The Growth of *Arachnoides placenta* (L.) (Echinoidea)

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ABSTRACT: *Arachnoides placenta* (L.) increases in diameter 7 mm during the first year, 4 mm during the second year, and 4 mm in the third year after metamorphosis.

The relationship between diameter and weight of the test is approximately of cubic form.

The spawning period in north Queensland probably is June to July, and the time of metamorphosis probably September.

The growth characteristics are compared with other echinoid species.

THE "SAND DOLLAR," *Arachnoides placenta* (L.), has been recorded from a wide geographical area ranging from the Andaman Islands through the Philippines and along the northern and northeastern coasts of Australia (Clark, 1946). The distribution of the species on the Queensland coast extends from Thursday Island (Clark, 1921) to Mackay (Endean, 1953, 1956). Clark (1938) recorded some observations on the habits of this "sand dollar" from Darwin, but no data on the growth of the species have been traced.

METHODS AND RESULTS

The animals used in this study were taken at Lucinda (18°31′S, 146°19′E) in the middle of the range of *A. placenta* along the Queensland coast. Lucinda beach is a gently sloping sandy strand with many offshore shoals. The spring tidal range is 8 ft. At low tide *Arachnoides* is distributed from approximately mean sea level to below low water of spring tides, lying on, or a little under, the sand surface.

Collections were made at daytime spring low tides on 10 occasions from March 1961 to February 1962. In collecting, all specimens within a narrow strip extending from the last high water mark to below low tide were taken. In general, animals were collected by hand, but random digging and sieving along the length of the traverse ensured sampling of the population down to a diameter of approximately 6 mm.

Measurements of diameter were read to the nearest millimeter and weights of oven-dried whole animals to the nearest milligram.

The temperature data were recorded at Townsville Harbour breakwater (19° 15′S, 146° 50′E) and varied from a June mean of 20.5°C to a January mean of 31.5°C (Fig. 3).

The records of diameters were arranged in 1-mm class intervals (Table 1), and the data were smoothed prior to plotting as a series of monthly histograms (Fig. 2). From these histograms the modes of frequency distribution of diameter were extracted and drawn as a growth curve (Fig. 3).

These results show *Arachnoides* increasing in diameter from 11 to 18 mm during the November to February period of the first year after metamorphosis. From March to October there is little increase in size, but a second season of active growth commences in October and in the ensuing three to four months the diameter enlarges from 18 to 22 mm. In the second year there is a further seven- to eight-month period with no obvious growth, followed by another growing season when the animal increases from 22 to 26 mm in diameter during approximately four months.

The rate of growth during the active growing period decreases with age, being 2.3 mm per month in the first growing season, 2 mm per month in the second, and 1.3 mm per month in the third.

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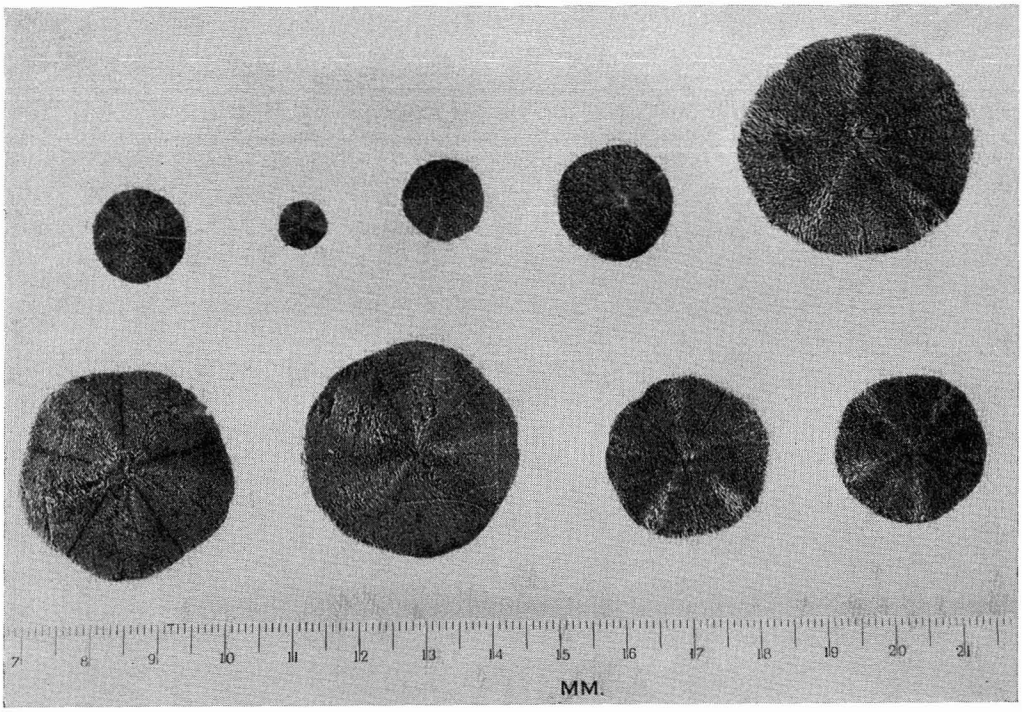

FIG. 1. Selected examples of *A. placenta.*

The period of growth occurs during the part of the year when sea water temperatures are rising (Fig. 3).

The relationship between diameter and weight of test for 125 selected specimens is shown in Figure 4. The equation for the relationship is of the form

$$\log W = 3.061 \ (\log d) - 1.519$$

where W is the weight of the dried test and d the diameter of the animal.

DISCUSSION

Extrapolation from the known data would suggest that metamorphosis occurs during September. If it is assumed that the length of larval life is similar to that for another tropical echinoid, *Tripneustes esculentus,* which is two months (Lewis, 1958), it may be deduced that *Arachnoides placenta* spawns in June or July. Lewis (1958) lists July and August as the spawning period for *T. esculentus;* and Hyman (1955), quoting Mortenson, notes that *Mellita sexiesperforata* spawns in March and April in the West Indies. It would appear that the West Indian species spawn during the early summer for their locality, while *A. placenta* spawns during the Queensland winter at sea temperatures between 20°C and 22°C.

The occurrence of some *Arachnoides* individuals of diameters up to 36 mm suggests a life span of up to five years, assuming the rate of growth for older animals to be similar to that calculated for specimens up to the third year. Crozier (1920) suggested four to five years as the normal life span for the similar but larger Atlantic species *Mellita sexiesperforata* at Bermuda, and Moore (1934) estimated four to eight years as the duration of life for *Echinus esculentus* in Britain. Lewis (1958), working with *Tripneustes* at Barbados, was not able to determine a life span because of commercial fishing for the species.

The recording of a specimen of *A. placenta* of 96 mm diameter from Lindeman Island (Clark, 1946) suggests the possibility of a situation similar to that described by Moore

TABLE 1

FREQUENCY DISTRIBUTION OF DIAMETER IN MILLIMETERS OF *A. placenta* (ORIGINAL DATA)

	NUMBER OF SPECIMENS										
DIAMETER (IN MM)	MAR. 25	MAY 21	JUNE 15	JULY 17	AUG. 15	OCT. 5	CCT. 22	NOV. 21	DEC. 12	JAN. 16	FEB. 12
7						5					
8				1	1	1					7
9				4		1					1
10	1	1		2	2	3					3
11	1	1		11	7	5	1	1			7
12	1	1	4	11	8	8		1			2
13	6	3	6	25	13	15	1				6
14	3	9	2	33	15	25					4
15	10	10	8	51	30	35	3			7	6
16	2	13	5	60	35	31	3	1	3	13	10
17	17	17	10	65	60	36	6	10	2	12	9
18	26	22	30	63	55	40	8	20	9	29	22
19	34	22	25	55	45	27	21	24	20	33	25
20	33	22	30	43	68	27	23	53	37	24	11
21	35	22	31	45	38	16	33	50	50	31	19
22	41	25	24	47	36	12	35	45	49	28	24
23	31	26	29	33	24	11	31	43	45	25	17
24	33	23	18	34	24	13	22	24	45	18	10
25	26	25	14	47	15	9	21	25	28	14	24
26	21	17	11	34	13	4	11	20	11	26	23
27	8	15	10	20	9	2	11	11	14	23	9
28	17	15	16	14	6	5	10	13	12	8	5
29	7	10	16	13	10	2	7	7	12	5	4
30	4	6	5	5	2	2	2	2	4	2	3
31	3	4	1	2	1	4	2	1	1	4	3
32		6	5	2	2		4	3	2	3	4
33	2	1	5	4	2		1			2	3
34						1		1	1	1	2
35			1			1		1			
36			2		1						

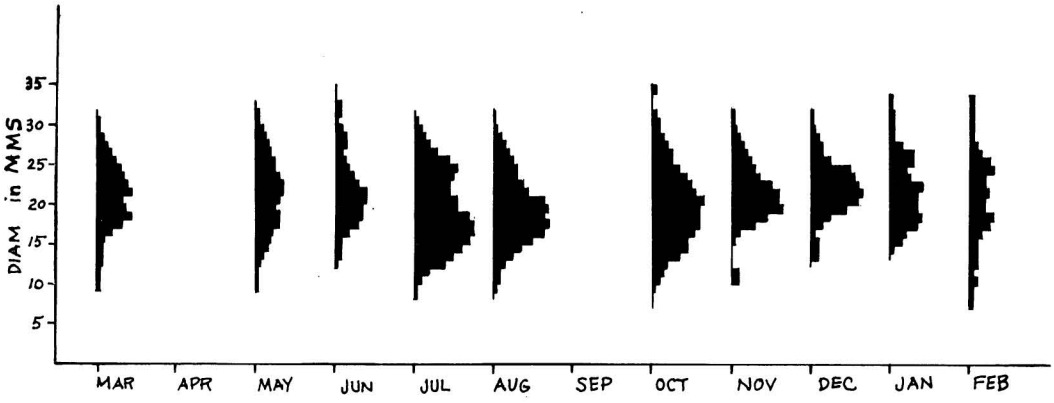

FIG. 2. Frequency distribution histograms of diameter in millimeters, *A. placenta* (smoothed data).

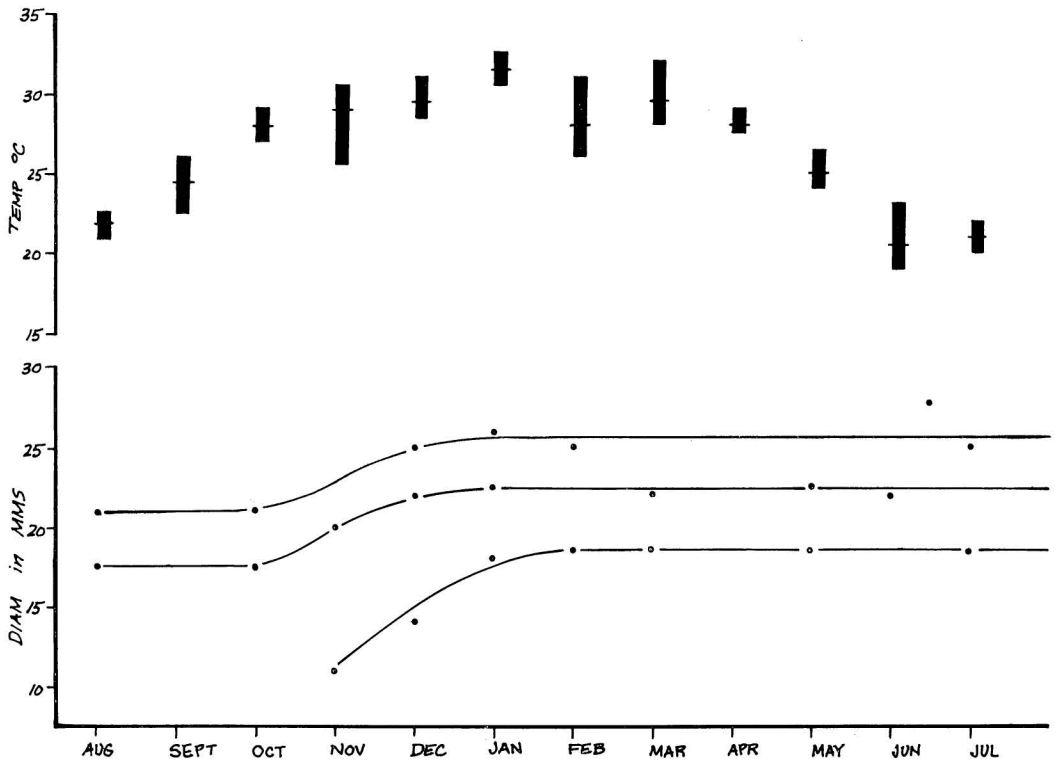

FIG. 3. Growth curve for *A. placenta* related to sea water temperatures at Townsville.

(1934), where size and test thickness distinguished an "inshore race" of *Echinus esculentus*.

Direct comparison of the growth rate of *A. placenta* with the results of growth studies on other echinoids is difficult because of marked species differences in size and shape. In Table 2 the increase in size per annum is expressed as a percentage of the diameter for the preceding year for selected species. The data for *Mellita* are possibly those most relevant, inasmuch as this species is similar in shape to *Arachnoides* in contrast to the spherical form of the other species listed.

TABLE 2

COMPARISON OF GROWTH RATES OF SELECTED ECHINOIDS

	PERCENTAGE INCREASE IN DIAMETER					
YEAR	*Echinus* (Moore, 1935)	*Psammechinus* (Bull, 1938)	*Strongylocentrotus* (Norway) (Greig, 1928*)	*Strongylocentrotus* (Maine) (Swan, 1958)	*Mellita* (Crozier, 1920)	*Arachnoides*
2	36	30	150	176	30	22
3	12	12	60	68	14	19
4	10	3	33	25	43	
5	14	23	25			
6		5	20			

* Quoted by Hyman (1955).

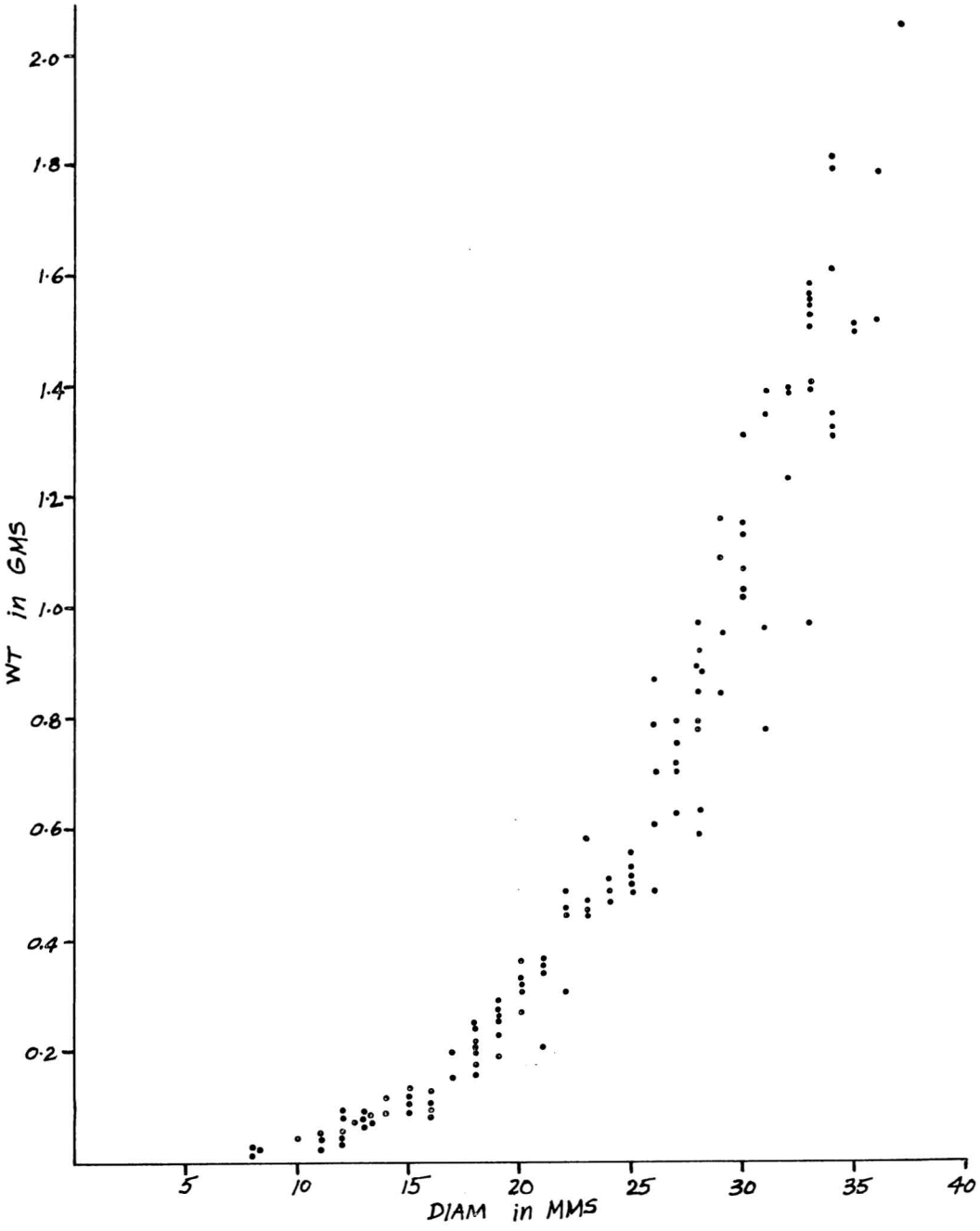

FIG. 4. Diameter and weight relationship for *A. placenta*.

It would appear that the percentage increase in diameter during the second year is less for *Arachnoides* than for other echinoids. Those species inhabiting cooler waters apparently grow more rapidly than do the tropical *A. placenta,* but by the end of the third year *Mellita,* a warm water echinoid, and *Arachnoides* present a similar picture.

The diameter-to-weight relationship for *A. placenta* approximates the expected cubic form and is similar to that expressed by Swan (1958) for *Strongylocentrotus droebachiensis.* However, the wide range of weight values for any one diameter makes it difficult to reduce the relationship to a series of separate equations as Swan (1958) has done for the Maine species.

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