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El poder adhesivo de las ventosas de Octopus bimaculatus Verrill.

Las ventosas extirpadas de los tentáculos del cefalópodo Octopus bimaculatus pueden ejercer una presión que varía de 45 a 70 por ciento de atmósfera, cuando se las estimula eléctricamente.

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AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, MAY 23

THE POWER OF ADHESION IN THE SUCKERS OF OCTOPUS BIMACULATUS VERRILL[1]

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ONE FIGURE

During the summer months Octopus bimaculatus can be found abundantly in the rocky tidal pools in the neighborhood of the Scripps Institution for Biological Research at La Jolla, California. When this animal is picked up it commonly attaches itself to the hand and fingers of the collector by its suckers, thus producing a strange and almost uncanny sensation. Not only will the whole animal suck to the hand, but an excised arm will exhibit coör-dinated movements and vigorous suction, and even an isolated sucker, when stimulated electrically, will hold to the finger of the experimenter apparently with as much vigor as when it was a portion of the whole animal. These parts, therefore, exhibit a very unusual degree of autonomy and, since the isolated suckers are very conveniently handled, they afford excellent material on which to test the power of suction.

Freshly excised suckers were suspended by a strong thread to a hanging spring-balance. The sucking disc, which faced downward, was then applied to a piece of wet smooth wood and the sucker brought into action by stimulating its base with a faradic current. The electrodes by which the current was applied were manipulated by one hand of the experimenter while by the other hand the piece of wood, to which the sucker had become attached, was lowered till the suction was overcome and the wood and sucker parted. Meanwhile the observer watched the indicator on the spring-balance and noted the point indicated on the scale when the parting occurred. This point gave the breaking force involved and was read in grams. As a rule, four or five such read-

[1] Contributions from the Zoölogical Laboratory of the Museum of Comparative Zoölogy at Harvard College. No. 331.

ings could be obtained from each sucker. As it was the object of this investigation to ascertain the maximum capacity of each sucker, the highest breaking force among the four or five observed was taken rather than an average.

The faces of the suckers in Octopus are very regularly circular and after each test the diameter of the given sucker was measured in millimeters. From these diameters the areas of suction of the several suckers were calculated in square millimeters. The theoretical maximum suction for each such area was then worked out on the assumption that an atmosphere is equal to 1.033 kilo-

TABLE 1

Diameters of suction areas (millimeters), calculated areas of suction (square millimeters), breaking forces (grams), theoretical maximum suction (grams), and percentages of efficiency for eight suckers from the arms of Octopus bimaculatus

	NUMBER OF SUCKER							
	1	2	3	4	5	6	7	8
Observed diameters of suction areas in mm.	2.3	2.8	3.0	3.9	4.5	5.2	5.5	6.0
Calculated areas of suction in sq. mm.	4.15	6.16	7.07	11.95	15.90	21.24	23.76	28.27
Observed breaking forces in grams	29.2	42.5	51.0	62.4	79.4	99.2	122.1	147.4
Theoretical maximum suction in grams	42.9	63.6	73.0	123.4	164.2	219.4	245.4	292.0
Efficiency in percentages	68	67	70	51	48	45	50	50

grams per square centimeter. These derived results together with the original observations are brought together in table 1.

In table 1 the suckers have been arranged in the order of size from smallest to largest. The smallest one shows the smallest breaking force, 29.2 grams, and the largest one the largest, 147.4 grams, the others forming a series between these two extremes. This series, however, does not conform very closely to the series of theoretical maximum suctions calculated for the series of suckers on the basis of atmospheric pressure. The relation of these two series is more easily understood from the plottings in figure 1 than from the numbers in table 1. The theoretical maximum suction calculated for the eight suckers is shown by the dots in curve B. The observed breaking forces for these eight suckers are designated by the crosses that afford the basis for curve A. At all points curve A lies below curve B and this relation is what should be expected, for it is quite impossible that a sucker acting purely as such should at sea level exert more than one atmosphere of pressure.

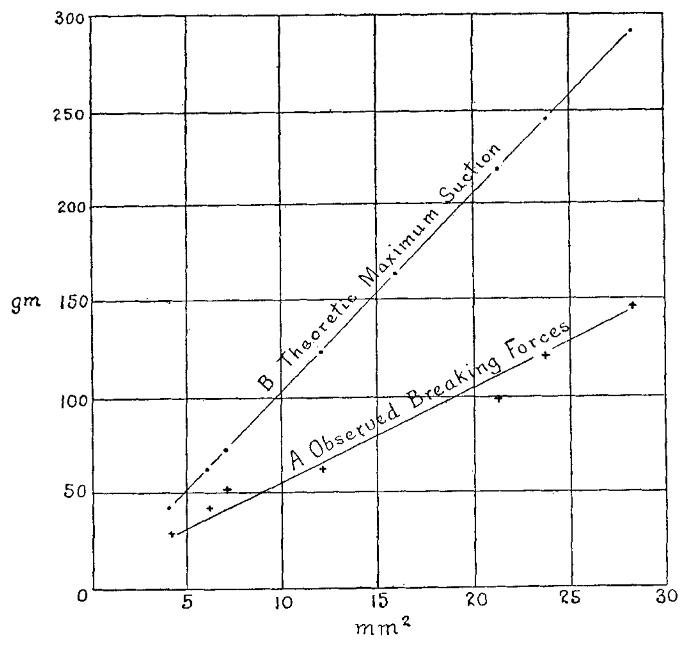

Fig. 1 Plottings of the observed breaking forces (A) and of the theoretical maximum suction (B) of suckers of different sizes (table 1); the ordinates represent grams, the abscissae square millimeters.

If in any sucker the breaking force were equal to the theoretical maximum, that sucker could be said to have an efficiency of 100 per cent. Such, however, is never the case, for, as is shown at the bottom of table 1, the efficiency of these suckers is never higher than 70 per cent of the maximum and may fall as low as 45 per cent, with an average on the eight readings of 56 per cent. This efficiency appears to be rather higher for the smaller suckers than for the larger ones. But even in the smaller suckers it is well under the theoretical maximum and falls far short of the efficiency of the sucking organs of such animals as the sea-anemone Cribrina (Parker, '17), which can exert a pressure of about one atmosphere.

LITERATURE CITED

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