0	8
33	0	8
34	0	8
35	0	8
36	1	7
37	2	6

The following tables are the migrations observed in lab. Each table is for a different holdfast of Hedophyllum. The time of low tide and number of population involved is marked.

Table V Low tide 5:30 A.M. Population size 27 holdfast submerged

Time	Number on leaves
5:50 A. M.	11
6:10	18
6:25	13
6:40	5
7:00	6
7:25	7
7:40	7
8:00	4

Table VI Low tide 5:30 a.m. population 13 holdfast removed fromm H20

Time	Number on leaves
5:50	9
6:10	10

Table VI cont.

Time	Number of animals on leaves
6:25	6
6:40	5
7:30	2

Table VII Low tide 5:30 A.M. Population 12 ~~Unsubmerged~~ Hold fast out of water

Time	Number on leaves
5:55 A.M.	4
6:10	3
6:25	3
6:45	2

Table VIII Low tide 5:30 A.M. Population 15 ~~Unsubmerged~~ Hold fast out of water

Time	Number on leaves
5:40	1
5:55	11
6:15	10
6:25	13
6:45	3
7:00	3
7:30	2

Table IX Low tide 8:44 A. M. Population 17 Holdfast submerged

Time	number on leaves
8:00	0
8:30	10
8:45	6
9:00	8
9:15	8
9:30	4
9:45	3
10:00	3
10:15	3

Table X Low tide 8:45 A.M. Population 39 Holdfast submerged

Time	number on leaves
8:00	0
8:30	8
8:45	6
9:00	8
9:15	5
9:30	5
9:45	4
10:00	4
10:15	3
10:30	3

Table XI Low tide 8:45 population 39 Holdfast out of water

Time	number on leaves
8:00	0
8:10	10
8:30	20
8:45	21
9:00	10
9:15	8
9:30	5
9:45	10
10:00	4
10:15	4
10:30	0

Table XII Low tide 8:45 Population 29 Holfast eut of water

Time	number on leaves
8:00	0
8:10	5
8:30	20
8:45	11
9:00	5
9:15	3
9:30	6
9:45	3
9:56	2
10:00	2
10:15	2
10:30	0

Table XIII Low tide 8:45 A.M. Population 11 Holdfast out of water

Time	number on leaves
8:00	0
8:10	0
8:30	0
8:45	2
9:00	1
9:15	2
9:30	2
9:45	0
10:00	0
10:15	0
10:30	0

Table XIV Low tide 8:45 A.M. Population 26 Holdfast submerged

Time	number on leaves
8:00	0
8:30	0
8:45	0
9:00	2
9:15	1
9:30	0
9:45	1
10:00	0
10:15	0

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cont.

Table XX Low tide 9:03 A.M. Population 39 holdfast submerged

Time	number on leaves
11:00	0
1:30	0

Table XXI Low tide 9:03 Population 33 Holdfast submerged

Time	number on leaves
10:00	0
10:15	2
10:30	2
11:00	1

Table XV Low tide 9:03 A.M. removed from water 10:00

Time	Number on leaves
10:00	5
10:15	9
10:30	10
10:45	8
11:00	5
11:15	4
11:30	2
11:45	2

Table XVI Low tide 9:03 A.M. Removed from water 10:00

Time	number on leaves
10:00	3
10:15	10
10:30	10
10:45	5
11:00	4
11:15	2
11:30	2
11:45	1
1:15	0

Table XVII Low tide 9:03 A.M. pop. 11 holdfast removed from wat

Time	number on leaves
10:00	2
10:15	2
10:30	6
10:45	2
11:00	2
11:15	2
11:30	0
1:15	0

Table XVIII Low tide Population 17 Holdfast submerged

Time	number on leaves
10:00	3
10:15	10
10:30	5
10:45	2
11:00	3
11:40	3
11:45	3
1:15	0

Table XIX Low tide 9:03 A.M. Population 39 holdfast submerged

Time	number on leaves
10:00	1
10:15	1
10:30	4
10:45	3

The following tables are for the migrati n experiments conducted in light and dimly lit conditions.

Table XXII Dim light Holdfast removed from water

Time	number on leaves
3:05 P.M.	0
3:20	13
3:30	20
3:40	25
3:45	25
4:35	15
4:45	5

Table XXIII Light Holdfast removed f rom water

Time	number on leaves
3:05 P.M.	0
3:30	4
3:40	10
3:45	20
4:20	20
4:35	18
4:15	14
4:45	4

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