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ZOOLOGY

WILLIAM EMERSON RITTER
EDITOR

VOLUME II
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ZOOLOGY

Vol. 2, Introduction, pp. i-xvii. April 5, 1905

CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO

A GENERAL STATEMENT OF THE IDEAS AND THE PRESENT AIMS AND STATUS OF THE MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO

BY

WM. E. RITTER

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Director of the Station.

CONTENTS.

1.—The Idea of a Marine Biological Survey.

Volume II of the University of California Publications, Zoology, is now either published or in the Editor's hands, waiting to be put into type. It is composed exclusively of "Results from the Laboratory of the Marine Biological Association of San Diego."

The investigations on the coast of Southern California now having been in progress for several years, and their continuance being assured for a few years more at least, it seems fitting that this first volume of results should be introduced by some statement of the general ideas animating the undertaking, and of the efforts being made, and means available to realize these ideas. *Investigations in marine biology, intensive rather than extensive in character* (to borrow a useful agricultural phrase) is the key note of the idea. An immediate consequence of the adoption of such an idea as a rule of action, has been the necessity of making a clear distinction between *marine biology*, and *general biology prosecuted by researches on marine organisms.* I have elsewhere written as follows of this distinction:

"The former has for its aim, in the large, the getting of as comprehensive an understanding as possible of the life of the sea. It, of course, presents itself under a great variety of secondary questions; but the sum total of the phenomena of *marine* plants and animals will never be lost sight of as its real aim. The latter makes use of animals and plants that live in the sea in general biological researches. That these organisms happen to be marine is an incident merely. The investigator turns away from them without hesitation when others, from whatever source, come to hand that suit his purpose better. Further, the user of marine organisms in such investigations is quite indifferent to everything concerning them that does not bear upon his particular problem. He puts aside the marine animal after it has served his purpose without having even noticed, perhaps, the major part of its traits and qualities and the questions concerning it."

For this particular undertaking, I believe the ideal, broad and general as it is, is eminently useful. It is useful because it gives definiteness and coördination to action, and furnishes a commanding point of view and stimulus. It is justifiable to hold and be guided by it, even though assurance of opportunity to carry it out fully is absent.

The aim as formulated in the articles of incorporation of the Association is, "To make a Biological Survey of the waters of the Pacific adjacent to the Coast of Southern California."

2.—The Area to be Surveyed.

The funds available being small, an important and ever-present practical question is that of fixing limits. One of the first of these was that of limiting the territory to be surveyed. The irregularly triangular area extending from Point Conception, Lat. 34° 27′, at the north, to a base line extending westward from the southern boundary of the United States, Lat. 32° 28′, bounded on the east by the coast line, and on the west by the meridian of Point Concepcion, Long. 120° 25′, was selected. The shore line of this area, exclusive of the islands, is about 280 miles. The length of the western side is about 120 miles, and that of its southern side about 194 miles. The area contains, therefore, over 11,600 square miles.

It is, of course, not to be supposed that a stone wall has been built about this area, and that we give no heed to anything outside of it. As a matter of fact, nothing is clearer than that complete knowledge of it is impossible without extending the explorations widely beyond it. That it makes a well defined base of operations, is about the view we take of it.

The qualifications of the region are: a position well to the south; a considerable extent of continental shelf, presenting a large diversity of bottom, with numerous islands and shoals; proximity to oceanic depths and other truly oceanic conditions; a favorable climate; a large variety of shore line; and accessibility through sea ports and railroads. Two of these advantages, that of climate and proximity to oceanic conditions, are held to be of very great importance. A fundamental element in investigations of the sort contemplated is *continuousness* of the field work. Data gathering must go on throughout the year at frequent intervals. The weather here offers little obstacle to this. Heavy storms are rare, and these are practically limited to three or four months—January, February, March, and April. For the rest of the year there are few days on which, for a portion of the day at least, work cannot be carried on anywhere in the area with slight interference from heavy seas; and even during the months subject to storms only rarely is it interfered with. The practical importance of this can hardly be overvalued, as all experienced in this sort of work will appreciate. Not only does it make a completeness of field observations practicable, that could hardly be secured with any kind of a vessel in more storm afflicted regions; but it reduces the cost of exploration to the minimum, for the work can be done in a vessel much smaller, and hence much less expensive of operation than is ordinarily required for such work. Dredging and trawling to a depth of 500 fathoms at least from a vessel of 60 foot keel, manned by three men, is perfectly feasible; and sounding and various kinds of work on surface and intermediate waters can be done at considerably greater depths with the same equipment.

The following table, made up from data contained in the Monthly Synopses of the United State Weather Bureau, presents information concerning climatic conditions at San Diego during 1904, an entirely typical year.

TABLE OF METEOROLOGICAL CONDITIONS, 1904.

Month.	Locality.	Temperature.		Precipitation.		Wind.	
		Mean Max.	Mean Min.	Total.	Days with .01in. or more.	Total movement in miles.	Max. velocity, miles per hour.
January.							
	Nantucket	34	22	5.98	16	11,849	60
	Key West	73	82	1.42	7	7,834	31
	Farallone	54	49	.88	7	12,117	48
	San Francisco	56	45	1.05	5	4,292	26
	San Diego	**65**	**47**	**.04**	**2**	**4,310**	**27**
February.							
	Nantucket	32	19	3.86	15	11,386	47
	Key West	76	66	1.08	4	7,106	33
	Farallone	53	49	6.13	16	10,149	50
	San Francisco	55	46	5.89	16	5,561	31
	San Diego	**61**	**48**	**1 50**	**6**	**3,802**	**36**

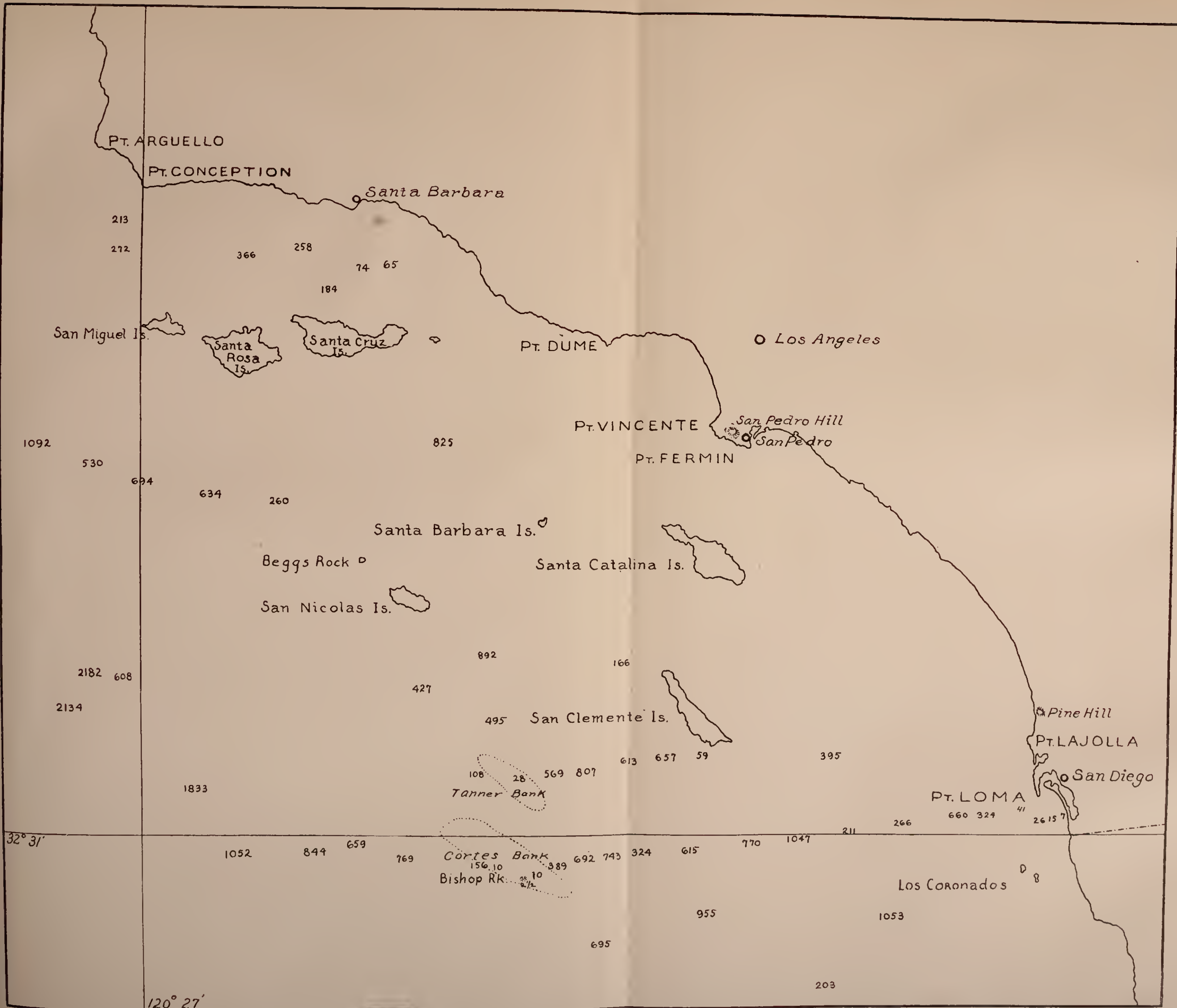
Month.	Locality.	Temperature. Mean Max.	Mean. Min.	Precipitation. Total.	Days with .01m. or more.	Wind. Total movement in miles.	Max. velocity, miles per hour.
March.							
	Nantucket	39	29	2.11	10	11,294	45
	Key West	79	70	1.94	4	7,242	30
	Farallone	60	49	6.30	24	11,940	70
	San Francisco	57	47	6.01	23	7,126	48
	San Diego	**63**	**50**	**2.17**	**10**	**5,041**	**27**
April.							
	Nantucket	48	38	4.08	17	10,274	42
	Key West	80	71	1.51	7	7,378	48
	Farallone	57	50	2.29	13	10,890	45
	San Francisco	63	50	1.29	8	6,544	32
	San Diego	**66**	**52**	**.15**	**3**	**4,665**	**23**
May.							
	Nantucket	61	50	2.39	7	9,033	36
	Key West	82	73	13.01	12	6,018	32
	Farallone	55	51	.23	1	14,993	55
	San Francisco	66	52	.30	1	8,921	42
	San Diego	**65**	**56**	**.12**	**3**	**4,153**	**27**
June.							
	Nantucket	65	54	2.38	12	9,019	42
	Key West	86	77	1.70	12	6,856	28
	Farallone	55	51	.01	1	13,757	54
	San Francisco	66	52	Trace	0	9,448	36
	San Diego	**69**	**60**	**0**	**0**	**4,531**	**20**
July.							
	Nantucket	74	62	2.09	9	8,011	30
	Key West	87	77	1.40	11	6,750	28
	Farallone	56	52	0	0	11,974	40
	San Francisco	62	52	.02	1	10,574	38
	San Diego	**71**	**62**	**0**	**0**	**4,335**	**23**
August.							
	Nantucket	71	61	2.25	12	8,377	35
	Key West	88	77	4.24	13	6,417	31
	Farallone	56	53	Trace	0	11,066	40
	San Francisco	62	52	.06	2	9,674	36
	San Diego	**76**	**66**	**Trace**	**0**	**4,165**	**17**
September.							
	Nantucket	67	56	.78	5	8,869	58
	Key West	87	77	3.55	16	6,092	27
	Farallone	No records.					
	San Francisco	71	57	5.07	5	7,141	36
	San Diego	**76**	**64**	**Trace**	**0**	**4,132**	**20**

Month. Locality.	Temperature. Mean Max.	Temperature. Mean Min.	Precipitation. Total.	Precipitation. Days with .01in. or more.	Wind. Total movement in miles.	Wind. Max. velocity, miles per hour.
OCTOBER.						
Nantucket	57	47	1.01	8	11,700	48
Key West	82	74	1.57	14	8,675	71
Farallone	61	56	2.01	7	10,791	50
San Francisco	68	56	2.37	7	5,506	32
San Diego	**74**	**59**	**.17**	**3**	**4,171**	**20**
NOVEMBER.						
Nantucket	46	35	3.29	8	11,394	60
Key West	76	68	6.22	12	7,573	43
Farallone	59	51	1.58	6	9,168	43
San Francisco	63	53	1.07	5	3,851	22
San Diego	**74**	**54**	**0**	**0**	**3,930**	**23**
DECEMBER.						
Nantucket	35	25	4.67	17	13,184	64
Key West	74	65	.34	2	6,841	26
Farallone	57	51	2.22	10	11,431	58
San Francisco	55	46	1.59	10	4,876	38
San Diego	**66**	**51**	**2.46**	**7**	**3,884**	**19**

Perhaps the most important fact, from the present point of view, exhibited by this table is that pertaining to winds. It will be noted, for San Diego, that the maximum velocity for the year was 36 miles an hour, in February. On the basis of the "Beaufort Scale" of wind velocities, this is a "Strong Breeze." February and March are the climax of the stormy season. For the months May to December, inclusive, the maximum velocities run from "Gentle Breeze" to "Fresh Breeze."

La Jolla, the suburb of San Diego at which the laboratory is located, is on a rocky point jutting into the open sea with water of 200 fathoms attainable inside of five miles; so the ecological problems of oceanic plankton, and of bottom-forms can be here attacked under peculiarly favorably conditions.

The western boundary of the area corresponds roughly to the edge of the continental shelf in this region, and immediately beyond this 2,000 to 2,300 fathoms are reached. While this extreme depth is distant about 200 miles from San Diego, by making San Nicholas Island a temporary base the 2,000 fathom



MAP 1.—Showing the Area to be surveyed. Modified from United States Coast and Geodetic Survey Chart.

curve is only 65 miles away. Within the area is a wide range of depth and great variety of bottom. A basin 40 miles off Point Loma has a depth of over 1,000 fathoms. On the other hand, the Cortes Banks, just beyond the southern boundary, carry but 15 feet of water at low tide.

There can be no doubt that deep sea and 'longshore investigations have not yet been brought together to the extent they ought to be.

3.—The Initial Step.

The first step in such a survey would obviously be to find out what plants and animals inhabit the area; to establish a speaking acquaintance, as one may say, with the organisms that are later to be more intimately known. So far this has absorbed most of the effort, and it will of necessity demand the continuance of much effort for a long time in the future. The ideal being kept always in view, the mere description of the new species for the exclusive use of expert taxonomists in the several groups, would not be sufficient. The entire fauna and flora must be recorded in such a way as to make the records a good foundation for the broader and deeper studies to follow. These considerations have determined the character of the faunistic papers now published, and that will come hereafter. The present volume contains the following contributions to a knowledge of the fauna:

No.1.—The Hydroids of the San Diego Region, by Professor H. B. Torrey.

No. 2.—The Ctenophores of the San Diego Region, by Professor H. B. Torrey.

No.3.—The Pelagic Tunicata of the San Diego Region, excepting the Larvacea, by Professor Wm. E. Ritter.

No. 4.—The Pelagic Copepoda of the San Diego Region, by C. O. Esterly.

No. 5.—The Nonencrusting cheilostomatous Bryozoa of the West Coast of North America, by Dr. Alice Robertson.

No. 6.—The Dinoflagellata of the San Diego Region, by Professor C. A. Kofoid.

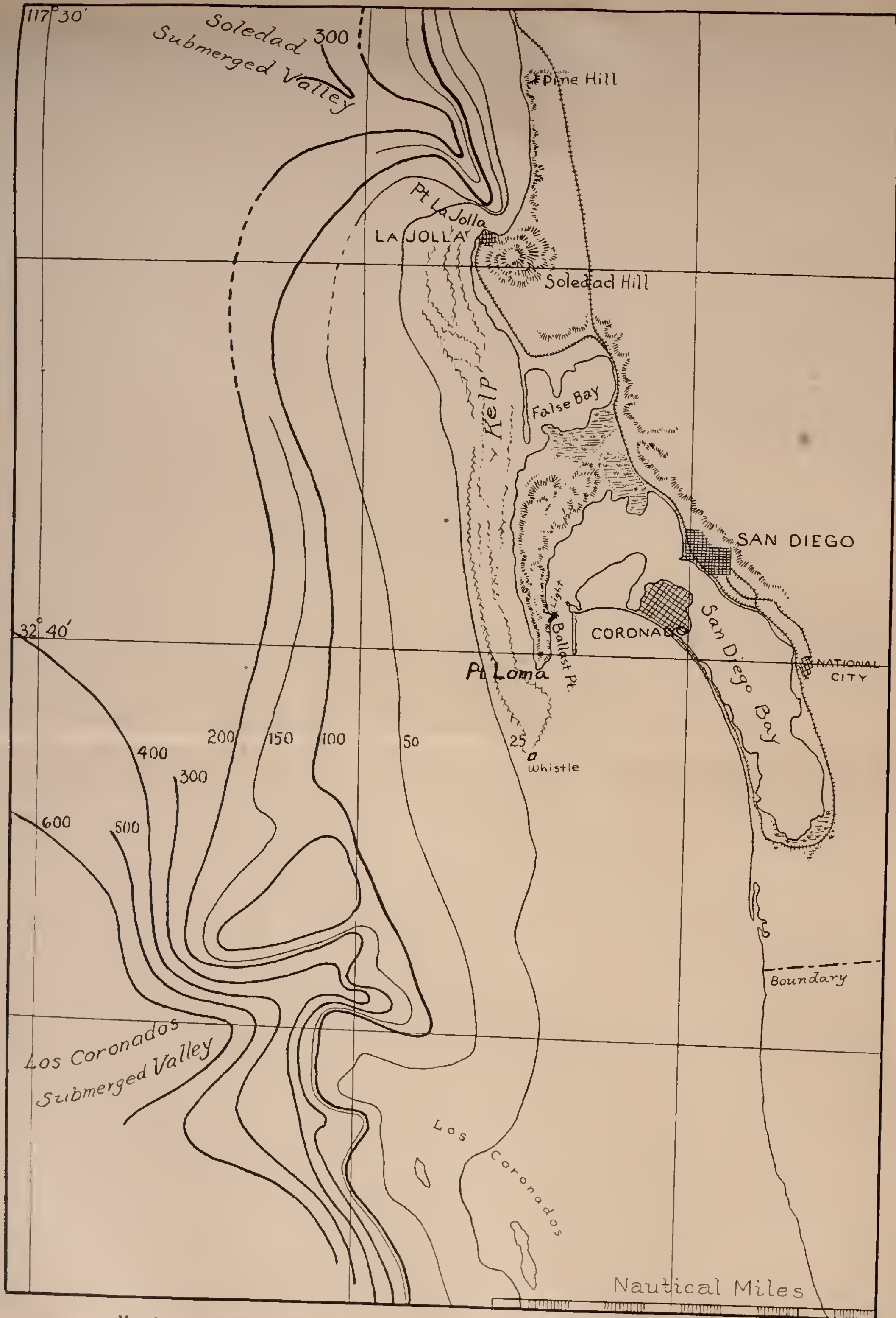
Not only are new species described, but all that have thus far been found in the area are characterized, and in most cases illustrated by figures, so that these papers will constitute a series of hand-books, as far as they go, for the identification of the species treated. It is also intended that the bibliographical lists accompanying the papers shall serve as useful guides to the literature of the several groups for those who may take them up for the study of special problems connected with them.

4.—**Order of Advance on the Numerous Lines of Investigations.**

While there is no reason for attempting a rigorously laid out order of attack on the numerous problems, at natural sequence, within certain limits, will establish an order; and where practical administrative conditions conveniently adapt themselves to such sequence this order will be followed. For example, the species representing a given pelagic group having been got well in hand, a natural second step would be the determination of the seasonal distribution of the group, since the study of the collections for the taxonomy would surely bring together, incidentally, considerable data on this problem. Following close upon the treatment of seasonal distribution would come that of horizontal and vertical distribution, the chorology; and inseparably linked with these would be the problems of food and reproduction; and these again would lead to problems of migration, with their intimate dependence upon temperature and other environmental factors. And here, completeness of knowledge being ever the watchword, the demand would arise for applying experimental and statistical methods in the effort to get at the deeper significance of the facts observed, and generalizations reached from the observational investigations. The chain of questions hanging one to another is endless and, of course, completeness of knowledge in a literal sense, is an unattainable ideal.

5.—**Knowledge of the Physical Conditions of the Area.**

It does not need to be said, in the light of general biological conceptions reigning in this day, that an aim at comprehensiveness of knowledge cannot for a moment neglect the physical conditions under which organisms live. What has to be consid-



Map 2.—Immediate vicinity of San Diego and La Jolla, showing bottom contours in fathoms. Modified from a map by Professor George Davidson.

ered in connection with a marine undertaking like the present, is the specific things that must be done, and the means for doing them. Oceanography is in position to hand óver to the marine biologist, ready prepared, a large amount of the information he must have; and, likewise, physics and chemistry have important resources that can be drawn upon. But these general sources in nowise obviate the necessity for constant and searching studies on the sea water in connection with such a survey as that contemplated. Conditions of the water as to temperature, and currents; mineral, gaseous, and albuminoid content, etc., must be known at *the particular time and place to which the biological studies pertain*, and no general knowledge of this character can suffice. Physics, chemistry, and hydrography must, therefore, be integral parts of such a survey.

6.—**Instrumentalities for Prosecuting such a Survey.**

It is obvious that no small outlay of money would be essential for even a good beginning; and that considerable progress in it could be made only with large expenditures for both equipment and operation. The ideal laboratory building would not be large, but would be constructed with great care. Aquaria would constitute an important element in the plant for the work on shore. From \$50,000 to \$75,000 should build and equip an ample laboratory and aquaria.

Equipment for the work at sea would demand the greater portion of the capital. For the deep-water work a ship of the class of the U. S. Fisheries steamer Albatross would be essential. For less depths, say 1,000 fathoms and under, a much smaller vessel would be as efficient or even more so, since it can be handled so much more quickly. As noted above, our area is extremely favorable for this purpose. A vessel that could be built and made ready for sea (without scientific apparatus) for \$10,000 or \$12,000 would be ample.

Operating expenses would be considerable; and this leads me to speak of the factor most important, but least tried, for the successful carrying out of such an idea.

7.—**Necessity of a Salaried Staff.**

Obviously, there must be coördinated effort of numerous special investigators to make any headway. How is this to be secured? In only one way: *by paying for it.* The diversity of talent and training called for, and the prolonged period of service requisite, preclude the possibility of success on any other basis. Botanists and zoologists there are who would gladly, and without thought of money compensation, prepare reports on collections in their special groups that might be sent to them; and occasionally one would be found not only willing but able to stand the expense of a sojourn for a few days or weeks at the Station, that he might make observations in the field and participate in the collecting. But for repeated and long continued work on both living and preserved material such as is implied by the range of problems contemplated, gratuitous service of this sort cannot be counted on. And why should it be expected or asked?

So with the other lines of research; a chemist could easily be found who would be glad to examine water samples that might be sent to his own laboratory; and geologists there would be who under like conditions, from their geological interest, would willingly report on bottom deposits. But where is the chemist, or physicist, or geologist, or hydrographer, who would be willing, or could afford, to undertake such systematic studies, largely of necessity at the Station, as would meet the biological requirements? There is really little more ground for assuming that a chemist's scientific interests should be sufficient to induce him to enter upon such a task, than that they should be sufficient to induce him to do the chemical work at a sugar factory, or a gas works.

In short, the only way by which such a survey can be carried on with any considerable measure of success is through an *organized, salaried staff.* This, of course, means a large and continuous expenditure. But the size of the expenditure would be fortunately lessened by the circumstance that while the staff would be in the aggregate rather large, only a portion, and in the main a comparatively small portion, of the time of each member would be demanded. In most cases occasional visits to the Station for brief periods, with most of the work done elsewhere, would suffice. So the chief and more permanent members could as well as not be persons in regular positions and with regular incomes in other institutions. Furthermore, the investigations are of such a nature that students in the stage of advancement of candidacy for the doctor's degree in a University could, by working under the guidance of those more experienced, be of much service.

8.—**Present Status, as to Ways and Means.**

An organization incorporated under the laws of California, known as the Marine Biological Association of San Diego, is at present the structural foundation upon which the survey rests: but the Association is prospectively a department of the University of California. Provision is made in the articles of incorporation that under specified conditions and at the expiration of a certain period, all the holdings and undertakings of the Association shall pass automatically and wholly into the hands and under the control of the Board of Regents of the University.

In the meantime, the University's part in the undertaking consists in a measure of coöperation through a committee of Regents, with the Managing Board of the Association, in the conduct of the business affairs of the survey; in the fact that the Director and most of the Scientific Staff are members of the University Faculty; in the granting to the Association permission to take to the Station each year a considerable amount of laboratory equipment and numerous library books; and finally, in publishing at its own expense the results of the investigations.

The assets of the Association at present are: a laboratory building at La Jolla, neither large nor of elaborate construction, but serviceable for most of the work now in progress; a schooner of nineteen tons register, with auxiliary power, and fitted with hoisting engine and gear; collecting apparatus; the nucleus of a library; and a definite guaranteed income for three years from July 1, 1904.

The present officers of the Association are:

H. H. Peters, President.

Dr. Fred Baker, Vice-president.

H. P. Wood, Secretary.

Julius Wangenheim, Treasurer.

Wm. E. Ritter, Scientific Director.

E. W. Scripps and Miss Ellen Scripps, members of the Board of Directors.

B. M. Davis, Resident Naturalist, 1904-05.

Manuel Cabral, Collector.

The permanent members of the staff since 1901 have been Wm. E. Ritter, Ph.D., Professor of Zoology in the University; C. A. Kofoid, Ph.D., Associate Professor of Histology and Embryology; H. B. Torrey, Ph.D., Assistant Professor of Zoology. In addition the following, all connected in some capacity with the University, have been members for longer or shorter times on assignment to particular pieces of work, and for the most part on the pay roll: W. J. Raymond, B.S., Assistant Professor of Physics; F. W. Bancroft, Ph.D., Instructor in Physiology; Alice Robertson, Ph.D., Assistant in Zoology; C. O. Esterly, A.B., Assistant in Zoology; John F. Bovard, B.S., Assistant in Zoology; Margaret Henderson, B.S.; H. M. Evans; L. H. Miller, M.S., Assistant in Zoology; Robert Williams, B.S.; and Effie J. Rigden.

9.—**Historical Note.**

Our work in this area did not begin with the San Diego Association, or even with San Diego as a base of operations. During six weeks of the summer of 1893 a party of teachers and students from the Department of Zoology of the University of California, housed in a tent laboratory at Avalon, Santa Catalina Island, made the first dip into these waters. Both the money and equipment for this piece of work were supplied by the Regents of the University. Another University party, with headquarters at San Pedro, put in several weeks of the summer of 1895. Nothing further of a formal character was attempted until 1891, though individual members of the department made repeated collecting trips to San Pedro throughout the intervening period. All this served to prove the great richness in marine life, the advantageousness as a collecting place, of the San Pedro district. When, consequently, it was resolved, in 1901, to make on effort on the basis of ideas that had beed taking shape for several years—those, in a word, which now animate the undertaking—San Pedro was believed to be the most favorable locus for whatever might be done. For this summer it was resolved to aim particularly at dredging operations in the shallow waters, made as thorough as the time and equipment would permit, with a reconnoissance to San Diego if possible. The University being unable to supply the money for this, a successful appeal was made to friends of the University and of science in Los Angeles and elsewhere. Funds to the amount of about $1,800 were secured, with which a large though open gasoline launch was hired and fitted for the work. She was kept going almost constantly from May 20 to August 6. While the dredging and trawling were the chief occupation, other lines of work were not wholly neglected, particularly plankton collecting and temperature taking. The proposed run to San Diego was made, and from the days devoted to the work there a good impression of the biological conditions of that region was obtained.

For the work on shore on old bath house was rented and converted into a simple laboratory. The summer of 1902 was likewise spent at San Pedro, but this year nothing was done at sea, attention being restricted to the littoral fauna.

During both these seasons formal courses of instruction in Zoology were given as part of the regular University Summer Session.

Before the next summer the laboratory building and best collecting grounds within the small inner harbor at San Pedro had been destroyed by the harbor improvements being prosecuted there by the U. S. Government. Owing to this and to encouraging proposals for financial aid from San Diego, led by Dr. Fred Baker, and to the good impression made by the experiences there in 1901, it was resolved, in the early spring of 1903, to move the base of operations to San Diego. During the years 1903 and 1904 the boat house at Coronado Beach, given and in part fitted up by the Coronado Beach Company, served as a laboratory building.

The work at San Pedro was made possible largely through the interest and efforts of Mr. J. A. Graves, Mr. H. W. O'Melveny, and Mr. Jacob Baruch of Los Angeles. The chief contributors of money here were: Mr. Jacob Baruch, Mrs. Phoebe A. Hearst, Mr. J. A. Graves, Mr. H. W. O'Melveny, Mr. Wm. G. Kerckhoff, Mr. Wm. R. Rowland, Mr. Van Nuys, The Los Angeles Terminal Railroad, Mrs. Margaret Fette, Mr. J. H. Shankland, Mr. John E. Plater, and Mr. Charles M. Wright.

By far the largest givers to the station since its removal to San Diego have been Mr. E. W. Scripps, Miramar; Miss Ellen B. Scripps, La Jolla, and Mr. H. H. Peters, San Diego. In addition, the following have contributed substantially: Mr. Wm. Clayton, for the Coronado Beach Company; Mrs. F. L. Keating, Mr. Henry W. Putnam, Mr. G. W. Marston, and Hon. U. S. Grant.

10.—**Remarks on the Present Status of Marine Biology in General.**

Situated as our station is, on a biologically almost unknown part of a little known ocean, our first concern, chronologically, must be with local conditions and problems. The meagerness of knowledge, not only of the fauna and flora, but also of the oceanography of the eastern part of the North Pacific can hardly be realized except by the few specialists whose studies have led them into immediate contact with it. Sir John Murray, the acknowledged prince of oceanographers, when the science is regarded as pertaining to the earth as a whole, has recently pointed out the urgent need of further exploration of the Pacific from about 150° W. Long. to the American coast. Our information about the most general facts concerning the currents, for instance, is wholly inadequate to constitute a foundation for investigations on distribution of organisms. And as to zoology, there are whole groups of prime importance for any of the wider questions of marine biology, like the *dinoflagellata*, the *radiolaria*, and the *chaetognatha*, about which there is hardly a recorded observation. Even the better studied groups, like the fishes, the mollusks, and the crustaceans, when ecologically regarded have been hardly more than glanced at.

But, hemmed in as we are and for a long time must be by the limitations of meager local knowledge, we yet venture to look somewhat beyond these limits to see where the general idea constituting the underpinning of our enterprise stands with reference to the present state of this domain of science; and in what particulars, if any, Nature has given us opportunities to be of special use in advancing it. Looking over the whole domain, one sees that while certain geographical regions, like the Mediterranean, the North and Baltic Seas, the environs of the British Islands, and, to a less extent, the North American half of the Atlantic, have been cultivated, intensely even, in certain particulars, when attention is directed to large problems rather than to space areas, the thoroughly subjugated portions are exceedingly small.

Let one go to the Bay of Naples, for instance, perhaps the best cultivated locality, and make inquiry about the ecology of the most familiar species found there, and see how far from satisfactory an answer can be obtained. In the realm of pelagic life, no one would contend that the great expeditions of the last half-century, even that of the Challenger, of the Blake, and the recent more concentrated and betted equipped German Plankton and Valdivia Expeditions, and those of the Albatross, have done more than to effect a reconnoissance of the field. The most general questions of seasonal, vertical, and areal distribution are still topics of widest divergence of view, and of lively discussion: and it is obvious that this diversity is in large measure due to the mere matter of dearth of readily ascertainable information. Beyond the most general truth, important is this is, that the bottom of the sea, even in its deeper parts, is inhabited by animals, how immediately one comes against a blank wall when he begins to ask questions about this life. How abundant is it? Does it actually reach into the profoundest depths? Are we to suppose it to be uniformly distributed over the entire ocean floor, modified only by local conditions, or as belonging essentially to the continental margins, with only an advance guard of stragglers, so to speak, reaching to the localities farthest removed from any land? How long, geologically, have the truly abyssal depths been inhabited, and when and how did they become inhabitable? From what source did the immigrants to these regions come? If from the littoral realms, has there been a general movement of approximately equal importance from all shores, or has it been chiefly from the polar regions? What is the significance, biologically, of the continental shelf? What of Murray's "mud line"?

When viewing this whole field of knowledge, and the means and methods of investigation, one must be struck by the prevailing uniformity and inadequacy of the existing marine stations for coping with the situation. This inadequacy is most manifest in two particulars; first, in the well nigh complete absence of endowment, which is essential for the assurance of that certainty and regularity of income by which alone continuous and long continued, definitely planned investigations can be prosecuted; and secondly, by the fundamental idea on which nearly all these institutions are based. They have been and are, with few exceptions, primarily resorts for individual investigators of specific biological problems, and not for systematically attacking the problems of marine biology proper.

I would wish to guard myself without fail against being understood as passing adverse criticism upon these laboratories. They were, most of them, brought into existence by an obvious, immediate, and pressing need. This they have met, and are meeting, magnificently. No other instrumentality has contributed so largely to the promotion of general biology. The particular need which gave them birth was not, however, that here considered. Only in the course of natural progress has this need come pressingly into existence. We are able now to formulate more definitely than has hitherto been possible, the problems in this field, and to see more clearly what methods and instruments must be used in their prosecution.

We are in position to appreciate, for example, as never before the importance of knowing the complete life-histories of animals. We are becoming ever more impressed as knowledge advances, with the truth that no segment of the phenomena presented by an animal, morphological or physiological, is fully understood until it is regarded in the light of the entire life career of that animal. We are likewise in position to see as never before what must be done to attain to this fullness of knowledge. We must, in the first place, learn by observation all the facts of the life-history of the animal. In the second place, we must make use at every point possible of a combination of observation and experimentation for the interpretation of these facts.

I verily believe the value of the experimental and statistical methods now so largely used in biology is not fully appreciated even by some of the most skilful and constant experimenters themselves, nor will it be until these methods are better coördinated with observation in Nature. The problems of animal migration, to be specific, we now know depend largely, at least so far as the simpler aquatic forms are concerned, on purely physiological reactions to temperature, light, sex relations, food, etc.; and we are already in possession of important clues to the way these questions must be studied; but we must learn, through careful and extended *observation of the animals in nature*, just what it is we have to interpret. Need for a kind of marine biological research not specially felt a few years ago is now becoming urgent.

The laboratory of the Liverpool Marine Biology Committee on the Isle of Man, under the directorship of Professor W. A. Herdman, and the proposals of the International Commission for the Investigation of the Sea, are distinctly in the direction of what the future must have for carrying on such researches.

The portions of Nature unsubjugated by science are vast—it almost seems as though they grow vaster the longer we work at them; and one of the great questions science has ever before her is that of making such effort as she is able to put forth count for the most. One way of doing this is by giving good heed, not alone to the talents and tastes of workers, and money endowments, but as well to the *opportunities* held out by Nature herself.

The conditions placed by Nature before us mark unmistakably the road we ought to take.

UNIVERSITY OF CALIFORNIA PUBLICATIONS

ZOOLOGY

Vol. 2, Nos. 1 and 2, pp. 1-51, Pl. 1. December 21, 1904

CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO

I

THE HYDROIDS OF THE SAN DIEGO REGION

II

THE CTENOPHORES OF THE SAN DIEGO REGION

BY
HARRY BEAL TORREY

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ZOOLOGY

Vol. 2, No. 1, pp. 1-43. December 21, 1904

CONTRIBUTIONS FROM THE LABORATORY

OF THE

MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO.

I.

THE HYDROIDS OF THE SAN DIEGO REGION.

BY

HARRY BEAL TORREY.

The San Diego Region, as here defined, extends along the coast from LaJolla, ten miles north of Pt. Loma, to the Coronado Is., fifteen miles south of the same point. In climate, topography and faunal characters, it is in many respects similar to the region about San Pedro, Cal., which lies some ninety miles to the northwest. The hydroids about San Pedro have been considered in a former paper (:02). The present work is concerned only with the local hydroids,[1] of which there are 42 known species, 8 being new; and all are represented in the collections of the University of California or the Marine Biological Association of San Diego. The accompanying table will show their recognized distribution.

No attempt has been made to give complete specific synonymies. The plan adopted gives (1) the original name of the species, (2) the permanent name if some change has been necessitated, and (3) all synonyms in papers dealing with Pacific Coast species.

[1] With the single exception of *S. pedrensis*.

TABLE OF DISTRIBUTION.	Alaska	Puget Sound.	California N. of San Diego.	San Diego.	East America.	Iceland, Gr., Spitzb., and J. M.	Europe.	Asia.	South Africa.	New Zealand.
Gymnoblastea										
Bougainvilliidae										
1. Bimeria gracilis Clark	....	....	....	+	....	....	....	....	....	....
2. Bougainvillia glorietta	....	....	....	+	....	....	....	....	....	....
Eudendriidae										
3. Eudendrium rameum (Pallas)	....	....	+	+	....	JG	+	N	....	....
4. ramosum (Linn.)	....	....	+	+	+	JG	+	....	....	....
5. sp.	....	....	....	+	....	....	....	....	....	....
Hydractiniidae										
6. Hydractinia californica	....	....	....	+	....	....	....	....	....	....
Pennariidae										
7. Corymorpha palma T.	....	....	+	+	....	....	....	....	....	....
8. Tubularia crocea (Ag.)	....	....	+	+	+	....	....	....	....	....
Calyptoblastea										
Haleciidae										
9. Halecium annulatum T.	....	....	....	+	....	....	....	....	....	....
10. kofoidi T.	....	....	+	+	....	....	....	....	....	....
11. washingtoni Nutting	....	+	....	+	....	....	....	....	....	....
Campanulariidae										
12. Campanularia edwardsi Nutting	....	....	....	+	....	....	....	....	....	....
13. everta Clark	....	....	+	+	....	....	....	....	....	....
14. hesperia	....	....	....	+	....	....	....	....	....	....
15. hincksi Alder	....	....	....	+	+	....	+	....	....	....
16. volubilis (Linn.)	....	+	+	+	+	I	+	NE	....	....
17. Obelia corona	....	....	....	+	....	....	....	....	....	....
18. dichotoma (Linn.)	+	+	+	+	+	....	+	N	....	....
19. geniculata (Linn.)	....	....	+	+	+	G	+	NE	....	+
20. Clytia bakeri	....	....	....	+	....	....	....	....	....	....
21. compressa (Clark)	+	....	+	+	....	....	....	....	....	....
22. hendersoni	....	....	....	+	....	....	....	....	....	....
23. universitatis	....	....	....	+	....	....	....	....	....	....
24. Calycella syringa (Linn.)	+	+	+	+	+	IG	+	N+E	....	....
Lafoeidae										
25. Lafoea dumosa (Flem.)	+	+	+	+	+	SG	+	NE	....	....
Sertulariidae										
Sertularella group										
26. Sertularella halecina T.	....	....	....	+	....	....	....	....	....	....
27. pedrensis	....	....	+	....	....	....	....	....	....	....
28. tenella (Alder)	....	+	....	+	+	....	....	....	....	+
29. tricuspidata (Alder)	+	+	....	+	+	+	+	NE	....	....
30. turgida (Trask)	....	+	+	+	....	....	....	....	....	....
Dynamena group										
31. Dynamena cornicina McC.	....	....	....	+	+	....	....	....	....	....
32. Sertularia desmoidis T.	....	....	+	+	....	....	....	....	....	....
33. furcata Trask	....	....	+	+	....	....	....	....	....	....
Thuiaria group										
34. Sertularia filicula E. & S.	+	+	+	+	+	G	+	NE	....	....
Plumulariidae										
35. Aglaophenia diegensis T.	....	....	....	+	....	....	....	....	....	....
36. inconspicua T.	....	....	....	+	....	....	....	....	....	....
37. pluma (Linn.)	....	....	....	+	....	....	+	....	+	....
38. struthionides (M.)	....	+	+	+	....	....	....	....	....	....
39. Diplocheilus allmani	....	....	....	+	....	....	....	....	....	....
40. Plumularia alicia T.	....	....	+	+	....	....	....	....	....	....
41. megalocephala A.	....	....	....	+	+	....	....	....	....	....
42. plumularioides (C.)	+	....	....	+	....	....	....	....	....	....
43 setacea (Ellis)	....	+	+	+	+	....	+	....	....	....
Totals	7	11	20	42	14	8	13	8	1	2

KEY TO FAMILIES, GENERA AND SPECIES.

1. No true hydrothecae or gonangia .... Gymnoblastea 2
1. True hydrothecae and gonangia present.......... Calyptoblastea 13
2. Tentacles in proximal and distal sets; hydranth abruptly set off from stem .... Pennariidae 3
2. Tentacles in one circlet, filiform 6
3. Solitary nutritive polyp, rooted in sand; perisarc rudimentary .... Corymorpha 4
3. Several nutritive polyps from common stolon; perisarc well developed; gonophores fixed.......... Tubularia 5
4. Not more than 30 proximal tentacles; gonophores without tentacles .... C. palma (p. 9)
5. About 25 proximal tentacles; gonophores with 6-10 flattened processes .... T. crocea (p. 10)
6. Colony encrusting; hydranths clavate; spiral zooids; spines on hydrorhiza .... Hydractiniidae, Hydractinia 7
6. Colony branching 8
7. Sterile hydranths with 6-10 tentacles; blastystyles with knoblike tentacles .... H. californica (p. 19)
8. Proboscis trumpet shaped; hydranth not fusiform .... Eudendriidae, Eudendrium 9
8. Proboscis conical; hydranth fusiform .... Bougainvilliidae 10
9. Stem and principle branches polysiphonic.......... E. rameum (p. 8)
9. Stem polysiphonic at base only; branches simple.......... E. ramosum (p. 8)
10. Gonophores fixed sporosacs.......... Bimeria 11
10. Gonophores liberated as medusae, with four pairs of tentacles .... Bougainvillia 12
11. Stems simple, only partially annulated; hydranth with 10-12 tentacles.......... B. gracilis (p. 6)
12. Stem and branches without annulae, often twined about each other.. .... B. glorietta (p. 7)
13. Nematophores absent 14
13. Nematophores present; hydrothecae sessile, on one side of stem or branches only .... Plumulariidae 38
14. Hydrothecae with definite basal septa; gonangia not aggregated 15
14. Hydrothecae without definite basal septa, tubular; smooth margined; gonangia aggregated .... Lafoeidae 28
15. Hydrothecae much wider than deep .... Haleciidae 16
15. Hydrothecae campanulate, usually deeper than wide, never adnate nor immersed .... Campanulariidae 19
15. Hydrothecae sessile, adnate or immersed, in 2 to 6 rows..Sertulariidae 30
16. Gonangia with sporosacs .... Halecium 17
17. Stem not fascicled.......... 18
17. Stem fascicled; ultimate branches geniculate..H. washingtoni (p.11)
18. Annulated; hydrathecae about half as deep as broad, margin everted .... H. annulatum (p. 10)

18. Not annulated; hydrothecae shallow, margin not everted .... H. kofoidi (p. 11)
19. Operculum of numerous small triangular pieces; unbranched; hydrothecae tubular .... Calycella, C. syringa (p. 20)
19. No operculum 20
20. Gonophores sessile, sporosacs .... Campanularia 21
20. Gonophores free medusae 23
21. Stems branched, non-fascicled; hydrotheca with 12-14 marginal teeth .... C. edwardsi (p. 11)
21. Stems unbranched 22
22. Hydrothecal margin with 12-15 crenations; gonangium compressed, small aperture .... C. everta (p. 12)
22. Hydrotheca with 10-12 square-topped teeth .... C. hincksi (p. 13)
22. Hydrotheca deep, with 11-12 short, sharp teeth .... C. hesperia (p. 12)
22. Hydrotheca small, tubular, with 9 low blunt teeth .... C. volubilis (p. 13)
23. Medusae liberated with at least 16 tentacles .... Obelia 24
23. Medusae liberated with 4 tentacles .... Clytia 26
24. Hydrothecal margin smooth 25
24. Hydrothecal margin bidentate .... O. corona (p. 14)
25. Branching irregular; stem non-geniculate .... O. dichotoma (p. 15)
25. Usually unbranched, except for pedicels; latter on shoulder processes of geniculate stem .... O. geniculata (p. 15)
26. Stems simple 27
26. Stems and branches polysiphonic; colonies large and bushy, hydrothecal margin with 12-15 teeth .... C. universitatis (p. 19)
27. Branched; hydrotheca delicate, with about 14 carinate teeth .... C. hendersoni (p. 18)
27. Unbranched; hydrotheca usually with thick wall, crenate margin; gonangium compressed, wide aperture .... C. compressa (p. 17)
27. No branches except hydranth pedicels; latter usually with but single annulus; hydrothecal margin smooth .... C. bakeri (p. 16)
28. Hydrothecae straight .... Lafoea 29
29. Hydrothecae sessile; stem creeping or erect and polysiphonic .... L. dumosa (p. 20)
30. Hydrothecae in two rows 31
31. Hydrothecae alternate, one to an internode .... Sertularella group 32
31. Hydrothecae opposite, one pair to an internode .... Dynamena group 35
31. Hydrothecae subopposite to alternate, more than two to an internode .... Thuiaria group 37
32. Hydrothecal margin dentate 33
32. Hydrothecal margin entire, everted, hydrotheca tubular; branches and gonangia rising within hydrothecae .... S. halecina (p. 26)
33. Three marginal teeth 34
33. Four marginal teeth; hydrothecae and stems annulated .... S. tenella (p. 28)
34. Hydrothecae corrugated; internodes long, slender; gonangia spinulose .... S. pedrensis (p. 27)

34. Hydrothecae smooth; internodes moderate; gonangia with high narrow transverse corrugations .... S. tricuspidata (p. 28)
34. Hydrothecae smooth or roughened; internodes stout, geniculate; gonangia with distal spines or annulae or both..S. turgida (p. 29)
35. Margin of hydrotheca without teeth.................... S. desmoides (p. 30)
35. Margin of hydrotheca with two teeth 36
36. Teeth prominent; mouth of hydrotheca large.......... S. furcata (p. 31)
36. Teeth moderate, mouth of hydrotheca small ...... D. cornicina (p. 30)
37. Aperture of hydrotheca round; hydrotheca abruptly narrowed distally.................... S. filicula (p. 32)
38. Nematophores fixed by a broad base 39
38. Nematophores fixed by a narrow base 44
39. Stem simple; hydrotheca with dentate margin, no anterior intrathecal ridge; corbulae without hydrothecae at bases of leaflets.......................... Aglaophenia 40
39. Stem simple; hydrotheca with anterior intrathecal ridge; single sapracalycine sarcostyle; no corbulae.................. Diplocheilus 43
40. Hydrotheca with 11 irregular teeth ....A. struthionides (p. 35)
40. Hydrotheca with 9 teeth 41
41. Median tooth recurved 42
41. Median tooth not recurved .... A. pluma (p. 34)
42. Hydrocladial nodes well marked; mesial nematophore reaches mouth of hydrotheca.................... A. inconspicua (p. 34)
42. Hydrocladial nodes weak; mesial nematophore does not reach mouth of hydrotheca .... A. diegensis (p. 33)
43. Margin of hydrotheca smooth; mesial nematophore very short and broad.................... D. allmani (p. 36)
44. Hydrocladia pinnately disposed on erect stem without thorny processes or nematophorous branchlets; no corbulae .... Plumularia 45
45. Hydrocladial internodes thecate and non-thecate 46
45. Hydrocladial internodes thecate only ....P. plumularioides (p. 38)
46. Nodal septa transverse 47
46. Nodal septa alternately transverse and oblique; thecate internodes twice as long as non-thecate .... P. alicia (p. 37)
47. Hydrocladia borne on short processes of stem, always alternate .... P. setacea (p. 39)
47. Hydrocladia borne on long processes of stem, very slender, opposite distally .... P. megalocephala (p. 37)

GYMNOBLASTEA.

Fam. Bougainvilliidae.

Gen. **Bimeria,** Wright, 1859.

1. **Bimeria gracilis** Clark.

Bimeria gracilis, Clark, 1876*a*, p. 252, pl. 38, fig. 3.

Thophosome. Stems rising from creeping hydrorhiza to height of 20 to 30 mm., with numerous short branches. Hydranths borne alternately on latter, on moderate pedicels; 9-11 rather stout tentacles. Stem usually smooth, occasionally wrinkled. Pedicels with 2 to 5 more or less indistinct annulae at the base. Perisarc opaque, extending to bases of tentacles.

Gonosome. Sporosacs ovate, borne on branches singly or in pairs. Pedicel short and smooth; spadix branched.

Fig. 1.—*Bimeria gracilis.* Gonophores.

Distribution. Dredged near the mouth of San Diego Bay, in 3 fathoms, July, 1903; La Jolla, at low water, July, 1903. San Diego (Clark).

There can be little doubt that this is Clark's species. The perisarc was covered with minute adhering particles. Male sporosacs are slightly smaller than female.

Gen. **Bougainvillia,** Lesson, 1836.

2. **Bougainvillia glorietta,** n. sp.

Trophosome. Stems branched, rising from a creeping hydrorhiza in clusters to the height of 20 to 30 cm. Stems, or stem and branches frequently twine about each other. Perisarc smooth, without annulae, occasionally wavy, unusually adhesive, covered with particles of dirt and diatoms, reaching bases of tentacles. Terminal hydranths largest, with 20 to 25 tentacles carried in two or three irregular whorls, the outermost shortest. Tentacles highly contractile, held stiffly when at rest.

Gonosome. Gonophores each on a short pedicel, in groups of two or three on branches or hydranth stalks.

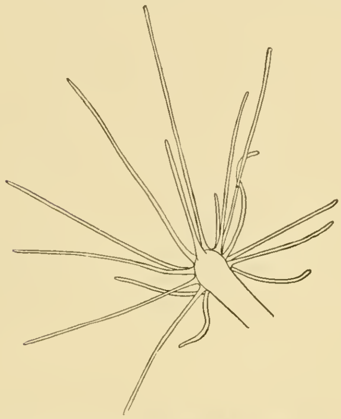


Fig. 2.—*Bougainvillia glorietta.* Hydranth from below.

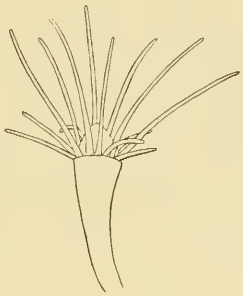


Fig. 3.—*B. glorietta.* Hydranth with tentacles partly retracted; edge of perisarc visible.

Distribution. San Diego Bay, Cal.

This is the second species of the genus to be found on this coast. The first was collected in San Francisco Bay by A. Agassiz ('65) and referred to *B. mertensi.* It was taken again by myself in Oakland Harbor, Cal., and is mentioned in a footnote on p. 1 of my former paper (:02). The present species resembles *B. superciliaris*, yet differs in lacking annulae in the perisarc and in the twining habit of stem and branches. Medusae with 4 pairs of tentacles, 4 simple mouth processes and 8 ocelli were still within the perisarc, July 5, 1903.

EUDENDRIIDAE.

Gen. **Eudendrium,** Ehrenberg, 1834.

3. **Eudendrium rameum** (Pallas).

Tubularia ramea, Pallas, 1766, p. 83.
Eudendrium rameum, Johnston, 1847, p. 45, pl. 5, figs. 1, 2.
Eudendrium rameum, Torrey, 1902, p. 33.

Trophosome. "Hydrocaulus profusely branched, attaining a height of from three to six inches, fascicled in the main stem and principal branches; main stem attaining a thickness of more than a quarter of an inch, and as well as the principal branches, very irregularly ramified; branches alternately losing their fasciculation and then consisting of single capillary tubes, which may continue to branch before the emission of the ultimates or hydranth-bearing ramuli, which are regularly alternate in their disposition; perisarc rigid, occasionally marked with nearly obsolete annulations on the smaller branches. Hydranths with about twenty tentacles, frequently atrophied in the male after the production of gonophores."

Gonosome. Male sporosacs two-chambered, borne upon the body of the hydranth in a verticil immediately below the tentacles; female sporosacs oval, scattered on the hydrocaulus for some distance below the hydranth." (Allman, '71.)

Distribution. Mouth of San Diego Bay, between tides (June 26, 1903; no gonosome); San Pedro, Cal., on float at surface (Dec., 1901; no gonosome). Mediterranean, Norway, Gt. Britain (Allman). Jan Mayen (Markt.) Helgoland (Hartlaub). Greenland (Levinsen). Northern Asia (Thompson).

4. **Eudendrium ramosum** (Linn.).

Tubularia ramosa, Linnaeus, 1767, p. 1302.
Eudendrium ramosum, Ehrenberg, 1834, p. 296.
Eudendrium ramosum, Torrey, 1902, p. 34.

Trophosome. Hydrocaulus much branched, fascicled at the base and attaining a height of four inches or more; primary ramifications irregular, after which the branches become regularly alternate and mostly distichous in their arrangement, giving off all along their length, from their upper or distal sides, short, usually simple ramuli, which support the hydranths on their summits; perisarc firm, annulated at the origin of the branches, or even along the entire length of the smaller branches. Hydranths usually with about twenty tentacles.

Gonosome. Male sporosacs two-chambered, borne on body of hydranth below tentacles which often atrophy. Female sporosacs piriform, scattered on body of hydranth and stalk immediately below it.

Distribution. Mouth of San Diego Bay, in 3 fathoms; Pacific Grove, Cal. Gt. Britain (Allman). Jan Mayen, Adria, Rovigno (Markt.). Helgoland (Hartlaub). Greenland (Bétencourt).

The San Diego material consists of three stem fragments which are provisionally placed in this species. The definition is Allman's ('71), with a few slight verbal changes.

5. **Eudendrium** sp.

A fragment of a colony, consisting of hydrorhiza and a few very short stems, was taken at Point Loma, June 27, 1903. The perisarc is sparsely and wavily annulated. Female blastostyles with tentacles.

Fam. HYDRACTINIIDAE.

Gen. **Hydractinia,** Van Beneden, 1844.

6. **Hydractinia californica,** n.sp.

Trophosome. Sterile hydranths 2 to 2.5 mm. long in extension, with 6 to 10 tentacles, usually in 2 recognizable whorls; proboscis domed to conical. Spines .5 to .9 mm. long, conical, often with truncated tops and irregular protuberances; with about 10 longitudinal dentate ridges.

Gonosome. Sporosacs, with 1 or 2 eggs in female, borne in clusters of 2 to 10 or more about half way from the base of the blastostyle. Latter with 5 to 10 knob-like clusters of nematocysts representing tentacles; 1 to 1.3 mm. long.

Colors. Perisarc deep brown, fleshy parts white.

Distribution. Off San Diego, in 50 fathoms. Covering the shells of *Dentalium polygonum* inhabited by hermit crab.

This species is very closely allied with *H. echinata* (Flem.) of Europe and *H. polyclina* Ag. of the eastern United States, which are themselves almost indistinguishable. It appears to differ from them in its much smaller number of tentacles. The latter arise in threes, fours, or fives, or irregularly; there is no single typical method.

Fam. PENNARIIDAE.

Gen. **Corymorpha,** Sars, 1835.

7. **Corymorpha palma.**

Corymorpha palma, Torrey, 1902, p. 37; 1902*a*, p. 987.

Trophosome. Stems each 6 to 14 cm. long, rooted in sand by a dense tangle of filamentous processes, and covered by perisarc proximally for one third or one fourth of its length; thickest near proximal end, tapering gradually into a narrow neck which supports the hydranth. Latter with 18 to 30 proximal tentacles in one whorl, with a span of about 2.5 cm.; distal tentacles more than twice as numerous, more or less irregularly placed around the mouth in several whorls.

Gonosome. Gonophores medusoid, permanently fixed to peduncles springing from the base of the proboscis just within the whorl of proximal tentacles, each with a ring and 4 radial canals, and a manubrium at least twice as long as the bell, without a mouth; tentacles wanting; velum may be present or absent.

Distribution. San Diego and San Pedro, Cal., throughout the year, between tides, on sand flats. Eggs laid in May, June, July.

Gen. **Tubularia,** Linnaeus, 1767.

8. **Tubularia crocea** (Ag.).

Parypha crocea, L. Agassiz, 1862, III, p. 249, pls. 23, 23*a*, figs. 1-7.
Parypha microcephala, A. Agassiz, 1865, p. 195.
Tubularia crocea (Ag.), Allman, 1871, p. 416.
Tubularia elegans, Clark, 1876*a*, p. 253, pl. 38, fig. 2.
Tubularia crocea, Torrey, 1902, p. 43, pl. 2, Figs. 22, 23.

Trophosome. Colony usually a bushy mass of stems, tangled below, which may be 10 cm. long and may occasionally branch. Hydranths with not more than 25 proximal tentacles.

Gonosome. Gonophores borne in pendulous clusters on peduncles arising between proximal and distal tentacles; with 6 to 10 flattened processes, varying in size, more prominent in female, sometimes hardly visible in male.

Distribution. San Diego Bay, San Pedro Harbor, and San Francisco Bay, Cal. Eastern United States (Agassiz).

CALYPTOBLASTEA.

Fam. HALECIIDAE.

Gen. **Halecium,** Oken, 1816.

9. **Halecium annulatum.**

Halecium annulatum, Torrey, 1902, p. 49, pl. 3, figs. 30, 31.

Trophosome. Stems rising from a creeping hydrorhiza to a height of 7 mm.; the longer have 2 regularly alternating branches. Stem and branches more or less regularly annulated throughout. Hydrothecae may be half as deep as broad; margin everted. Sessile hydrothecae alternately on either side of stem or branch; peduncles arising within these carry other hydrothecae which may also give rise to other peduncles.

Gonosome. Female gonangia broadly ovate, excessively compressed, with terminal aperture. Single gonophore with numerous ova, surrounded by blastostylar processes reaching to gonangial wall.

Distribution. Coronado Is., Mexico (July, 1903), and Coronado, Cal. (July, 1901). Growing on seaweed.

10. Halecium kofoidi.

Halecium kofoidi, Torrey, 1902, p. 49, pl. 3, figs. 32, 33.

Trophosome. Stems rising from creeping hydrorhiza, branching irregularly; largest colonies with thick trunk may reach 5 mm. in height. Branches arise just below hydrothecae; divided obliquely into internodes of approximately equal length. Each internode usually bears on a distal shoulder process a sessile hydrotheca which does not reach beyond the distal node. Within this hydrotheca another may arise, and another within the latter, both on short stalks somewhat constricted at the base and bent slightly away from the stem. Hydrothecal wall especially thick.

Gonosome. Male gonangia long, oval, smooth, 3 or 4 times as long as broad; may be waved proximally; small terminal aperture.

Distribution. Coronado Is., Mexico (July 25, 1903, on kelp at surface); Pt. Loma; mouth of San Diego Bay, 5 fathoms; Catalina Is., 42 fathoms.

11. Halecium washingtoni Nutting.

Halecium geniculatum, Nutting, 1899, p. 744, pl. 63, fig. 1.
Halecium washingtoni, Nutting, 1901, p. 789.
Halecium nuttingi, Torrey, 1902, p. 50.

Trophosome. Colony fascicled, branching in much the same plane, branches approximately alternate; non-fascicled branches more or less regularly annulated at their bases, with long internodes which are arranged in zigzags distally. Hydrothecae at the distal end of each internode, singly or in pairs, margins everted. Hydranths with 16 to 24 tentacles.

Gonosome. "Gonangia borne singly in the axils of the branches and branchlets, regularly ovoid in one view, barnacle-shaped in the other; aperture large, terminal" (Nutting, '99).

Distribution. Pt. Loma, July, 1901. Puget Sound (Nutting).

Fam. Campanulariidae.

Gen. Campanularia, Lamarck, 1816.

12. Campanularia edwardsi Nutting.

Campanularia edwardsi, Nutting, 1901, p. 346, fig. 28.

Trophosome. "Colony attaining a height of over an inch, branching somewhat irregularly, but with a distinct tendency to send off pedicels from the main stem in sub-opposite pairs. Stems, branches and pedicels exceedingly long and slender, with the annulation confined to the proximal portions, except the few just below the hydrothecae. Hydrothecae very large, deeply campanulate, with 12 to 14 exceedingly sharp, slender teeth. Hydranth with about 28 tentacles.

Gonosome. "Unknown" (Nutting).

Distribution. Mouth of San Diego Bay, in 3 fathoms. Woods Hole, Mass., between tides (Nutting).

There is much variation in the size and proportions of the hydrothecae, correlated apparently with mode of growth. The stems are usually densely clustered. Some of the larger stems, however, grow more freely above the rest. These longer stems bear the longest hydrothecae, which may be .92 mm. long. On the crowded stems, the hydrothecae may be no longer than .60 mm. Short scattered stems produce the largest hydrothecae of all. The diameter does not vary with the length, as the following measurements in mm. show: .625 x .26; .67 x .31; .68 x .45; .70 x .45; .72 x 39; .92 x .45. As a rule, however, the diameter is less than half the length. The thecae growing in the clusters are relatively broader.

The gonosome was not present, July 15, 1903.

13. **Campanularia everta** Clark.

Campanularia everta, Clark, 1876*a*, p. 253, pl. 39, fig. 4.
Campanularia everta, Torrey, 1902, p. 51, pl. 4, figs. 35-37.

Trophosome. Pedicels of variable length, smooth, wavy or irregularly annulated, arising directly from a creeping hydrorhiza; spherical annula immediately below each hydrotheca. Wall of latter varies greatly, from excessive thickness to thin; straight or convex in profile; margin usually crenate.

Gonosome. Gonangia somewhat compressed, ovate, with small round terminal aperture. Acrocysts may be present in female, which are somewhat larger than male.

Distribution. San Diego, low water to 24 fathoms; Catalina I., 42 fathoms; Pacific Grove, Cal. San Diego (Clark).

Gonosome present, June 26, 1903.

Transitions between all the forms of hydrothecae have been traced in the same colony. *C. everta* can be distinguished from *Clytia compressa* by the gonosome; the gonangia have a much narrower aperture and the gonophores are fixed sporosacs.

14. **Campanularia hesperia,** n. sp.

Trophosome. Stems simple, unbranched, from a creeping hydrorhiza, terminating in hydranths; with about 10 rings at base, 2 to 4 just below hydrothecae, and usually 3 or 4 others in the distal half of the stem. Hydrothecae less than half as broad as long (.5 x .22 mm.; .6 x .25 mm.), with 11 or 12 short, sharp marginal teeth. Hydranth with 22 to 24 tentacles.

Gonosome absent, July 13, 1903.

Fig. 4.—*Campanularia hesperia.* Hydrotheca and pedicel.

Distribution. La Jolla, Cal., between tides, on the tests of ascidians.

This species closely resembles *Clytia cylindrica* Ag. in habit and skeletal features, but the latter species has but 16 tentacles, and the absence of the gonosome makes it desirable to distinguish between the two for the present.

15. **Campanularia hincksi** Alder.

Campanularia Hinksii, Alder, 1857, p. 127.
Campanularia Hinksii, Hincks, 1868, p. 162, pl. 24, fig. 3.
Campanularia hinksi, Torrey, 1902, p. 53.

Trophosome. Pedicels arise directly from hydrorhiza. Hydrothecae large and deep, with 11 to 14 flat-topped teeth which may have rounded corners or be slightly hollowed out above. Wall very thin, with delicate longitudinal lines from the margin between the teeth.

Gonosome. Gonangia much elongated, slightly tapering distalward, to truncate end; 10 to 18 wavy annulations.

Distribution. Mouth of San Diego Bay, in 3 fathoms; off San Diego in 40 to 75 fathoms. Newport, R. I. (Nutting). British coasts, from 10 to 20 fathoms to deep water (Hincks).

Gonosome present, June 29, 1903.

16. **Campanularia volubilis** (Linn.).

Sertularia volubilis, Linnaeus, 1767, p. 1311.
Campanularia volubilis, Alder, 1856, p. 358, pl. 13, fig. 7.
Campanularia volubilis, Hartlaub, 1901, p. 357.
Campanularia volubilis, Torrey, 1902, p. 54, pl. 5, fig. 48.

Trophosome. Pedicels long, annulated, springing from hydrorhiza. Hydrothecae small, broadly tubular; margin with 9 to 10 short blunt teeth, frequently reduplicated.

Gonosome. Gonangia smooth, flask-shaped, somewhat compressed, with a long narrow neck and small circular aperture.

Distribution. San Diego, shore rocks; San Pedro, Cal., 9 fathoms; Tomales Bay, Cal., shore rocks. Near Vancouver, B. C. (Hartlaub). Gulf of St. Lawrence (Packard). Massachusetts

(Agassiz). Iceland, British coasts (Hincks). Norway (Sars). Helgoland (Hartlaub). White Sea (Mereschkowsky).

No gonosome in the San Diego specimens, June 26, 1903.

Gen. **Obelia,** P. et L., 1809.

17. **Obelia corona,** n. sp.

Trophosome. Colonies very low; stems simple, short, slightly flexuous, from a creeping stolon, with 3-6 annulae distal to each pedicel. Hydranths long, narrow, tapering, margin with 8-10 teeth, each with two sharp cusps, pedicel short, completely annulated, with 2-4 annulae. Hydranth with about 24 tentacles.

Gonosome. Gonangia about 3 times as long as broad, with wide aperture; pedicel slender, with 2-4 annulae. Numerous medusae, largest with 24 tentacles.

Dimensions. Hydrotheca: .44 x .20; .43 x .18 mm.
Gonangium: .76 x .20 mm. (including pedicel).

Fig. 5.—*Obelia corona.* Hydrotheeae.

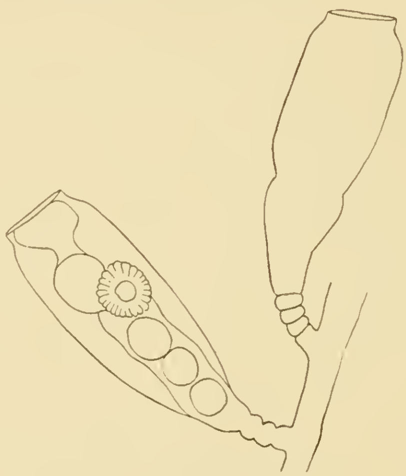


Fig. 6.—*O. corona.* Gonangia.

Distribution. San Diego Bay, on piles under wharves at low tide, July 15, 1904. Creeping over sponges.

Hydranths and gonangia are frequently borne on pedicels springing directly from the stolon. Stems and stolons transform with readiness into each other in the colonies at hand, owing doubtless to the many opportunities offered by life on a growing sponge for variations in the contact stimulus.

18. **Obelia dichotoma** (Linn.).

Sertularia dichotoma, Linnaeus, 1767, p. 1312.
Obelia dichotoma, Hincks, 1868, p. 156, pl. 28, fig. 1.
Obelia dichotoma, Calkins, 1899, p. 356, pl. 3, fig. 16.
Obelia dichotoma, Torrey, 1902, p. 57.

Trophosome. "Stem filiform, slender, nearly straight, irregularly branched, ringed above the origin of the branches, of a deep horn color: branches suberect, often very long, and more or less ramified, ringed at intervals, a single calycle in the axils; hydrothecae alternate, broadly companulate and deep, polyhedral above, each side corresponding with a very slight sinuation of the margin, borne on ringed pedicels, which vary in length from 4 or 5 to as many as 16 rings."

Gonosome. "Gonothecae axillary, slender, smooth, widening from the base upwards, and terminating above in a raised, somewhat conical aperture." (Hincks). Medusae liberated with 16 tentacles (Hincks), 20 to 24 (Southern California specimens).

Distribution. San Diego; San Pedro, Cal. Puget Sound (Calkins). Alaska (Nutting). Eastern United States (Nutting). Helgoland (Schulze). N. Asia (Thompson).

It is possible that the California species is the stock which produces an undescribed medusa of the genus *Obelia* that is very abundant in the neighborhood of San Diego. If this prove to be the case, the hydroid, though identical with *O. dichotoma* as regards the trophosome, will become a new species.

19. **Obelia geniculata** (Linn.).

Sertularia geniculata, Linnaeus, 1767, p. 1312.
Obelia geniculata, Allman, 1864, p. 372.
Obelia geniculata, Torrey, 1902, p. 58.

Trophosome. "Stem zigzag, sometimes sparingly branched, jointed at each of the flexures, and thickened immediately below them, so as to form a series of projections or rests, from which the pedicels arise, hydrothecae somewhat obconical, rather short, the length slightly exceeding the width, with a plain margin, borne on short, annulated stalks (rings (4-6), which are suberect and taper slightly upwards."

Gonosome. "Gonothecae axillary, urnshaped, attached by a short ringed stalk (3-4 rings)." (Hincks.) Medusae at time of liberation with 24 tentacles.

Distribution. Coronado, Cal., at surface; Catalina I., 42 fathoms; San Francisco, between tides. Eastern United States (Agassiz, Nutting). Europe (Hincks). White sea (Mereschkowsky). New Zealand (Hartlaub).

Gonosome present, July 1, 1903.

The geniculation varies in different parts of the colony and may be absent in some regions. The colonies from Coronado are unusually low, and branched. Otherwise they are not distinguishable from the typical forms.

Gen. **Clytia,** Lamouroux, 1816.

20. **Clytia bakeri,** n. sp.

Trophosome. Stems clustered, about 20 mm. long, without branches. Each stem free, for 2 to 5 mm., from pedicels of hydrothecae, which then follow each other alternately in quick succession; closely annulated at base, annulae increasing gradually in length, ultimately becoming internodes of stem. Stem internodes usually 3 to 4 times as long as broad, each bearing a pedicel on a shoulder process from distal end. Hydrothecae small, conical, without marginal teeth; pedicel consisting usually of but one annula almost as long as broad.

Gonosome. Gonangia long, narrow, with bottlenose apertures, tapering gradually to short peduncles; borne usually in pairs at the bases of hydrothecal pedicels. Sporosacs abundant, 12 to 20.

Fig. 7.—*Clytia bakeri.* Proximal portion of stem, showing characteristic annulation.

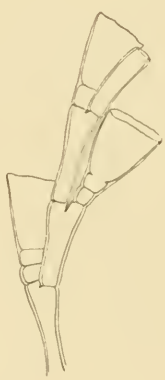


Fig. 8.—*C. bakeri.* Portion of stem in distal half, with three typical hydrothecae, one of which is sessile.

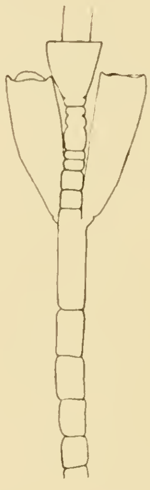


Fig. 9.—*C. bakeri.* Proximal region of stem with gonangia and hydrotheca with exceptionally long pedicel.

Distribution. Pacific Beach, in the surf, attached in tufts to the posterior region of both valves of the beach clam *Donax*, a most unusual situation for a hydroid, which may acount for the irregular, damaged margins of the hydrothecae. The beach was literally covered with the colonies, Jan. 2, 1904. Mouth of San Diego Bay, under similar circumstances, July, 1904.

There is considerable variation in the length of the annulae or internodes on the stem and the annulation of the pedicels. Occasionally a pedicel has several annulae (fig. 9), but this is the case only in the lower portion of the stem—*e.g.*, the pedicel referred to is the lowest in the colony. More often the hydrothecae are sessile; this condition is found in the distal portion of the colony. As a general rule, the annulation disapears from base to tip.

The dimensions of the hydrothecae in four average specimens, are as follows, length first, in mm.: .69 x .45; .68 x .50; .50 x .52; .48 x .37.

Dimensions of gonangia: .98 x .33; 1.14 x .28.

This species is named in honor of that tireless friend of education and public spirited citizen of San Diego, Dr. Fred Baker.

21. **Clytia compressa** (Clark).

Campanularia compressa, Clark, 1876*a*, p. 214, pl. 8, figs. 5, 6.
Clytia compressa, Nutting, 1901, p. 170, pl. 17, figs. 3, 4.
Cytia compressa, Torrey, 1902, p. 58, pl. 6, fig. 49.

Trophosome. As in *C. everta.*

Gonosome. Gonangia compressed, broadly ovate, with truncated top and large aperture.

Distribution. San Diego, 5 fathoms; San Pedro, Cal., 3 fathoms. Orca, Al. (Nutting). Shumagin Is., Al., 6-20 fathoms, on *Laminaria* (Clark).

Gonosome present, May 23 and July 13, 1901.

22. **Clytia hendersoni,** n. sp.

Trophosome. Colonies branching, 3 to 5 cm. high. Internodes of the stem flexuous, with a pronounced knee at the base of each, and running parallel with hydranth pedicels for nearly half their length; above each knee, 3 to 8 annulae. Pedicels completely annulated, with 6-14 annulae. Hydrothecae large, deep, 1.00-1.2 mm. long by .40-.60 mm. in diameter, tapering gradually, with very thin and easily collapsible walls, bordered by about 14 very sharp, keeled teeth.

Gonosome. Gonangia with wide mouths, widest in distal half, tapering, 3 times as long as broad, with wavy contours but not annulated. Pedicels short, with 3 or 4 annulae. Usually 3 or 4 medusae in each gonangium, each with 4 tentacles and without gonads.

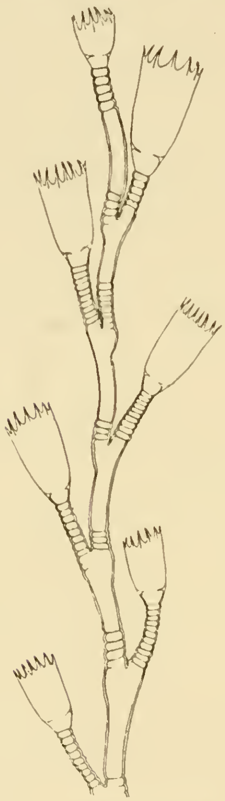


Fig. 10.—*Clytia hendersoni.* Stem with hydrothecae.

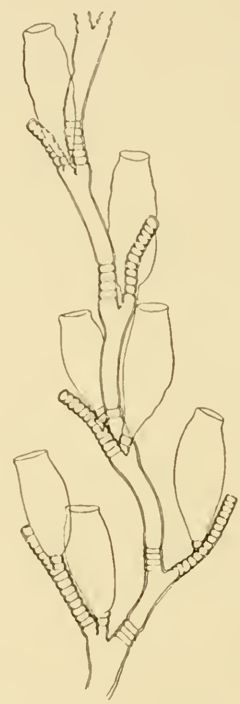


Fig. 11.—*C. hendersoni.* Stem with gonangia.

Distribution. San Diego Bay, 3 fathoms, July 15, 1903. Growing rather thickly on sponges. The flexuous character of the stem is more pronounced distally.

This species is named for Miss Margaret Henderson as a slight mark of appreciation of her efficient assistance in the preparation of this paper.

23. **Clytia universitatis,** n. sp.

Campanularia denticulata, Torrey, 1902, p. 51, pl. 4, fig. 34.

Trophosome. Stem long, branching irregularly, forming bushy tufts often exceeding 200 mm. in length. Stem and branches polysiphonic. Hydranth pedicels long, almost completely annulated; hydrothecae deep, tapering, with 12-15 marginal teeth; hydranths with about 28 tentacles.

Gonosome. Gonangia borne on stem, branches or hydranth pedicels, less than 3 times as long as broad, with short pedicel which may or may not contain a single annulus; with wide aperture. Contour somewhat irregular, occasionally 1 or 2 annulations distally. Medusae numerous, oldest with 4 tentacles.

Dimensions. Hydrothecae, in mm.: .70 x .37; .78 x .40; .81 x .39; .83 x 42. Gonangium: .95 x 39; 1.00 x .41.

Fig. 12.—*Clytia universitatis.* Hydrotheca.

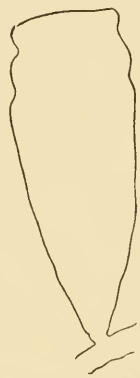


Fig. 13.—*C. universitatis.* Gonangium.

Distribution. San Diego Bay, on piles of wharves at low tide, July 15, 1904; San Pedro Bay, Cal., Dec., 1901.

The species bears a general resemblance to *Campanularia verticillata.* The pedicils of the hydranths, however, are not arranged in verticils, and the gonophores are not sporosacs. Young colonies taken in San Pedro Harbor, December, 1901, were previously identified with *C. denticulata* Clark, though certain differences were noted and the immaturity of the colonies prevented an accurate determination.

Gen. **Calycella,** Hincks, 1861.

24. **Calycella syringa** (Linn.).

Sertularia syringa, Linnaeus, 1767, p. 1311.
Calicella syringa, Hincks, 1861, p. 294.
Calycella syringa, Hincks, 1868, p. 206, pl. 39, fig. 2.
Calycella syringa, Calkins, 1899, p. 358, pl. 4, fig. 20.
Calycella syringa, Clark, 1876, p. 217, pl. 12, fig. 25.
Calycella syringa, Hartlaub, 1901, p. 358.
Calycella syringa, Nutting, 1899, p. 741; 1901, p. 176.
Calycella syringa, Torrey, 1902, p. 59, pl. 6, fig. 50.

Trophosome. Pedicels borne on stolon, shorter than hydrothecae. Margins of hydrothecae frequently reduplicated.

Gonosome. Gonangia on stolon, with acrocysts at maturity; ovate, smooth.

Distribution. San Diego Bay, 1 to 5 fathoms. Puget Sound: Berg Inlet and Kadiak, Al. (Nutting). Coal Harbor and Shumagin Is., Al. (Clark). White Sea (Mereschkowsky). Northern Asia (Thompson). Kara Sea (Berg). British Coasts, Iceland in 100 fathoms (Hincks). Greenland (Levinsen). Helgoland (Hartlaub).

No gonosome in San Diego colonies, July 15, 1903.

Fam. LAFOEIDAE.

Gen. **Lafoea,** Lamouroux, 1821.

25. **Lafoea dumosa** (Flem.).

Sertularia dumosa, Fleming, 1828, p. 83.
Lafoea dumosa, Sars, 1862.
Lafoea dumosa, Hincks, 1868, p. 200, pl. 41, fig. 1.
Lafoea dumosa, Clark, 1876, p. 216, pl. 12, fig. 23.
Lafoea dumosa, Nutting, 1899, p. 747, pl. 64.
Lafoea dumosa, Torrey, 1902, p. 59.

Trophosome. Stem simple and creeping or fascicled and erect. Hydrothecae strong, narrowed toward the base, with little or no pedicels.

Gonosome. Gonangia columnar, with bottle necks, crowded together in encrusting masses.

Distribution. San Diego Bay, in 6 fathoms; Port Orchard, Puget Sound. California Coast (Clark). Alaska (Clark, Nutting). White Sea (Mereschkowsky). New England Coast (Verrill, Nutting). West Indies, 450 fathoms (Allman). British Coasts (Hincks). Spitzbergen (Marktanner-T.). North Cape, Norway (Sars). Helgoland (Hartlaub).

Both the erect and creeping forms were found at San Diego. Overgrown with *C. hincksi.* No gonosome, June 29, July 15, 1903.

Fam. SERTULARIIDAE.

Anyone who has had occasion to work among the *Sertulariidae* will admire the masterly way in which Nutting (:04) has dealt with the perplexing questions of classification in that family. I am not yet prepared, however, to abandon Schneider's plan of segregating the species into typical groups which shall take the places of genera. These groups do not necessarily give their names to the species which they include. Thus they discourage the growth of synonyms, offer no awkward bars to the free passage of any species from one group to nearer relatives, and at the same time lessen the confusion which the present unsettled state of opinion regarding the relationships of existing species tends to produce.

When it is not easy to define groups clearly, owing either to the uncertain values of diagnostic characters or to baffling transitional forms, it is plainly desirable to have as few groups as convenience will permit. Marktanner-Turnerestcher ('90) distinguished 18 genera. Nutting has reduced this unusual total to 12; but that number, I am convinced, is still too large. The distinction between *Thuiaria* and *Abietinaria* hardly seems of enough service to overweigh the practical difficulties which it invites; and although Nutting has put forth every effort to make it useful, he has only succeeded in distinguishing the genera by relying now on one, now on another combination of characters, not an attractive makeshift. But however desirable or undesirable this procedure may be, I make no reservations in condemning Allman's genera *Thecocladium* and *Synthecium* as Nutting has defined them. According to Allman, *Thecocladium* is distinguishable by the intrathecal origin of its branches, *Synthecium* by the intrathecal origin of its gonangia. The justice of my objections (:02, pp. 61, 62) to genera founded on single characters of such a sort is admitted by Nutting, who then attempts to strengthen both genera, but particularly *Synthecium*, which alone ocurs in American waters, by supporting them on combinations of characters. *Synthecium* is accordingly based upon a combination of strictly opposite branches, smooth margined hydrothecae, absence of opercula, as well as the intratheeal origin of the gonangia.

Analysis, however, does not reveal the strength which is claimed for this structure. In the first place, combinations are of little value unless the characters selected for combination vary independently of each other, which is obviously not true of margin and operculum, as Nutting is aware. In the second place, it is well known that at some stage in the development of all hydroids, a perisarcal membrane blocks the exit of the hydranth from the hydrotheca, and that this membrane becomes the one-, two-, three-, or four-parted adult operculum, according to the character of the margin, or may be wanting altogether. Among sertularians with smooth round margins, it is often delicate, and is commonly lost. In *Sertularella formosa*, according to Nutting, it is usually wanting, but occasionally appears as a "thin membrane stretched like a drumhead across the aperture." In *Sertularella hartlaubi*, according to the same authority, the operculum is "in some cases an adcauline flap, in others apparently an irregularly ruptured membrane stretched straight across the aperture like a drumhead." *Sertularella halecina* (a *Synthecium* according to Nutting) possesses a thin drumhead operculum before the hydranth emerges for the first time, but is non-operculate in the adult. Such facts only lead inevitably to the conclusion of Hartlaub (:00, p. 8) that the absence of an operculum is of no taxonomic consequence. In the third place, Nutting does not appear to insist that *Synthecium* shall exhibit the opposite branching which his definition demands, when he places *S. halecina* in that genus. It is possible to assume that he was heedless of the mode of branching in this species, but this assumption is hardly applicable to the alternately branching *Synthecium alternans* Allman. It is more probable that Nutting included *S. halecina* in spite of its branching. Yet in thus escaping the responsibility of removing it from *Synthecium* to *Sertularella* or to an entirely new genus, he abandons opposite branching as a distinguishing mark of *Synthecium*. It would appear, then, that there are but two instead of four characters on whose association the genus is really based: the smooth round margin of the hydrothecae and the intrathecal origin of the gonangia.

Are these characters of equal rank? Evidently Nutting prefers the latter, since he does not hesitate to align such a smooth round margined species as *S. formosa* with the typical dentate operculate species of *Sertularella*. Here I can by no means agree with his judgment, but must take the ground which I previously occupied (:02, p. 62). The mere *location* of gonangia, whether arising within or outside of hydrothecae, cannot to my mind be of such taxonomic importance as the striking differences of the trophosomes in species like *S. halecina* and *S. tubitheca;* though I am far from refusing its aid as a means of distinguishing *species*.

The general grounds which I formerly urged against *Synthecium* need not be repeated here. I am still in hearty accord with the position then taken, but a review of actual conditions in *S. halecina* may prove more convincing. In the majority of cases, the gonophores of this species arise within hydrothecae. Occasionally, however, they are borne directly on the stolon (fig. 14), as in *Dynamena cornicina.* When such a difference in the position of the gonangia exists in different species, it has been held by Allman and Nutting to indicate generic distinction. For instance, *Sertularella integritheca,* with smooth round margined hydrothecae and extrathecal gonangia, is said to be generically distinct from such a form as *Synthecium alternans* Allman, with intrathecal gonangia but otherwise similar to *S. integritheca.* Occasional conditions such as the intrathecal origin of gonangia in species in which the gonangia are usually extrathecal, are held by the same authors to be abnormalities which may be disregarded in classification. The extrathecal origin of the gonangia of *S. halecina*[1] being but occasional, would naturally find a place in the same category. These views do not appear to me to be justifiable, for the occasional presence of extrathecal gonangia must lessen the importance of the usual condition, and should *not* be disregarded for this very reason.

[1] If it be objected that the extrathecal gonangia in *S. halecina* arise on the stolon instead of the stem, it may be remembered that stem and stolon are fundamentally the same structure, and transform into each other with the utmost readiness.

According to Nutting (:04, p. 42), "it occurs not infrequently in several widely different forms among the Sertularidae that a gonangium will occasionally have its origin within the lumen of the hydrotheca, although these species normally produce gonangia in the ordinary position." The very fact that what is typical of *S. halecina* is atypical of most other sertularians, though not infrequent, and what is occasional in *S. halecina* is usually typical of the others, only leads to a rejection of the view which lays more than specific importance on the difference in the typical position of gonangia in different species.

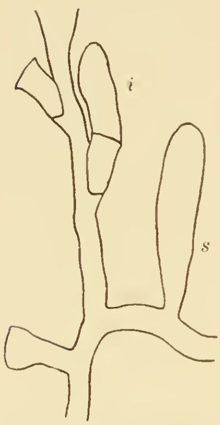


Fig. 14.—*Sertularella halecina.* Portion of stolon with gonangium (s); base of one stem, with intrathecal gonangium (i).

Fig. 15.—*S. halecina.* Portion of stem showing origin of branch just below hydrotheca (x).

Fig. 16.—*S. halecina.* Portion of colony. Showing an extrathecal branch (x).

If the branches of *S. halecina* be now considered, it will be seen that they, as well as the gonangia, emerge typically from hydrothecae. In this respect, then, *S. halecina* is a *Thecocladium.* Yet this character is not invariable. Occasionally branches arise independently of hydrothecae. Four such cases are shown in figs. 15, 16, 17, 18. In figs. 15, 17, 18, the branches arise on the bulging stem just beneath hydrothecae, a familiar origin of branches in the *Sertulariidae.* In fig. 16, the branch is not associated with a hydrotheca in any way. All these cases (except fig. 17) were found on the same colony; and it is interesting that of three successive branches from a short section of the same stem (fig. 18), the origin of the first is typical of *Thecocladium*, the origin of the second and third is typical of *Sertularella*. Without denying the usefulness of the usual manner

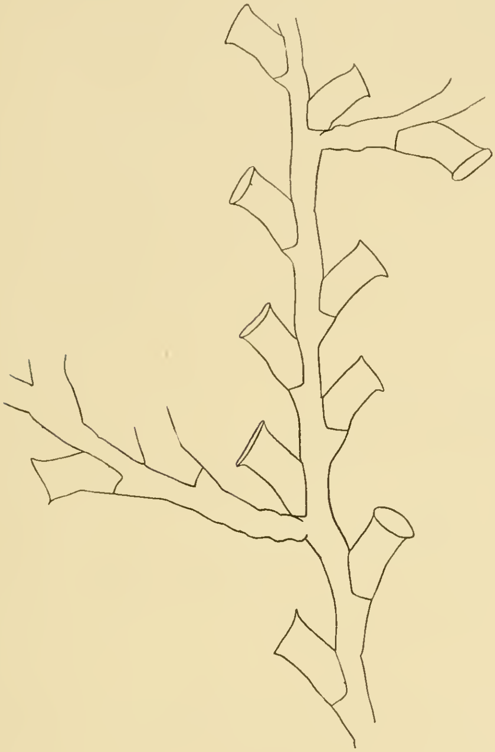


Fig. 17.—*S. halecina.* A younger stem than is shown in fig. 18 with two extrathecal branches.

Fig. 18.—*S. halecina.*—Stem with three branches two of which are extrathecal, the third intrathecal, in origin. The stem is old, with damaged hydrothecae.

of branching, or any other typical character, in defining species, the facts which have just been enumerated hardly supply the idea of stability which is commonly associated with the conception of a genus.

Sertularella halecina is at once a typical *Synthecium* in the character of the hydrothecal margin and the intrathecal origin of the gonangia, a typical *Thecocladium* in the intrathecal origin of the branches, a typical *Sertularella* in the manner of the origin of both branches and gonangia. Allman refers to the intrathecal origin of two branches in *Synthecium campylocarpum* as an abnormality, and Nutting speaks similarly of the intrathecal origin of the only two branches which were present in the material from which I described *Sertularella dentifera*. Both cases may be abnormal, in the sense of unusual; but in the light of conditions in *S. halecina*, is it wise to dismiss them forthwith as taxonomically insignificant? Which are the abnormal, the insignificant characters in *S. halecina?* I must confess my inability to decide. Until such a decision be reached, I do not think better can be done than to consider the species a member of the *Sertularella* group, in which it was originally placed.

Sertularella group.

26. **Sertularella halecina.**

Sertularella halecina, Torrey, 1902, p. 61, p. 6, fig. 55.

Trophosome. Stems from a creeping stolon rise to height of 30 mm., with few branches which originate either within hydrothecae or just below them. Nodal divisions faint, often wanting. Hydrothecae adnate at base only, cylindrical, with slight swelling on lower side of base, wide aperture with smooth, everted rim.

Gonosome. Gonangia arise within hydrothecae or from stolon, long, tubular; single tubular gonophore.

Distribution. San Diego Bay, 3 to 12 fathoms; growing on kelp and among bryozoa. Gonosome present, July, 1901; June, July, 1903.

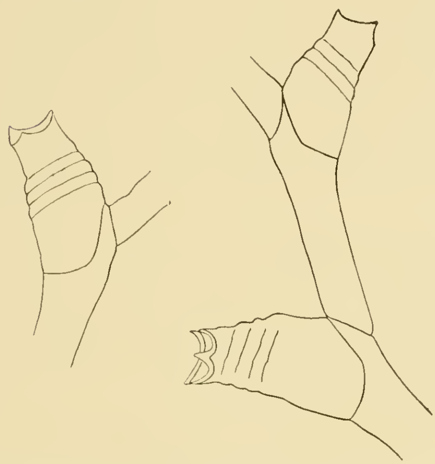
My reasons for withdrawing this species from *Synthecium*, where Nutting placed it, have been given above. I am not yet prepared to consider it identical with *S. cylindrica* Bale (Nutting, :04), because there is no record of the method of origin of branches and gonangia in the latter, and the margins of the hydrothecae are not so distinctly or characteristically everted.

27. **Sertularella pedrensis,** n. sp.

Sertularella conica, Torrey, 1902, p. 60.

Trophosome. Stems from creeping stolon, longest 35 mm., with occasional branches; stems and branches divided into slender internodes of variable length. Hydrothecae distant, borne at distal ends of internodes, free for two thirds their length, narrowing to tridentate apertures, which are often reduplicated, with tripartite opercula; each hydroheca with 3 to 6 transverse rugae which are stronger on adcauline side.

Gonosome. Gonangia ovate, covered thickly and completely with slender spines.



Figs. 19, 20.—*Sertularia pedrensis.* Hydrothecae.

Fig. 21. — *S. pedrensis.* Gonangium.

Distribution. San Pedro, Cal.

The trophosome of this species so closely resembles Allman's descriptions and figures of *S. conica*, that I formerly identified it with the latter. Nutting (:04) has since pointed out that the hydrothecae of *S. conica* have four marginal teeth, a fact which at once distinguishes the two species. The recent discovery of two gonangia on the San Pedro colonies affords an unmistakable diagnostic character.

28. **Sertularella tenella** Alder.

Sertularia tenella, Alder, 1856, p. 357, pl. 13, figs. 3-6.
Sertularella tenella, Alder, 1857, p. 113.
Serularella tenella, Hincks, 1868, p. 242, pl. 47, fig. 3.
Sertularella tenella, Hartlaub, 1901, p. 360, pl. 21, figs. 12, 20, 21.
Sertularella tenella, Torrey, 1902, p. 64.

Trophosome. "Zoophyte minute; stems short, slender, simple or slightly branched, zigzagged and jointed and twisted above each calycle; hydrothecae rather distant, elongate, barrel shaped, finely ribbed across, the aperture erect, patent, squared, 4-toothed, and closed by a four sided operculum."

Gonosome. "Gonothecae ovate, slender, ringed transversely, produced above into a short, tubular orifice" (Hincks).

Distribution. La Jolla, Cal., between tides; San Diego, 9 fathoms. Bare I. (Hartlaub). Gt. Britain, between tides to deep water (Hincks). New Zealand (Hartlaub).

Growing on rocks and *Fucus.* No gonosome, July 16, 1901, July 13, 1903. Longest stem, 4 mm.; length of hydrotheca, .4 to .5 mm., breadth, .25 mm.

29. **Sertularella tricuspidata** (Alder).

Sertularia tricuspidata, Alder, 1856, p. 356, pl. 13, figs. 1, 2.
Sertularella tricuspidata, Hincks, 1868, p. 239, pl. 47, fig. 1.
Sertularella tricuspidata, Clark, 1876, p. 224, pl. 12, figs. 26, 27.
Sertularella tricuspidata, Nutting, 1899, p. 741.
Sertularella tricuspidata, Hartlaub, 1901, p. 359.
Sertularella tricuspidata, Nutting, 1901, p. 183.
Sertularella hesperia, Torrey, 1902, p. 63, pl. 7, figs. 57, 58.

Trophosome. "Colony a matted mass of shoots and twigs sometimes attaining a height of 5 or 6 inches. Stem not fascicled, slender, divided into internodes, each of which bears a hydrotheca or a branch with its axillary hydrotheca. Branches irregularly alternate, often branching profusely either alternately or dichotomously, divided into regular internodes each of which bears a hydrotheca, some of the nodes being double and oblique, which gives a twisted appearance to the branch. Hydrothecae distant, small, cylindrical, without corrugations, the distal half or more being free; margin with three strong, equal and equidistant teeth."

Gonosome. "Gonangia borne profusely on the main stem and branches, large, oblong-ovate, marked throughout with very prominent compressed annular ridges, the uppermost of which forms a bowl-shaped structure from the center of which arises the tubular neck which ends in a slightly everted margin and round aperture."

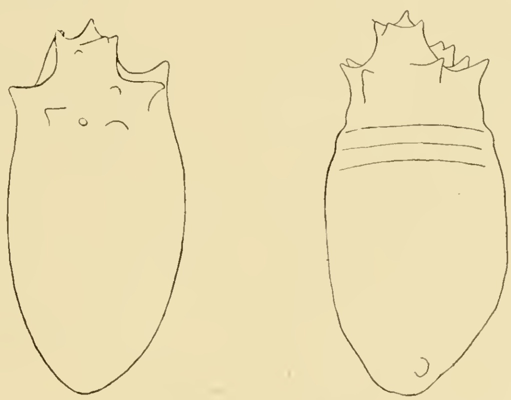
Distribution. San Diego Bay, 1 to 9 fathoms. "Abundant throughout the north polar and north temperate regions of the world" (Nutting, :04).

30. **Sertularella turgida** (Trask).

Sertularia turgida, Trask, 1854, p. 113, pl. 4, fig. 1.
Sertularella turgida, Clark, 1876*a*, p. 259, pl. 38, figs. 4, 5.
Sertularella conica, Calkins, 1899, p. 359, pl. 4, fig. 22.
Sertularella nodulosa, Calkins, 1899, p. 360, pl. 5, fig. 29.
Sertularella turgida, Hartlaub, 1901, p. 360, pl. 21, figs. 5, 6.
Sertularella turgida, Torrey, 1902, p. 64, pl. 7, figs. 59-62; pl. 8, figs. 63-69.

Trophosome. Stems stout, from creeping stolon, about 30 mm. long, seldom branching; divided into short geniculate internodes. Hydrothecae large, stout, free for about half their length; aperture large, with 3 strong teeth.

Gonosome. Gonangia large, ovate, distally spinose or annulated or both; aperture small.



Figs. 22, 23.—*Sertularella turgida.* Gonangia.

Distribution. Pacific Coast, from Coronado Is. to 54° N. lat. Off Japan (Albatross hydrographic station 3775). Between tides to 204 fathoms.

This is by far the most variable species on the coast, a characteristic to which reference was made in my former paper (:02, p. 65). Figs. 22 and 23 make more complete the transitions between forms of gonangia there figured. From a spiny type an annulated type is reached through a spiny-annulated condition. The hydrotheeae are extremely variable, as regards shape, wrinkling and immersion. The internodes vary much in length and thickness.

Dynamena group.

31. **Dynamena cornicina** McCrady.

Dynamena cornicina, McCrady, 1858, p. 204.
Sertularia complexa, Clark, 1879, p. 245, pl. 4, figs. 26-8.
Sertularia complexa, Bale, 1888, p. 769, pl. 18, figs. 1-4.
Sertularia cornicina, Nutting, 1901, p. 359, fig. 56.
Sertularia complexa, Nutting, 1901, p. 360, fig. 57.
Sertularia cornicina, Nutting, 1904, p. 58, pl. 4, figs. 1-5.

Trophosome. Stems short, slender, unbranched, rising from a creeping stolon to height of 10 to 20 mm.; divided into regular internodes each with a pair of opposite hydrothecae distally. Hydrothecae tubular, adnate in front for two thirds their length; margin with two teeth.

Gonosome. Gonangia borne at base of stems, broadly ovate, annulated throughout, with broad aperture.

Distribution. Coronado Is., Cal., on seaweed at the surface. Charleston, S. C. (McCrady). Woods Hole, Mass. (Nutting). Pourtales Plateau (Nutting). Yucatan Coast (Clark). Australia (Bale).

The colonies from the Coronado Islands were identical with *S. complexa*, though there were easy transitions to the typical trophosome of *D. cornicina.* I have followed Nutting in considering the two species synonymous.

D. cornicina is very close to *S. desmoides*, from which it appears to differ in the absence of branches, the sharply toothed aperture, and the position of the nodal constrictions immediately above rather than immediately below the hydrothecae.

32. **Sertularia desmoides.**

Sertularia desmoidis, Torrey, 1902, p. 65, pl. 8, figs. 70-72.
Sertularia desmoides, Nutting, 1904, p. 56, pl. 3, figs. 1-3.

Trophosome. Stems from creeping stolon, rising to height of 30-50 mm., branching sparely and irregularly. Internodes vary in length, but the portion distal to the hydrothecae is never longer than the rest of the internode. Two hydrothecae on the proximal portion of each internode, opposite and contiguous on one side of the stem for one half their length, bending sharply outward in distal half and narrowing to a smooth or somewhat bilabiate operculate aperture.

Gonosome. Gonangia sessile, ovate, half as broad as long, with a wavy outline and broad round aperture.

Distribution. San Diego, 1-25 fathoms; San Clemente I., 42 fathoms; San Pedro, Cal., 13 fathoms. Albatross station 2939, lat. N. 33° 36′, long. W. 118° 09′ 30″, 27 fathoms (Nutting).

Gonosome present, July, 1901, June 27, 1903. Both robust and attenuated varieties were obtained.

33. **Sertularia furcata** Trask.

Sertularia furcata, Trask, 1854, p. 112, pl. 5, fig. 2.
Sertularia furcata, Agassiz, 1865, p. 145.
Sertularia furcata, Clark, 1876*a*, p. 258, pl. 39, fig. 3.
Sertularia furcata, Torrey, 1902, p. 66, pl. 8, figs. 73-5.

Trophosome. Stems short, unbranched, rising from a creeping stolon to height of 10-15 mm.; divided into short internodes, each with a pair of hydrothecae opposite and in contact on one side of the stem for half their length. Two strong marginal teeth and a large aperture.

Gonosome. Gonangia broadly ovate, compressed, with moderate terminal aperture.

Distribution. San Diego Bay, 5 fathoms; Coronado Is., Mex., 18-24 fathoms; San Pedro, Cal., 9 fathoms; San Francisco, shore rocks. Farallone Is., Cal. (Trask). Santa Barbara and Santa Cruz, Cal. (Clark).

Nutting (:04) has identified this species with the *Dynamena pulchella* of d'Orbigny from Patagonia, quoting Clark's description of *S. furcata*, however. I am unable to follow him because his reproduction of d'Orbigny's figures does not show the contact of the members of each pair of hydrothecae, which is a marked character of the species, the internodes are longer and more slender than the constantly short internodes of *S. furcata*, and the two species are widely separated geographically as well. It is true that Clark's figure does not show the contact of the hydrothecae, but that is because he has probably drawn the reverse rather than the face of the stem. This view is supported by the position of the gonangia, which ordinarily occur on the face of the stem, and by the similarity of Clark's figure to fig. 73 of my former paper, representing the reverse of one internode of the stem.

Gonangia were present in colonies collected in November, 1897, and July, 1901. By a strange confusion which I came upon in the preparation of the present paper, I laid claim in my former paper to the discovery of the gonosome of the species, though it was well known to me that Trask, as well as Clark,[1] had described and figured both trophosome and gonosome.

[1] Nutting (:04), who calls attention to this blunder, has himself erred in ascribing the first complete description, including gonosome, to Clark. I do not see Trask's paper in Nutting's bibliography, and infer that he was not acquainted with it at first hand.

Thuiaria group.

34. Sertularia filicula E. & S.

Sertularia filicula, Ellis and Solander, 1786, p. 57, pl. 6.
Sertularia anguina, Trask, 1854, p. 112, pl. 5, fig. 1.
Sertularia labrata, Murray, 1860, p. 250, pl. 11, fig. 2.
Sertularia filicula, Hincks, 1868, p. 264, pl.53, fig. 3.
Sertularia anguina, Clark, 1876*a*, p. 255, pl. 40, figs. 1, 2.
Sertularia anguina var. *robusta*, Clark, 1876*a*, p. 256, pl. 40, figs. 3, 4, 5.
Sertularia filicula, Torrey, 1902, p. 68, pl. 9, fig. 80.
Sertularia filicula, Nutting, 1904, p. 117, pl. 34, fig. 1.

Trophosome. Stems with alternating branches, pinnately disposed; divided into internodes each of which usually bears a branch and three hydrothecae, two sub-opposite, the third axillar. Branches may themselves branch; divided into unequal internodes, each bearing several hydrothecae, sub-opposite, in pairs. Hydrothecae flaskshaped, adnate for more than half their length, apertures small, round, opening upward.

Gonosome. Gonangia pearshaped, produced somewhat distally, ending with small round aperture.

Distribution. San Diego, 15-25 fathoms; San Pedro, San Francisco, Cal., shore rocks. Monterey to Point Reyes, Cal. (Trask). Vancouver I. (Dawson). Alaska, 10 fathoms; San Miguel I., Cal. (Clark). White Sea (Mereschkowsky). New England coast (Verrill). Grand Manan, 20 fathoms (Stimpson). Labrador (Packard). Greenland (Levinson). North Atlantic (Bonnevie). Norway (Marktanner-Turneretscher). British shores (Hincks).

Nutting's treatment of *Sertularia anguina* Trask is unfortunate. To begin with, the figures of his *Abietinaria anguina* (Trask) are so far from typical of *S. anguina* Trask, judging either from Trask's figures, Clark's figures or all of my own material, some of which was collected at the entrance of San Francisco Bay, where Trask also obtained the species, that I suspect they really represent a distinct species. He says the specimens he has seen "are from Santa Barbara, Cal., and Bering Sea, and they all agree well with Dr. Clark's description of *Sertularia anguina* var. *robusta*." His figures, however, resemble Clark's variety less than the typical *S. anguina* as shown by Clark's own figures. Yet in his synonymy there appear *S. anguina* Trask, *S. labrata* Murray (a correct synonym) and *S. anguina* var. *robusta* Clark, but *not* the *S. anguina* Trask of

Clark, the figures of which the without the slightest shadow of doubt typical of Trask's species. There is as little question that my *S. filicula* E. & S. (:04, p. 68, pl. 9, fig. 80) belongs with Trasks's and Clark's *S. anguina;* so I fail to see why Nutting placed it instead, though dubiously, with his *Abietinaria filicula* (Ellis and Solander).

After expressing his inability to agree with me "in considering this species identical with *A. filicula,*" Nutting at once adds in a footnote: "It is possible that the name *anguina* should be retained for the var. *robusta* of Clark, which is apparently distinct." I take these statements to mean that if *S. anguina* and *S. filicula* prove to be identical, the var. *robusta* should remain under Trask's old name. Why Nutting is unable to see the identity of the two species he does not say and I am at a loss to discover. My reasons for uniting them lie in the fact that Trask's figure of *S. anguina,* though crude and containing an error in showing 4 rather than 3 hydrothecae on the stem between the bases of successive branches, Murray's figure of *S. labrata,* Clark's figures of *S. anguina,* Hincks' figures of *S. filicula* and my own observations of both trophosome and gonosome refer unmistakably to the same species; and they agree with Nutting's figure (Pl. 34, fig. 1) of *Abietinaria filicula* (Ellis and Solander) and *not*, curiously enough, with his figures of *Abietinaria anguina* (Trask) on the same plate, figs. 5-7. They agree also with the var. *robusta* of Clark in all details save stoutness of the stem, a difference which is probably referable to differences of environment, not heredity.

Fam. PLUMULARIIDAE.

Gen. **Aglaophenia,** Lamouroux, 1812.

35. **Aglaophenia diegensis.**

Aglaophenia diegensis, Torrey, 1902, p. 71, pl. 9, figs. 84-86.

Trophosome. Stem 150 mm. long, with short internodes. Hydrocladia alternating, one to an internode; divided into equal internodes by faint nodes which may be wanting. Hydrothecae each longer than diameter of aperture; 9 irregular marginal teeth, median tooth sharp and recurved, adjacent teeth longest, smallest teeth next the hydrocladium. Mesial nematophore reaches level of hydrothecal aperture. Septal ridge just below supracalycine nematophores and one just above floor of hydrotheca.

Gonosome. Corbulae 3 to 4 times as long as broad, formed of 8-10 pairs of alternating leaflets, 8 nematophores on anterior edge of all but first and last. One, rarely two hydrothecae on anterior edge of all but first and last. One, rarely two hydrothecae between corbula and stem. Gonophores in two rows, about 12 in number.

Distribution. San Diego Bay, 1-7 fathoms; False Bay. The corbulae on the False Bay colonies, collected in January, 1904, are longer than that figured in my previous paper, collected in July, 1901; usually with ten leaflets.

36 **Aglaophenia inconspicua.**

Agiaophenia inconspicua, Torrey, 1902, p. 73, pl. 9, figs. 87-89.

Trophosome. Stems stout, in clusters, 35-40 mm. high; divided by antero-posteriorly oblique nodes into internodes as broad as long. Hydrocladia borne on same side of stem, alternate, one from each internode, 3-4 mm. long; divided transversely into equal internodes. A nematophore in the axil of each hydrocladium and two at its base in a line parallel with its axis. Hydrothecae deep, slightly compressed, free for not more than one quarter their length; 9 marginal teeth, median tooth recurved, the next on each side longest. Intrathecal ridge extending obliquely upward from near base of theca. Two ridges on each internode. Mesial nematophore reaching nearly or quite to the mouth of the theca. Supracalycine nematophores divergent, not reaching level of mouth of theca.

Gonosome. Corbulae not more than twice as long as deep, arched, slightly compressed; formed of 4 to 6 leaflets, the longest with 10 nematophores on distal edge and occasionally one or two on proximal edge near tip. One thecate internode between corbula and stem. Sporosacs 6-12.

Distribution. San Diego, 5 fathoms; gonosome present, July, 1901.

37. **Aglaophenia pluma** (Linn.).

Sertularia pluma, Linnaeus, 1767, p. 1309.

Aglaophenia pluma, Lamouroux, 1816, p. 170.

Aglaophenia pluma, Hincks, 1868, p. 286, pl. 63, fig. 1.

Aglaophenia pluma, Torrey, 1902, p. 73, pl. 10, figs. 90-91.

Trophosome. Stems attaining height of 100 mm. or more, gracefully rising from creeping stolon. Hydrocladia alternate, one to an internode. Hydrothecae each with 9 teeth, median tooth not recurved. Mesial nematophore not reaching level of aperture.

Govosome. Corbulae of about 9 leaflets, arched; a single hydrotheca at base of each.

Distribution. Off Coronado, Cal., on kelp. South Africa, Belgium, Mediterranean, Gt. Britain (Hincks).

38. **Aglaophenia struthionides** (Murray).

Plumularia struthionides, Murray, 1860, p. 251, pl. 12, fig. 2.
Aglaophenia franciscana, A. Agassiz, 1865, p. 140.
Aglaophenia struthionides, Clark, 1876*a*, p. 262, pl. 41, fig. 3.
Aglaophenia struthionides, Torrey, 1902, p. 73.

Trophosome. Stems long, strong, often attaining height of 150 mm., occasionally bearing stem-like branches; divided obliquely into short equal internodes each bearing a hydrocladium. Hydrothecae with flaring margin armed wih 11 irregular teeth: median tooth long, sharp, recurved; next on each side long and directed forward, next bent outward. Mesial nematophore usually reaches level of aperture.

Gonosome. Corbulae each formed of 8-13 pairs of leaflets; with 3, occasionally 2, hydrothecae at base.

Distribution. Puget Sound to San Diego. This is the commonest hydroid on the coast, frequently cast up on California beaches. Corbulae present, January, June, July.

Gen. **Diplocheilus,** Allman, 1883.

Trophosome. All internodes thecate, each internode with an infracalycine mesial nematophore not in contact with the hydrotheca, and a supracalycine median sarcostyle without definite nematophore; each hydrotheca with anterior intrathecal ridge.

Gonosome. Gonangia unprotected.

Allman founded this genus on the following characters: a duplicature of the walls of the hydrothecae "forming an external calycine envelope," a shield-like mesial nematophore not adnate to the hydrotheca, and the absence of lateral nematophores. Bale ('93) has demonstrated that the hydrothecae of the single species (*D. mirabilis* Allman) for which the genus was created do not possess the double walls described by Allman, but are constructed after the fashion of the hydrothecae of *Kirchenpaueria producta* Bale, with anterior intrathecal ridges which, from certain viewpoints, suggest a duplicature of the walls. Bale has also demonstrated the opening of a median sarcostyle above each hydrotheca, flanked by webs of perisarc between theca and internode which form a broad, non-typical nematophore. Allman's definition has been modified to accord with these facts.

All the trophosomal characters of *D. mirabilis* which have been mentioned are found also in *K. producta* Bale. The striking similarity of the trophosomes of the two species leaves no doubt of their generic unity, in spite of the absence of the gonosome in *D. mirabilis.* Bale, however, is certainly in error in finding in Jiekeli's *Kirchenpaueria* the bond of union. According to Jiekeli's figure ('83, pl. 28, fig. 27), the hydroid for which he erects the genus is an eleutheroplean plumularian—probably a *Plumularia*—with nematophores broken away. The frequent absence of nematophores in species which characteristically possess them and the absence of any other distinguishing characters remove the slender claims to priority over *Diplocheilus* which have been made for this inadequate genus.

Diplocheilus allmani, n. sp.

Halicornaria producta, Torrey, 1902, p. 75, pl. 10, fig. 95.

Trophosome. Colony with simple stem, divided obliquely into internodes which vary in length according to age. Hydrocladia alternate, each from a shoulder process projecting from the middle region of each internode. Each hydrocladium divided more or less obliquely into equal thecate internodes. Each hydrotheca somewhat compressed below, somewhat flaring distally, with a broadly oval, smooth orifice; about as deep as long; free for one third of its length. Strong anterior intrathecal septum about two thirds the length of the hydrotheca from the bottom, reaching about one third across it at widest point. Cauline nematophores absent with the exception of single axillary nematophores. Mesial nematophore short, not reaching the base of hydrotheca, expanding into the form of a sickle shaped segment of a saucer with a diameter two thirds that of hydrotheca and embracing the internode for half its circumference. Single median supracalycine sarcostyle, flanked by two webs of perisarc stretched between theca and internode, forming a non-typical median nematophore.

Gonosome absent.

Distribution. Pt. Loma, Cal., on seaweed and sponges.

The differences which separate *D. mirabilis* Allman, *D. producta* (Bale) and *D. allmani* are slight. *D. allmani*, originally thought to be identical with *D. producta*, possesses hydrothecae with flaring rims and broadly ovate apertures instead of the compressed form and narrowed apertures of *D. producta*. It differs from *D. mirabilis* in the absence of all cauline nematophores save those in the axils of the hydrocladia, and the cauline internodes never bear more than one hydrocladium each. The immaturity and paucity of my material make it impossible to determine the real value of these differences. For the present, then, it seems desirable to distinguish the species.

Gen. **Plumularia,** Lamarck, 1816.

40. **Plumularia alicia.**

Plumularia alicia, Torrey, 1902, p. 75, pl. 10, figs. 96, 97.

Trophosome. Stems in clusters, slender, loosely branching, 7 to 13 cm. high: divided transversely by faint nodes into short equal internodes. Hydrocladia atlernate, one from distal end of each internode, and with 4 to 7 hydrothecae; thecate and non-thecate internodes alternate, separated by nodal septa which are alternately transverse and oblique; thecate internodes twice as long as non-thecate. Proximal and distal septal ridge in each internode. Hydrothecae free for at least half their length, adcauline contours, in profile, somewhat recurved. A single nematophore on each internode of stem on side opposite origin of hydrocladium; 2 nematophores in each axil; each hydrocladial non-thecate internode with 1 nematophore; thecate internodes with 1 mesial and 2 supracalycine nematophores. Perisarc of stem thick and brown, of hydrocladia delicate and colorless.

Gonosome. Male gonangia small, ovate, attached by very short peduncles between the nematophores in the axils of the stem or branches.

Distribution. San Diego, 15 to 25 fathoms; Long Beach, Cal., 5 to 13 fathoms. Gonosome present, June and July, 1901.

41. **Plumularia megalocephala** Allman.

Plumularia megalocephala, Allman, 1877, p. 31, pl. 19, figs. 1, 2.
Plumularia megalocephala, Nutting, 1900, p. 57, pl. 1, fig. 5.

Trophosome. ''Hydrocaulus irregularly branched, not fascicled; pinnae alternate, each borne close to the distal end of an internode of the stem, where it is supported on a long stout process of the internode; proximal internode of pinna short and destitute of hydrotheca; following internodes longer, every alternate one carrying a hydrotheca, and slightly longer than the others. Hydrothecae small and shallow, each borne near the middle of its internode, and supporting a very large hydranth. Beside the supracalycine pair of nematophores, each hydrotheca-bearing internode carrying a single mesial nematophore at the proximal side of the hydrotheca; intervening internode carrying two mesial nematophores, and short basal internode carrying one.

''*Gonosome* not known'' (Allman).

Distribution. Off San Diego, in 40-75 fathoms. Off Alligator Reef, 14 fathoms (Allman). Albatross Station 2669, lat. N. 31° 9′, long. W. 79° 33′, 352 fathoms (Nutting).

''The internode intercalated between the hydrotheca-bearing internodes was sometimes present, sometimes absent, and was of variable length. The internodes of the stem carry two nematophores placed laterally and alternately, and one or two pairs on it a lateral process'' (Allman).

Nutting adds the fact in his description that the hydrocladia "alternate as a rule, but not regularly so in some specimens, where they are occasionally opposite toward the distal end of the stem.

The San Diego material consists of two stems, the longest measuring 100 mm., both unbranched. The stem internodes vary in length, due to the obliteration of one or two nodes, and bear one, two or three hydrocaldia respectively. The number of their lateral nematophores varies with their length, from two to four. There is a pair of nematophores on each basal process, also an unpaired conical open process from which coenosarc projected in one case, and is probably to be reckoned as a nematophore. The hydrocladia are slender. In the first formed regions of the colony they alternate; in the younger, distal regions they are usually opposite, as Nutting has said. A further variation in the distal region consists in an alternation of successive pairs of hydrocladia, so that the members of every other pair lie in a plane making an angle somewhat less than 90° with the original plane of the colony. The basal internode of each hydrocladium is short toward the base of the stem, with a single mesial nematophore. In the younger distal part of the colony it is usually wanting. Occasionally a non-thecate internode fuses with a thecate internode. The thecate internodes frequently bear two mesial nematophores.

One stem had produced a heteromorphic shoot with several hydrocladia alternately placed, as is the rule with the basal part of the stem.

This species appears to be closely allied with *P. filicula* Allman, but its hydrothecae are not so deep and its habit is less regular.

42. **Plumularia plumularioides** (Clark).

Halecium(?) plumularioides, Clark, 1876, p. 217, pl. 10, figs. 16, 17.

Plumularia plumularioides, Nutting, 1901, p. 62, pl. 4, fig. 3.

Plumularia plumularoides, Torrey, 1902, p. 78, pl. 11, figs. 103, 104.

Trophosome. "Hydrocaulus erect, simple, straight, divided by transverse joints into internodes of considerable length, regularly branched and with a few annulations at the base; branches arranged alternately on opposite sides of the stem, one to each internode, having their origin in a small shoulder-like process just below each joint, divided usually into regular internodes, though in some cases, short internodes occur between the longer ones. Hydrothecae arranged uniserially, usually one to each internode, partly adherent to the stem, or entirely free, shallow, tapering slightly to the base, with an entire rim.'' (Clark).

Gonosome. Gonangia borne on the shoulder processes supporting the hydrocladia. Immature ones alone known; widest distally, tapering abruptly to base.

Distribution. San Diego, 15 to 25 fathoms. Cape Etolin, Al., 8 to 10 fathoms (Clark).

43. **Plumularia setacea** (Ellis).

Corallina setacea, Ellis, 1755, p. 19.
Plumularia setacea, Lamarck, 1816, p. 129.
Plumularia setacea, Hincks, 1868, p. 296, pl. 66, fig. 1.
Plumularia setacea, Clark, 1876*a*, p. 261, pl. 41, figs. 1, 2.
Plumularia setacea, Nutting, 1900, p. 56, pl. 1, figs. 1-4.
Plumularia palmeri, Nutting, 1900, p. 65, pl. 6, figs. 4, 5; 1901, p. 188.
Plumularia setacea, Torrey, 1902, p. 79, pl. 11, fig. 105.

Trophosome. Stems 5 to 100 mm. long, non-fascicled, divided into internodes, each bearing a hydrocladium from a distal process. Hydrocladia alternate; basal internode short, non-thecate; thecate and non-thecate internodes alternate; there may or may not be septal ridges at either end of each internode and associated with the hydrothecae. Latter not deeper than broad, broadest at margin. Nematophores polythalamic, 2 supra and 1 infra-calycine, 1 on each non-thecate internode except the basal internode of each hydrocladium, 2 on each cauline internode, 1 on the side opposite the hydrocladium, the other axillary.

Gonosome. Gonangia borne on the stem near the axils of the hydrocladia, much elongated, female somewhat longer and stouter than the male, with a long, narrow neck; small terminal aperture.

Distribution. Pt. Loma, La Jolla, Catalina I., San Pedro. and Monterey, Cal. Victoria, B. C., Santa Barbara and San Diego (Nutting). Eastern U. S. (Nutting). Coasts of Europe and Gt. Britain (Hincks). Helgoland (Hartlaub).

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CONTRIBUTIONS FROM THE LABORATORY
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MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO.

II.

THE CTENOPHORES OF THE SAN DIEGO REGION.

BY
HARRY BEAL TORREY.

Ord. CYDIPPIDA.

Ctenophorae spherical, cylindrical or compressed, with or without winglike aboral processes; two simple or pinnate tentacles usually retractile into a sheath; meridional and oesophageal canals end blindly.

Fam Pleurobrachiidae.

Cydippida without winglike aboral appendages. Body approximately round in cross section. Sub-tentacular and sub-oesophageal rows of swimming plates equal in length.

Gen. **Euplokamis,** Chun, 1880.

Body elongated; cylindrical or moderately compressed; rows of swimming plates reaching from pole to pole; tentacle sheath present.

Three *ctenophores* taken in Prince William Sound, Alaska, by Professor Ritter, and now in the collection of the University of California, belong undoubtedly to Mertens' *Beroe cucumis (Euplokamis cucumis,* Chun). All are compressed somewhat, so that the transverse diameters are to each other as 6 to 5. *Pleurobrachia,* a typical example of a spherical ctenophore, may also be compressed to the same extent. For these reasons, too much stress should not be laid on the circular cross section of *Euplokamis,* which is rather to be distinguished from *Pleurobrachia* by its elongation, from *Mertensia* by its slight degree of compression and equal rows of swimming plates. According to recent figures by Vanhöffen (:04), cross sections of specimens of *Mertensia ovum* taken in Greenland were three to four times as long as broad.

1. **Euplokamis californensis,** n. sp.

Body moderately compressed, somewhat flattened at sensory pole, narrowed toward mouth. Tentacle sheaths about three fourths the length of the body, lying close to and parallel with the oesophageal canals, diverging slightly to openings near sensory pole. The four interradial canals arise independently from funnel. Distances from funnel to aboral and oral poles as 1 to 2. Tentacles yellow brown; inner opening of oesophagus purple.

Distribution. San Diego, Cal. Taken at the surface and in vertical hauls from various depths to 125 fathoms with non-closing nets, during May, June and July. None were more than 25 mm. long. This species is very closely related to *E. cucumis*, with which it may prove to be identical. It is near, also, to the *Cydippe elliptica* of Eschscholtz, from the tropical Pacific.

Pleurobrachia, Fleming, 1822.

Body spherical, interradial canals from two stem canals.

2. **Pleurobrachia bachei** A. Ag.

Pleurobrachia bachei A. Ag., L. Agassiz, 1860, p. 294.
A. Agassiz, 1865, p. 34.

Oesophagus equal to or less than funnel tube in length; tentacle sheaths distant from funnel, about half as long as body, divergent, openings about one fourth the distance from pole to pole from sense organ; stems canals long, all canals slender.

Remarkably transparent, and colorless with the exception of the tentacles, which are yellowish red, and the oesophagus, which is blotched with deep purple proximally.

Distribution. San Diego to Puget Sound. This species differs from *P. pileus* (Fabr.) of the Atlantic, having a shorter oesophagus and longer funnel tube, and longer and more slender stem and interradial canals. The openings of the tentacle sacs are somewhat farther from the sensory pole.

Ord. LOBATA.

Body compressed, with two lateral lobes. Subtentacular rows of swimming plates shorter than others, with four auricular processes at their ends. Mouth large. Four interradial canals direct from the funnel. Tentacles rudimentary, near oral pole, without sheathes. A *Mertensia* stage in the development.

Fam. Bolinidae.

Bolina, Mertens, 1833.

3. **Bolina** sp.

There are two recognized species of Lobata on the western coast of North America: *Bolina septentrionalis* Mertens, from Behring Str. and *B. microptera* A. Ag., from the Gulf of Georgia. Agassiz and Mayer have described another, *Eucharis grandiformis*, from the Fiji Islands. It is probable that the very young Lobata which have been taken in large numbers off San Diego for the past two summers belong to *B. microptera*, which may ultimately prove to be identical with Mertens' circumboreal species. But the development of these immature individuals has not proceeded to the appearance of the auricles, and the total absence of mature individuals make it obviously impossible for the present to determine even the family of the species with accuracy.

Ord. BEROIDA.

Ctenophorae elongated, conical or ovate, compressed, with large mouth and oesophagus. Tentacles and tentacle canals wanting. Meridional canals communicate with oesophageal canals at the edge of the mouth, and send out numerous branches which may form a peripheral network.

Fam. Beroidae.

With the characters of the order.

Beroë, Browne, 1756.

With the characters of the family.

4. **Beroë forskali** M. Edw., Chun.

?Beroë rufescens Forskal, 1775, p. 111.
Cydalisia mitraeformis, Lesson, 1843, p. 138, pl. 2, fig. 2.
Idya penicillata, Mertens, 1833, p. 534, pl. 12.
Beroë Forskalii, Milne-Edwards, 1841, p. 207, pl. 5.
Beroë Forskalii, Chun, 1880, p. 309, pl. 14, figs. 3-5; pl. 14a, figs. 6-10.

Body much compressed, conical, tapering from the very broad mouth with full lips to a narrow sensory pole. Fine network of vessels between meridional canals, communicating also with oesophageal canals. Gonads in lateral follicles of meridional canals. Rows of swimming plates reach almost from mouth to tip.

Distribution. San Diego, Cal. Peru (Lesson). South Pacific (Mertens). Mediterranean (Forskal).

Taken about ten miles off shore, at the surface and in vertical hauls from various depths to 125 fathoms with non-closing nets, during May, June and July. A single mature specimen was taken, with the typical pointed form which is much more pronounced than in young individuals. The early stages were commonly taken in considerable numbers, and resemble in shape the young of *B. (roseola) cucumis* according to L. Agassiz, and the adult of *B. cyathina* according to A. Agassiz, the aboral end hemispherical and the rows of swimming plates short. The transition to the pointed forms is gradual and convincing The very young are colorless, the half grown are rosy, with brilliantly irridescent rows of swimming plates.

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EXPLANATION OF PLATE 1.

Fig. 1.—Mertensia ovum.

Fig. 2.—Beroë forskali.

Fig. 3.—Pleurobrachia bachei.

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III

THE PELAGIC TUNICATA OF THE SAN DIEGO REGION, EXCEPTING THE LARVACEA

BY

WM. E. RITTER

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CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO.

III.

THE PELAGIC TUNICATA OF THE SAN DIEGO REGION, EXCEPTING THE LARVACEA.

BY
WM. E. RITTER.

In accordance with the general plan of the series of faunistic papers of which the present is one, the object has been kept constantly in view not merely of describing the new pelagic tunicates occurring in the area and of reporting the presence of such already familiar ones as have thus far been found; but of furnishing a ground work, as well designed and securely constructed as possible, for future investigations into the general biology of this group of animals.

Diagnoses are given of all the species thus far observed—in the Thaliacea covering each of the different generations; and as far as possible these have been written from the living animals. Furthermore, all the forms actually observed in any numbers are figured. Everyone, however, who has had experience with these creatures is aware of the impossibility of making drawings of them that are at best more than crude outlines; and that to accomplish this the carcasses, always at the best badly out of shape, must be resorted to for many points. Lateral views are shown in every case, partly because it seemed that on the whole these are the most useful as aids to identification, and partly because most of the published figures of the same species present dorsal views; and I have thought the lateral views would supplement to good advantage the figures of other writers.

Before the alternation of generations in salpa was known, the oozooid and blastozooid generations were described as separate species; and, of course, were given different specific names. In most instances the describers of the two generations were different persons. From this duplication of names considerable confusion has arisen, not all writers having adopted the same course in the treatment of the names after the true relations between the two generations had been recognized. Following the lead of Krohn, 1846, the majority, probably, of authors have retained both the specific names, writing them with a hyphen, thus, *Salpa democrata-mucronata*. Others, on the contrary, have retained but one of the names, but unfortunately those who have adopted this course have not all retained the same name; thus Lahille, 1890, has used *confoederata,* and Brooks, 1893, *scutigera*, for *S. confoederata-scutigera*. I have followed Krohn, with the slight modification that I have uniformly placed that name first in the couplet that was proposed at the earlier date. This has reversed the order in several species, as, for example, *S. fusiformis-runcinata*, this being written by other authors *runcinata-fusiformis*. But as *fusiformis* was proposed by Cuvier in 1804, while *runcinata* was introduced for the other generation by Chamisso in 1819, it seems more fitting that *fusiformis* should lead in the couplet, as should also the name Cuvier indicating the author's names after the species.

The species treated in this paper are as follows:

SALPIDAE.

- *Cyclosalpa bakeri*, n.sp.
- *Cyclosalpa affinis.*
- *Salpa fusiformis-runcinata.*
- *Salpa tilesii.*
- *Salpa democratica-mucronata.*
- *Salpa zonaria-cordiformis.*
- *Salpa cylindrica.*
- *Salpa confoederata-scutigera.*

DOLIOLIDAE.

- *Doliolum tritonis.*
- *Doliolum ehrenbergii.*
- *Doliolum mülleri.*

Pyrosomidae.

Pyrosoma giganteum.

Of these, *Cyclosalpa bakeri* and the trophozooid of *Doliolum tritonis* have not hitherto been described.

Class UROCHORDA Lankester (Tunicata, Lamarck).

Order I.—THALIACEA Van der Höven.

Pelagic urochorda, with body of zooid more or less cylindrical, the branchial and atrial orifices being situated at opposite ends, or nearly so, of the body. Mantel musculature limited almost entirely to encircling fibres, these being grouped into definite bands. Propagation through an alternation of heteromorphic oozooid and blastozooid generations.

Fam. I.—Salpidae, Forbes, 1853.

Thaliacea in which the branchial stigmata are reduced to a single pair, each very large, between which, extending the entire length of the great pharyngeal cavity, is a prominent vascular band known as the gill. Muscle bands rarely extending around the body without interruption, the break usually being on the dorsal and ventral sides. Oozooids and blastozooids presenting each one form only.

Genus 1.—**Cyclosalpa,** DeBlainville, 1827.

Thalia, Browne, 1756.
Salpa, Forskahl, Cuvier, Traustedt, and most writers.
Cyclosalpa, Herdman, Lahille, Apstein.

Salpidae in which the intestine never forms a compact spherical mass known as the "nucleus," but is either extended along the dorsal side of the "gill" as a straight tube, or disposed in a large ring. Blastozooids set free from the proliferating stolon of the parent in circular groups, or whorls.

Genus 2. **Salpa,** Forskåhl, 1775.

Holothuria, Linn, 1758.
Dagysa, Banks and Solander, 1773.
Biphora, Bruguière, 1789.
Tethys, Tilesius, 1802.
Pegea, Savigny, 1816.
Jasis, Savigny, 1816.
Pterolyra, Lesson, 1830.
Dubrieullia, Lesson, 1830.

Salpidae in which the intestine is massed into a compact spherical body known as a nucleus. Blastozooids detached from the proliferating stolon of the parent either one by one or in groups consisting of two parallel series.

Cyclosalpa bakeri n. sp.

(a) *Solitary (budding) generation.*—Pl. II, all figures. Body somewhat cask-shaped, the posterior end a little narrower than the anterior; a distinct, though not deep, constriction setting off the anterior end. Long axis nearly straight as seen in preserved specimens,[1] Pl. II, fig. 1; section of body everywhere circular. Length of largest zooid seen, 41 mm., this with salpa chain well developed. Test exceedingly soft and transparent and wholly devoid of colored pigment. Five white "longitudinal organs" on each side, the first pair between second and third muscle bands. Upper lip of branchial orifice truncate, lower lip rounded and protruding more than upper. Atrial orifice without lips. Muscle bands very delicate and difficult to trace. Body bands ten, though at neither end decisively separable from orifice muscles. All bands except ninth and tenth, and sometimes eighth, interrupted dorsally, and all except first, ninth and tenth interrupted ventrally. First trending backward on dorsal side, the ends becoming nearly parallel and reaching as far back as the third; also connected on dorsal side with the posterior lip band by two parallel longitudinal muscles. Second also trending backward on dorsal side to terminate almost coincidentally with first and third. Seventh bending abruptly forward on dorsal side and running parallel close together as far as the fifth, sometimes broken into fragments, Pl. II, fig. 2. Eighth also turning forward on dorsum, but less abruptly than seventh, sometimes interrupted in median line, sometimes not. Second band trending backward on ventral side; likewise third, though less than second. Fifth inclined somewhat forward ven-

[1] Though attention should be called here to fig. 4, Pl. II, which outlines the form of a specimen alive and swimming. From this observation, and from the fact that *C. affinis* certainly has normally a more sinuate general form in life than after preservation, I am inclined to believe that when sufficient numbers of living individuals of this species have been examined to determine the point, it will be found that fig. 4 represents the normal form more nearly than does fig. 1.

trally, and sixth bending abruptly forward to terminate on a level with the fifth. Ninth inclining forward on each side to touch the eighth tangentially, then bending sharply back to cross the tenth, so that on the median ventral line ninth is behind tenth.

Three bands in dorsal lip of branchial orifice, the first divided into a broader and narrower portion, the second trending broadly backward on ventral side to become confluent with second body muscle; third joining second behind angle of orifice. Second muscle of ventral lip trending sharply backward laterally to terminate at the crossing of the second upper lip and first body muscles. A longitudinal band on each side extending forward from the second body band to angle of orifice. Endostyle rather slender, and with a gentle dorsal curvature near its anterior end, extending from midway between the second ventral lip and the first body muscle, to the seventh muscle. Gill of usual form and extent, posterior termination nearly coincident with that of the endostyle. Ganglion considerably behind anterior termination of gill, and remote from hypophysis; sense organ broad horseshoe shaped, open end forward. Hypophysis at the anterior termination of the gill; in the form of a twisted horseshoe with open end forward and slightly to the right. Intestine straight, extending forward above the gill nearly to the ganglion. Stomach globular, not large. Two strap like lobes of nearly equal size and length given off backward from the short bend of the intestine. Heart slightly in front of the posterior termination of the endostyle, in the interval between the sixth and seventh muscle bands. Stolon apparently arising in front of the heart, extending forward in the mid-ventral line to emerge to the outside through an opening between the second and third muscle bands.

(b) *Aggregate (sexual) generation.* Pl. III, figs. 7 and 8. The only zooids seen of this generation were still attached to the stolon, and I am, consequently, unable either to describe the full grown animal, or to say anything positive about the whorls. From the fact, however, that the musculature is essentially the same in form and arrangement as that here described, through several stages preceding the one on which the description is based, it is safe to presume that it will be found to be practically the same in the adult. The hypophyseal-ganglionic complex, and especially the digestive tract, are, however, obviously still immature. As to the whorls of zooids, it can only be said at present that the close similarity of this species to *Cyclosalpa affinis* and *C. pinnata* in the arrangement of the zooids in the chain, makes it highly probable that the whorls are likewise much the same in the two. The diagnosis is from zooids 4 mm. long, exclusive of the intestinal tract.

Body compressed, cask shaped, the ends imperfectly truncate, though adult form probably not yet assumed. Test thick, and consistency of animal as a whole much firmer than adults of solitary generation. Peduncle for attachment to stolen situated on ventral side nearer anterior end, relatively long and narrow, containing continuations of the first and second body muscles. Branchial orifice terminal, lips (at this stage) scarcely recognizable. Atrial orifice small, situated at dorso-posterior angle (in this stage). Body muscles, 4 on dorsal side, and 4 on ventral, these branching and anastomosing laterally in a complicated way, and always with a *definite asymmetry*, the arrangement on either side of a given zooid depending on whether the zooid be a right or left one in the salpa chain; or, what amounts to the same thing, whether the side is turned toward the anterior or the posterior end of the parent of the chain. Arrangement on side *toward* anterior end of parent is as follows: second muscle bifurcates a little distance from median dorsal line, the branches uniting again about opposite the endostyle to extend into the ventral peduncle, Pl. III, fig. 7. Third muscle likewise bifurcates about same distance as second from dorsal median line, the anterior branch extending down to cross the ventral median line and to become continuous with its fellow of the opposite side of the zooid, and also anastomosing with a ventral longitudinal band running into the peduncle. The posterior branch likewise extending across ventral line to join fellow of opposite side, but also sending two delicate branches posteriorward, approximately parallel with the endostyle, the more dorsal passing midway between the atrial orifice and the esophagus, the other ventrad of the esophagus, and both extending into the "post abdomen," Pl. III, fig. 7. Arrangement on side turned toward *posterior* end of parent is as follows: second muscle *not bifurcating;* third bifurcating near dorsal line as on opposite side, the anterior branch again bifurcating to send a branch forward which anastomoses with second muscle, the single band thus produced passing into the ventral peduncle, Pl. III, fig. 8. In the asymmetry of the muscles this species resembles *S. rostrata, S. punctata, S. magalhanica* of Apstein. The climax of the phenomenon is reached in *S. rostrata.* First and second muscles united on each side by two longitudinal bands, Pl. III, fig. 7. In addition to the dorsal lip muscle given off as a branch from first body muscle, an angular lip muscle on each side its dorsal limb reaching over and becoming continuous with its mate of the other side; another small upper lip muscle near edge of lip. The fourth body muscle of dorsal side, relatively very small, bifurcating on each side short distance from dorsal median line, the anterior branch anastomosing with posterior branch of third muscle, and posterior branch passing under atrial orifice. The fourth ventral muscle is really the posterior branch of third dorsal muscle.

As already stated, the ganglio-hypophyseal complex and the intestinal tract are clearly immature in the largest zooids seen. I, consequently, refrain from including a characterization of them in the diagnosis of the species. Certain facts about the intestinal tract, however, should be mentioned. In the first place, the late period in the life of the zooid at which it becomes complete, at least as compared with *C. affinis*, is noteworthy. In the latter species, the intestine has assumed its final form and position while the bud is still in the chain, and even before the whorls are formed. In *C. bakeri*, on the contrary, the way in which the anal end of the intestine projects freely from the posterior end of the body as a whole, shows clearly that the organ is not yet complete, even in the oldest zooids found. With little doubt the final form is a circle here as in *affinis.* An apparently wholly unique feature in *bakeri,* however, seems to be the two appendages of the intestine shown in the figures. The intestinal tract as a whole has the form of a horseshoe, the plane of the shoe being approximately at right angles with the sagittal plane of the zooid. The entire bow projects backward beyond the posterior end of the endostyle and gill. The mouth of the esophagus is situated a little dorsal and to the right of the end of the endostyle; and the anus enters the atrium to the left of the endostyle. The esophagus is marked off from the stomach by being distinctly less in diameter than the stomach. At the anterior end of the intestine a cecum nearly as large as the intestine itself is given off, which curves backward and upward and forms a very conspicuous object in all the stages of development observed, *co.*, figs. 7 and 8.

From the posterior extremity of the intestinal bow a great finger-like outgrowth of the mantle extends backward and upward. This appendage is even longer and more conspicuous than the stomachal cecum described above. Into it extend prolongations of the posterior branches of both dorsal and ventral body muscles; and in addition it contains a well defined axial strand, the connections and nature of which are doubtful, *p. d.*, figs. This appendage would seem to be comparable with the portion of the post-abdomen that extends beyond the intestinal loop in various compound ascidians. The axial strand is probably the testis, or a portion of it. The ovary is situated on the right side of the body at the extreme posterior end, midway between the atrial orifice and the esophagus; and the oviduct, which is unusually long, extends forward to a level with the third ventral muscle band.

C. bakeri appears to have more in common with *C. floridana*, Apstein, than with any other known species. It is, however, very distinct from this latter, as is obvious from the following, among several other differences: The largest specimen of *C. floridana* seen by Apstein was 12 mm long. In view of the considerable number of specimens taken by the Plankton Expedition, the great disparity in size thus indicated shows pretty conclusively that *C. bakeri* is a much larger species than *floridana*. The lateral glandular organs of the solitary *floridana* are distinctly less extensive than in *bakeri*, and are, according to Apstein's statement, continuous on each side as in *C. pinnata*. The intestine of *floridana* has a single appendage, while that of *bakeri* has two. The closest resemblance between the two is in the musculatures of the solitary forms, but even here there are well marked differences, which, however, need not be dwelt upon, since a comparison of my figures with that of Apstein will make them clear. It is worth noting that this adds another to the list of species in which the intestine of the aggregate generation is in the form of a circle, these species being *C. affinis, C. floridana* and *C. bakeri*.

The specimens of *C. bakeri* thus far obtained are few, and the variations in the muscle bands in these few suggest that further study of more ample material may modify somewhat the scheme given in the diagnosis; I cannot, however, believe that such modification can materially alter the results so far as concerns the definition of the species. In no species of salpa with which I have had experience have I found so much difficulty in tracing the muscles. This difficulty is due to the softness of the animal, and the extreme delicacy and transparency of the muscles themselves. The separation of the muscles into body muscles on the one hand, and orifice muscles on the other, I recognize as being a particularly arbitrary matter in this species. For example, there would be almost as much reason for considering what I have enumerated as the first body muscle, a lip muscle; or, on the other hand, for calling what in my scheme is the third upper lip muscle, a body muscle. In fact, I have little doubt that what Apstein has designated number one in *floridana* corresponds to my third dorsal lip muscle. But the homologizing of the muscle bands in the different species of salpa is an exceedingly difficult, if indeed possible, thing; though comparison of the developmental stages would probably help in the matter.

In all, about fourteen specimens of the species have been taken during the last three years, all on the coast of southern California, and all excepting one, which was taken in March, during the months of June and July.

Cyclosalpa affinis (Chamisso).

Salpa affinis Chamisso, 1819, p. 11, pl. figs. 2A-C, solitary generation; 2D-E, aggregate generation.
Cyclosalpa affinis Blainville, 1827.
Salpa affinis Meyen, 1832, p. 407.
Salpa affinis Traustedt, 1885, p. 357, Pl. I, figs. 6, 7, and 8.
Cyclosalpa affinis Herdman, 1888, p. 86.
Cyclosalpa affinis Lahille, 1890, p. 11.
Salpa affinis Apstein, 1894, p. 4; *Cyclosalpa*, p. 24.

(a) *Solitary (budding) generation.*—Fig. 9. Body distinctly larger at anterior end, and tapering nearly uniformly to the posterior end: the anterior end with a pronounced ventral bend, the posterior with a nearly equal dorsal bend. Test rather thin and soft, and highly transparent, without special thickenings or

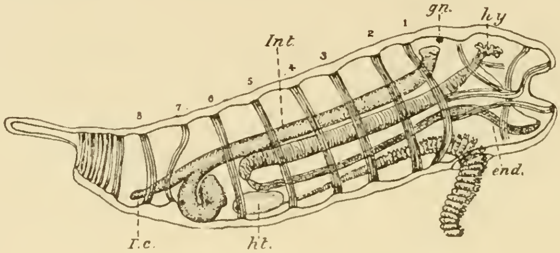


Fig. 9.—*S. affinis*, solitary generation.

asperities; a pair of lateral and somewhat dorsal appendages at the posterior end. No lineaform "glandular" organs. Length of full grown zooids, 80 to 100 mm. Branchial orifice directed somewhat ventrad, lips prominent, upper overarching. Atrial orifice without lips, directed somewhat dorsad, armed, particularly in older specimens, with a pair of latero-dorsal appendages. Body muscles eight, all excepting last interrupted on ventral side. First and second interrupted on dorsal side (in older specimens only). First trending backward to some extent on ventral side. Lip muscles of branchial orifice complicated; two sphincters in upper and one in lower; two longitudinal bands on each side running forward from the first body band, one to the dorsal lip, the other to the ventral; a band on each side extending from the angle of the orifice postero-dorsad; a pair of short, strong dorsal longitudinal bands in dorsal lip. Endostyle distinctly curved in its anterior third to correspond with the ventral bend of the body as a whole; extending from far forward in the ventral lip back to the esophagus; both extremities turned abruptly up, the anterior more conspicuously so than the posterior. Ganglion slightly in front of anus. Hypophyseal mouth a large, highly convoluted, nearly closed ring, with opening to the left (fig. 11). Gill long and narrow, extending from slightly in front of the anus to the esophagus, terminating, consequently,

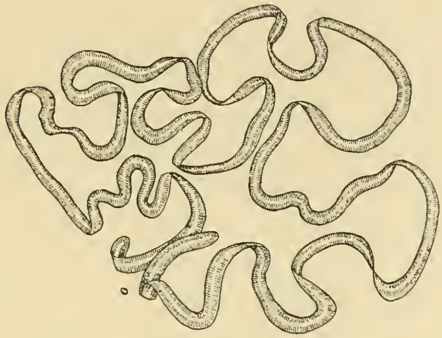


Fig. 11.—Hypophysis of *C. affinis.*

nearly coincidently with the endostyle. Intestine nearly straight and of uniform character, though turned a little dorsad and to the left at anal end; the anus somewhat trumpet shaped. Stomach in the sharp curve of the tract, flattened; a large cecum extending backward appearing as a direct posterior prolongation of the intestine. Entire intestine uniform orange, generally, but occasionally devoid of color. Pericardium-heart large, situated ventrad of the posterior end of the endostyle. Salpa chain reaching forward in mid-ventral line under the endostyle and emerging to the outside far forward, between the ventral ends of the first body muscle band.

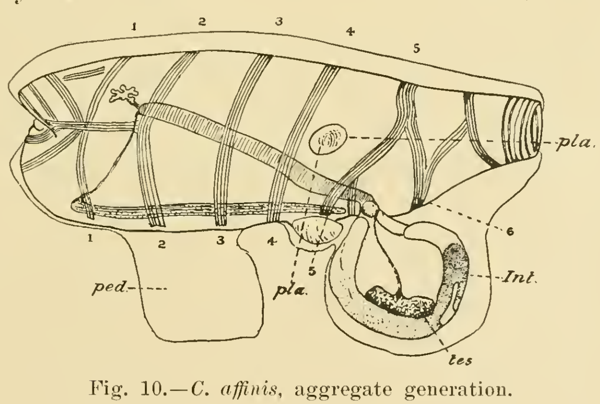


Fig. 10.—*C. affinis*, aggregate generation.

(b) *Aggregate (sexual) generation.*—Fig. 10. Aggregations containing from nine to twenty zooids, united radially about a common centre, by the large ventral peduncle, remaining intact until zooids are fully grown; in nature, six or eight or more of the whorls united tangentially. Body in general cylindrical, though somewhat arched dorsally, and tapering at the atrial end. Rather soft and of uniform consistency, there being no thickened or specially stiffened areas in the test; the connecting peduncle and protruding intestinal tract forming very prominent projections from the ventral side. Full grown zooids from 60 to 70 mm. long. Body usually quite transparent and without pigment, but occasionally traces of pink on surface of test about anterior end. Lips of branchial orifice prominent, of approximately equal size; atrial orifice without lips. Body muscles five on the dorsal side and six on the ventral, all continuous across the dorsal side, and all except sixth interrupted by a narrow interval ventrally; the fifth and sixth ventral muscles joining laterally to form the fifth dorsal. The second band giving off a longitudinal muscle laterally, which extends forward to the angle of the branchial orifice; the fifth giving off a small branch on each side, which extends back close under the intestine; the sixth, with a branch on each side connecting with the first atrial. A well developed band in each lip of the branchial orifice meeting in a wide angle on each side. First atrial band nearly as broad as body bands; the other atrials, about eight in number, very delicate. Endostyle extending from slightly in front of the first body muscle to behind the fifth muscle, and quite to the intestine. Gill extending from somewhat in front of the second muscle fully to the intestine, hence terminating near the posterior end of the endostyle. Ganglion and sense organ under the second body muscle, and a little posterior to the anterior end of the gill. Hypophyseal mouth close in front of the anterior end of the gill, large and much convoluted, becoming rosette shaped, the band narrowly open to the right. The intestine projecting from the ventral side like a hernia; forming almost a circle of relatively large size, in full grown zooids 1.5 cm. in diameter, the curve extending downward and forward, so that the anus is very near to, and to the left of, the esophageal mouth. Stomach scarcely larger in diameter than intestine, and not distinctly set off from it. Esophagus short and much smaller in diameter. Deep yellow, nearly uniform throughout. Heart conspicuous, immediately in front of intestinal ring on ventral side. Placenta with embryos on right side between fourth and fifth muscle bands. Testis, an elongated white mass in the intestinal ring closely applied to the intestine. Vas deferens given off from the middle of the testis, passing across the intestinal circle, and opening near the esophageal mouth.

Down to the present time this has been one of the rarer of the early known species of salpa. It was described by Chamisso, by whom it was taken in the region of the Sandwich Islands. It did not occur in the Challenger collections, and has not until now been reported again from the Pacific, so far as I am aware. Meyer observed it, though not closely, nor in great abundance, about the Canary Islands, and we have several other references to its occurrence in the tropical and subtropical Atlantic. The Plankton Expedition took, according to Apstein, a total of nine specimens at two stations; one in the Gulf Stream, Lat. 41.6, the other in the Sargasso Sea, Lat. 31.5. Voigt, 1854, includes it in his list of species of the Mediterranean in the vicinity of Nice, but gives no further information about it. Its constant abundance on the southwestern coast of North America, in a plankton area at least adjacent to, if not in reality part of, that from which it was originally described, and its apparent rarity in other parts of the world, would seem to indicate that the headquarters of the species is here, though such a suggestion relative to the distribution of strictly pelagic organisms can have little value until supported by much more data than we yet possess. Despite the considerable differences between the Salpa here treated as *C. affinis* and any of the published descriptions and figures of the species, I am convinced of the correctness of the identification. All the discrepancies of any moment may be accounted for from the fact that the descriptions and figures hitherto published have probably all been made from museum specimens. For example, the straight long axis of the solitary generation as shown in the figures of Chamisso and Traustedt, give a wholly erroneous impression of the general form of the species, but the true shape as shown in lateral view, fig. 9, can be fully appreciated only by examining the living swimming animal. Preserved specimens have more the form of the figures of the authors above mentioned. Again, the two processes at the atrial end are not adequately recognized in any of the published figures. This is due in part to the fact that they are very short in the younger zooids, and in part to their being, in adult preserved specimens, either broken or worn off. I have examined specimens of about 1.5 cm. in length from the mid-Pacific, practically the region in which Chamisso obtained his, and find the processes short though distinctly indicated, essentially as they are shown in Traustedt's figs. 7 and 8, Pl. I. Finally, Traustedt figures an arrangement and anatomosing of the seventh and eighth muscle bands of the solitary generation, somewhat different from anything I have seen, but the point is a trivial one, even if his representations are entirely correct.

The species has been obtained at Santa Catalina Island and off San Diego during the months of March, June, July, and August. It was particularly abundant during March, 1904, in the last named locality, and was reproducing actively, both sexually and asexually.

Salpa fusiformis-runcinata Cuvier.-Cham.

Salpa fusiformis Cuvier, 1804, p. 23, fig. 10.
Salpa runcinata Chamisso, 1819, p. 16, Pl. figs. 5A-5I.
Salpa runcinata-fusiformis Krohn, 1846, p. 112.
Salpa runcinata-fusiformis, Leuckart, 1854, p. 3 ad seq. Pl. I, figs. 6, 8, 16, 17, 18; and Pl. II, figs. 1, 3, 4, 5, 13, 15, and 18.
Salpa runcinata-fusiformis Traustedt, 1885, p. 370, Pl. 2, figs. 29, 30, 31.
Salpa runcinata-fusiformis Herdman, 1888, p. 76, Pl. 6, figs. 5-12.
Salpa fusiformis Apstein, 1901, p. 1117, figs. 6a and 6b.

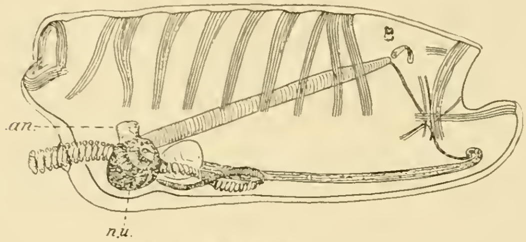


Fig. 12.—*S. fusiformis-runcinata*, solitary generation.

(a) *Solitary (budding) generation.*—Fig. 12. Nearly cylindrical, somewhat larger at the atrial end, both orifices terminal, truncate in general effect at both ends. Length of largest specimens, 70 mm., 76 mm., to 80 mm. Test variable, in some thin and soft, particularly anteriorly; in others, thicker and firmer, particularly posteriorly; a number, from eight to twelve, more or less regular, longitudinal, serrated ridges running from the atrial end forward a variable distance, but most prominent over the nucleus. Branchial orifice with two lips, of which the dorsal is distinctly the higher. Atrial orifice also with inconspicuous dorsal and ventral lips. Body muscles nine, confined to the dorsal side and reaching down laterally scarcely half way to the endostyle, where they terminate abruptly. First three anterior body muscles confluent dorsally; all the muscle bands distinctly broader dorsally. A constrictor muscle in the dorsal lip, and one in the ventral lip, both terminating behind the angle of branchial orifice, where the ends cross each other and extend a short distance beyond the point of crossing. Atrial orifice with six or eight muscles of a few fibres each, those of the dorsal and ventral lips terminating at the angles, where they cross one another. Endostyle slender, straight, extending from the level of the angle of the branchial orifice back to the intestine, on a level with the eighth muscle band. "Gill" long, narrow, and nearly straight, extending from a little in front of the first muscle band to the ninth band. Hypophysis horseshoe shaped, its plane nearly in the sagittal plane of the animal's body, about midway between the muscle band of the upper lip and the first body band. Intestinal tract making a compact "nucleus," corresponding to the interval between the eighth and ninth muscle bands, and projecting somewhat on ventral side; the broad short end of the rectum projecting dorsad from the nucleus to open into the cloaca. Dark red generally, though not universally. Heart on ventral side, immediately in front of intestinal mass. Chain of buds extending forward along ventral median line from near the nucleus for a variable distance, then bending on itself and reaching back to emerge to the outside through an orifice behind the nucleus.

(b) *Aggregate (sexual) generation.*—Fig. 13. Body elliptical in outline, with processes at each end, short and broad in the young, much longer in full grown zooids, where they become as long as the body. At the outset these processes are always asymmetrical, the anterior being to the right, the posterior to the left, or vice versa (the one figured is anterior process right, and posterior left). Length of large specimen, 25 mm.; usually smaller. Branchial orifice inclined distinctly upward, though not wholly dorsal. Atrial opening nearly directly backward. Lips of branchial orifice not prominent, dorsal deeper, but ventral extending farther forward in correlation with the obliquity of the orifice. Atrial orifice scarcely lipped. Body muscles

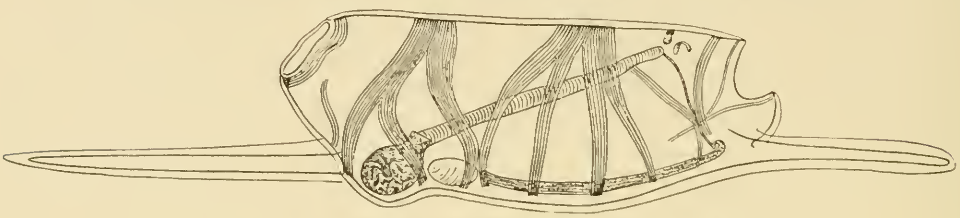


Fig. 13.—*S. fusiformis-runcinata*, aggregate generation.

seven, never interrupted on dorsum, and never continuous across the ventral side. Anterior four, and posterior three, confluent on dorsum. Last of anterior group and first of posterior group confluent laterally, but the two disconnected at ends. Posterior two, the sixth and seventh, confluent well down the side, the two separating, the sixth to pass in front of the nucleus, the seventh behind it. The seventh usually confluent with a smaller muscle belonging to the atrial orifice. A large muscle band in the dorsal lip of the branchial orifice a short distance back from the edge, a delicate one at the very edge, and a broad band in the ventral lip. An angular muscle band at the angle of the branchial orifice on each side, its angle directed toward the angle of the orifice, and its two limbs directed, the one ventrad, the other dorsoposteriad. Endostyle slender, extending far forward under the ventral lip to a level with the ventral ends of the sixth muscle, some distance in front of the nucleus. Gill rather shorter, relatively, than in the solitary generation, and making a wider angle with the endostyle. Anterior end about middle of the interval between the dorsal lip and the anterior group of muscle bands, posterior end at the nucleus, hence some distance behind the posterior end of the endostyle. "Nucleus" rather small, compact, egg shaped, situated far back, projecting somewhat from the general surface of the animal. Color of nucleus orange, though not uniform in all parts. Heart between posterior end of endostyle and nucleus.

This is by considerable the most abundant species of salpa of the western shores of North America, and probably of the whole Pacific Ocean, at any rate north of the equator. It has been taken at almost every point on the coast from Alaska to Lower California, and at many of these in large numbers. On the whole California coast it has been taken in nearly every month of the year, though the systematic collecting at San Diego thus far indicates it to be considerably more abundant during the summer than in the midwinter months.

Salpa fusiformis-runcinata, form **echinata.**

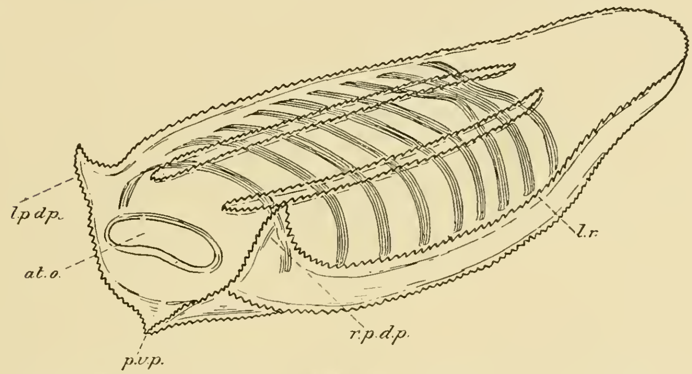


Fig. 14.—*S. fusiformis-runcinata,* echinate form. Postero-dorsal view, showing serrations of test, and muscle bands.

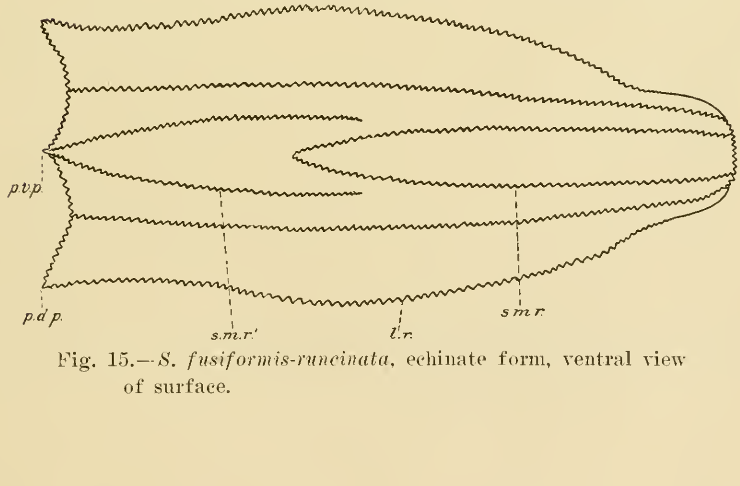


Fig. 15.—*S. fusiformis-runcinata*, echinate form, ventral view of surface.

Having worked over a large quantity of material of *S. fusiformis-runcinata* with reference to the question of the status of *echinata*, I reach the conclusion that a well marked style, or form of the species, which may be called *echinata*, must be recognized, but that it is not a distinct, persistent variety, as Apstein has treated it; much less a species as Herdman concluded from his study of the Challenger material.

There are two particulars by which, at their fullest expression, the form is distinguished from the typical *fusiformis-runcinata*. One is the echination of the test, the other the arrangement of the body muscles. Figs. 14 and 15 are diagrams, though made with special care, from the examination of three specimens which agreed almost perfectly in these particulars. Fig. 14 is a postero-dorso-dextral view. It shows two double rows of echinations on the dorsal surface that begin some distance behind the anterior end and extend to the posterior end, but do not terminate in spines. Laterally from these is a row on each side on the edge of a prominent ridge—almost a fin—of test, this ridge extending the entire length of the body and terminating posteriorly in two prominent processes, *r.* and *i. p. d. p.* On the ventral side are two sets of submedian rows (Fig. 15, *s. m. r.* and *s. m. r.'*), an anterior and a posterior, each set open anteriorly but joined posteriorly, the posterior junction of the posterior set being in a prominent posterior ventral process *p. v. p.*, and laterally from these are again two more rows. As to the muscles, the three anterior ones, though converging somewhat, scarcely touch one another as they do typically in *fusiformis-runcinata*. The eighth and ninth do not even converge; they are entirely parallel. Herein is perhaps the most striking difference between *echinata* and the type of the species.

This description applies exclusively to the solitary generation. As to the aggregate generation, one finds an occasional lot of zooids that are unusually robust, this being especially apparent at the posterior end of the animal, where the posterior process of test becomes much thickened and solidified, with the serrated edges highly developed. In one lot of this sort observed off San Diego in March, 1904, the animals reached a total length of 50 mm. or more; and several zooids in one gathering made by the Albatross (data as to time and locality lacking, but certainly Pacific Ocean material) a total length of 60 mm. was reached, the body here, exclusive of the processes, being 40 mm. These last were somewhat larger than the largest Challenger specimens of *echinata*. That these robust aggregate zooids belong with the *echinata* form of the solitary generation may be held as probable, although nothing less than absolute proof of this will warrant associating them positively in classification.

Now a few more words in support of my opinion that we have here a case of extreme, for this group of animals, individual variation, or fluctuation, rather than a true variety, or "elementary species." In the first place, as to the echination of the test. It is doubtful if this is ever wholly absent in *S. fusiformis-runcinata*. Certainly if it is, it is so only exceptionally. So far as the evidence goes on this point, it is to the effect that the thickening of the test at the posterior end, the prominence of the ridges, and the serrations increase with the size, and presumably with the age, of the zooids in both generations. But more extended and exact information is needed here. There are undoubtedly some observations opposed to this supposition. For example, I have one specimen of the solitary generation taken at Bolinas Bay, California, November 18, 1895, which, although scarcely more than half the size of the largest *echinata*, yet possesses the longest, heaviest three posterior processes I have seen in any zooids whatever. But here the serrations are almost entirely wanting. In this specimen, too, the muscle plan is strictly that of *fusiformis-runcinata*—that is, the anterior three and posterior two are fully fused. And here I would say that the examination of a large number of specimens with reference to the point has failed to discover a single instance of the *separation of these muscles in a small zooid.* I consequently incline to the opinion that the *separation of the muscles is an age character.* But here, too, more positive evidence is needed. My provisional conclusion is, then, than *echinata is* an old age form of *fusiformis-runcinata.*

In view of the usually clear delimitation of species in Salpa, the question of the status of *echinata* is especially interesting. It well deserves more extensive and critical examination. Apstein's suggestion that we have here a variety that pertains to the solitary generation alone is interesting, but can hardly be regarded as of much value until established by direct evidence.

This form has been taken several times at various places on the California coast during the last ten or twelve years. It would seem to be coincident with the typical *fusiformis-runcinata* in distribution.

Salpa tilesii-costata (Cuvier-Quoy et Gaim.).

Salpa tilesii Cuvier, 1804, p. 375, figs. 3-6.
Salpa costata Quoy et Gaim, 1834, Zoöl. t. 3, p. 587, Pl. 86, figs. 1-5.
Salpa costata-tilesii Krohn, 1846, p. 114.
Salpa costata-tilesii Traustedt, 1885, p. 379, Pl. 1, figs. 10 and 11; and Pl. II, figs. 38-41, and 47.
Salpa costata-tilesii Herdman, 1888, p. 60, Pl. 4, figs. 1. 4, 8.
Salpa costata Brooks. 1893, p. 10 (particularly), Pl. IV, fig. 4; Pl. VIII, fig. 4.
Salpa Tilesii Apstein, 1894, p. 16; 1901, p. 111 10, figs. 11a, 11b.

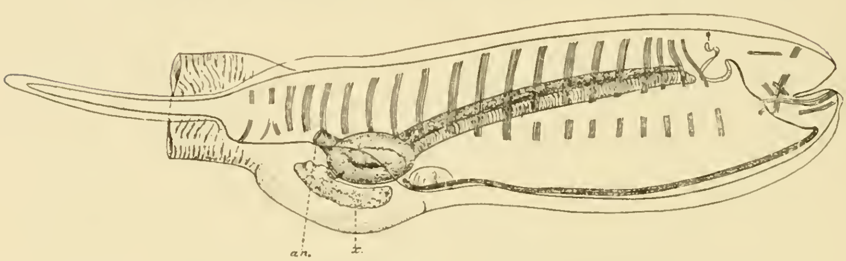


Fig. 16.—*S. tilesii-costata*, solitary generation.

(a) *Solitary (budding) generation.*—Fig. 16. Body much larger anteriorly, tapering gradually back to the region of the nucleus, then expanding again rather abruptly to the atrial termination. A prominent hump on the ventral side corresponding to the nucleus. Anterior end rounded; posterior truncate but for slight lateral notches, and armed with a pair of firm compressed, green edged appendages arising laterally from a little in front of the edge of the atrial orifice. Both orifices distinctly terminal. Lips of branchial orifice prominent, the ventral somewhat more so, upper finely serrated on its inner edge. Length of longest specimen, 19 cm., exclusive of appendages, which were 47 mm. Test thick and firm, particularly on the ventral side, and most of all over the nucleus. Whole surface, except for a broad area at the anterior end, beset with low, spine like processes. Frequently a girdle of indefinite limitation of dark green in the mid body, across the dorsal side and extending well down toward the mid-ventral line, the color, which is on the surface of the test, being densest laterally. The edges of the posterior appendages densely and uniformly colored with the same green. Body muscle bands 20, occasionally 19 or even 18, uniformly spaced and mostly all parallel, but the first and second inclined somewhat backward on the dorsum. All (in old zooids only?) limited to the dorsal half of the body, and all interrupted in the mid-dorsal line, and typically, the 7th or 8th or 9th interrupted laterally. A single broad band in dorsal lip broadly interrupted on each side of median line; also a pair of short, longitudinal, nearly parallel, widely separated bands in this lip; two bands in ventral lip; a complicated and variable crossing of short bands at angle of orifice. Nine or ten or more delicate, wavy, more or less interrupted bands belonging to the atrial siphon. Endostyle slender, gently curved to conform to the outline of the body, reaching entirely back to the nucleus. Gill relatively rather short, extending from a little in front of the first muscle band to the nucleus. Hyphysis close to anterior end of gill, but short distance in front of ganglion, forming a distinctly pendant tubercle, on which the rather large, irregularly triangular mouth mouth is situated.

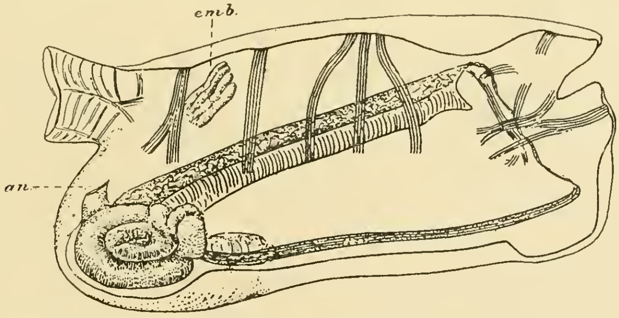


Fig. 17.—*Costata-tilesii,* aggregate generaion.

(b) *Aggregate (sexual) generation.*—Fig. 17. Body in general cylindrical, but irregular, especially posteriorly from the projection of the intestinal mass and the atrial siphon. Remaining in the aggregated condition and firmly united at least until 7 cm. long, and while thus united, body somewhat asymmetrical from the mode of aggregation, the branchial and atrial orifices being turned respectively to the right or left, depending on whether the zooid be right or left in the chain. Largest zooid seen, 14 cm. Test rather thick and stiff, particularly on ventral side, and most of all over nucleus, where in old zooids it becomes opalescent. Surface in some, though not in all, beset with low, broad, scattered processes, these on the whole more pronounced on dorsum. An irregular area of yellowish green in the test over the nucleus, and occasional small patches of this on dorsum. Lips of branchial orifice prominent, of nearly equal height, the dorsal overarching; ventral projecting forward and below in a blunt prow. Atrial siphon narrow, thin walled, elongated, without lips. Body muscle bands five, limited to the dorsal side, and not extending more than half way down to the mid-ventral line. The first three drawing together, but not touching on the dorsum, and each interrupted by a narrow interval in the mid-dorsal line. These three muscles, and frequently the fourth, interrupted on the side toward the axis of the chain, but usually not on the other side. Fifth muscle forked on each side. A single strong band in the dorsal lip, widely interrupted on both sides of the middle, two bands in the ventral lip, the dorsal and ventral lip bands crossing and intermingling in a complex but somewhat variable way at the angles of the orifice. Two short longitudinal bands in dorsal lip. Numerous delicate bands in atrial siphon, all confluent with a longitudinal band on each side. Endostyle slender, nearly straight, reaching back entirely to the nucleus. Gill relatively short, scarcely reaching into the anterior third of the animal; hypophysis small, hardly recognizable without dissection. Nucleus relatively large, compact, ovate, regular; rectum far back, projecting dorsad several millimeters above the general level of the nucleus, greenish brown at its anterior end, yellow posteriorly, with an irregular scarlet area on its dorsal side and extending somewhat on to the gill. Embryos normally four, situated dorsally to the right of the median line, between the fourth and fifth body muscles.

Although this, by far the largest, most magnificent of all our species of Salpa, has never been taken in great abundance on the California coast, it is by no means rare, since a few specimens at a time have been frequently collected at numerous points during the last fifteen years. The collections show it to have been taken in March, May, June, July, August, and November, with the largest numbers in March and July.

Salpa democratica-mucronata Forsk.

Salpa democratica Forskåhl, 1775, p. 113, Pl. 36, fig. G (solitary gener.)
Salpa mucronata Forskåhl, 1775, p. 114, Pl. 36, fig. D (aggregate gener.)
Salpa Cabotti Agassiz, 1886, p. 17, figs. 1-5.
Salpa democratica-mucronata Krohn, 1846, p. 112-113.
Salpa democratica-mucronata Leuckart, 1854, p. 3, et seq., Pl. I, figs. 1, 3, and numerous others.
Salpa democratica-mucronata Traustedt, 1885, p. 365, Pl. 2, figs. 25 and 28.
Salpa democratica-mucronata Herdman, 1888, Pl. VIII, figs. 1-10.
Salpa democratica Brooks, 1893, pp. 6-16, particularly for anatomy. Pl. 2, especially.
Thalia democratica-mucronata Herdman, 1899, p. 748.
Salpa mucronata Apstein, 1901, p. III 5, figs. 5a and 5b.

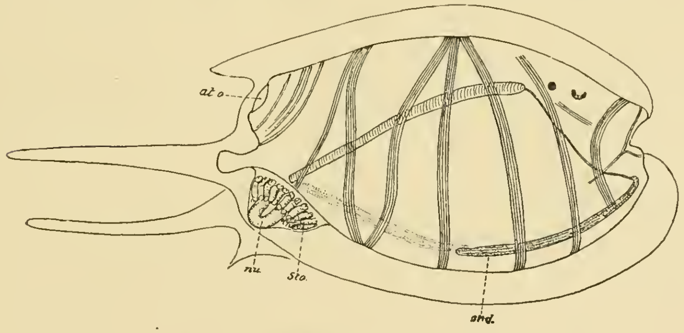


Fig. 18.—*S. democratica-mucronata*, solitary generation.

(a) *Solitary (budding) generation.*—Fig. 18. Form ovate, the posterior end armed with a pair of long,slender, bilaterally placed processes, with a median ventral process, usually bifid, the ventral horn much shorter than its mate, which is sometimes nearly as long as the laterals; usually with a median dorsal process, sometimes of considerable length, but more frequently short or occasionally wanting. Length of body, exclusive of processes, about 8 mm. Test very thick and exceedingly transparent. A blunt pocket of the mantle reaching into the base of the long lateral processes. Branchial orifice inclined somewhat upward, with dorsal and ventral lips, the dorsal distinctly higher and broadly notched in middle. Atrial orifice nearly terminal, but inclined a little upward, without lips. A girdle and half another of minute spines on the test encircling the branchial orifice, and four bands of similar processes running lengthwise of the animal on the dorsal surface. Body muscle bands six, the first interrupted on dorsum; second, third, and fourth in contact, though hardly confluent dorsally; fifth and sixth also in contact dorsally. Bands all continuous across the ventral side, excepting the sixth, which is interrupted. Muscles all delicate, the sixth particularly so. A single rather broad muscle band belonging to the branchial orifice situated some distance away from the edge of the opening, continuous except for an interruption on the ventral side. A few scattered fibres around the atrial orifice. Endostyle relatively short, extending back only to the third muscle band, consequently leaving a wide interval between its posterior end and the nucleus, somewhat curved and rather thick. Gill extending from a little behind the first body muscle band back to the nucleus. Ganglion slightly in front of the anterior end of the gill. Hypophysis considerably in front of ganglion, and from surface view wholly disconnected from it; rather small, somewhat triangular in dorsal view. Nucleus very small, ovate, situated far back, light yellow. Chain of buds encircling the nucleus. Pericardium and heart so delicate as to be seen with difficulty in preserved specimens.

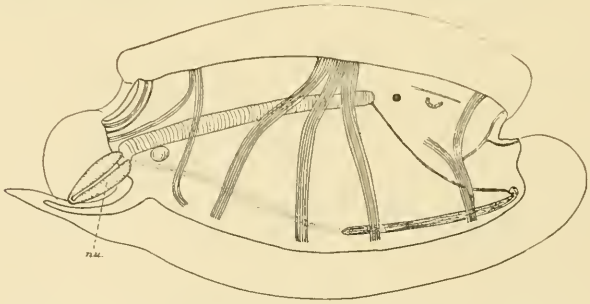


Fig. 19.—*S. democratica-mucronata,* aggregate generation.

(b) *Aggregate (sexual) generation.*—Fig. 19. Agreeing with solitary generation in general form, size, orifices, thickness and transparency of test, endostyle, gill, ganglion and hypophyseal organ, and nucleus. The pair of long posterior processes constantly present in the asexual generation, not present here, but a few processes into which the mantel extends are found on various parts of the body, but wholly irregular as to location. Body muscles four, first three confluent dorsally, but each interrupted ventrally; the fourth bending abruptly forward on the ventral side. A band as broad as the body bands at the branchial orifice, situated some distance back from the orifice itself, and continuous around the animal except for an interruption on the ventral side. Laterally on each side a branch given off from this band extending postero-dorsad; also a delicate muscle on each side extending from the band toward and around the extreme of the orifice; a pair of delicate longitudinal muscles in dorsal lip. Posteriorly, a delicate muscle given off from the fourth body band on the dorsal side, and extending to a variable extent backward and downward in the region of the atrial siphon. A number of delicate muscles belonging to atrial orifice. Ovary situated on right side, midway between fourth muscle band and nucleus.

In treating the muscles of this form I have followed the usual custom and enumerated four body muscles only. I strongly suspect, however, that in reality we have here six, as in the solitary form. On this view, the first muscle of the solitary form would be represented by the postero-lateral branches, fig. 19, of the sexual form; and the sixth of the solitary form would be represented by the delicate band given off from the fourth.

The species is, next to *fusiformis-runcinata*, the most abundant in the area. It has been taken during every month in the year in which plankton collecting has been systematically done, and in all probability is always present.

Salpa zonaria-cordiformis, Pall.-Quoy et Gaim.

Holothurium zonarium Pallas, 1774, Fasl. X, p. 26, Pl. 1, figs. 17, A, B, and C.
Salpa polycratica Forsk., 1775, p. 116, Pl. 36, fig. F.
Salpa zonaria Cham., 1819, p. 12, Pl. figs. 1A to G.
Salpa cordiformis Quoy et Gaim., 1827, p. 225, Pl. 8A, figs. 3-6.
Salpa cordiformis-zonaria Krohn, 1846, p. 112.
Salpa cordiformis-polycratica Vogt, 1854, p. 7.
Salpa cordiformis-zonaria Traustedt, 1884, p. 382, Pl. II, figs. 18, 19, 20, and 21.
Salpa cordiformis-zonaria Herdman, 1888, p. 70, Pl. VII, figs. 1-9.
Salpa cordiformis Brooks, 1893, p. 10 (particularly); Pl. III, figs. 2 and 3; Pl. IV, figs. 3, 5, 6; Pl. VIII, fig. 5.
Salpa zonaria Apstein, 1894, p. 19; 1901, p. III, 10, figs. 10a, 10b.

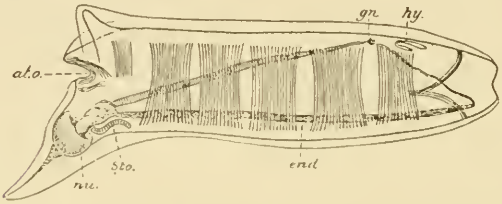


Fig. 20.—*S. cordiformis-zonaria*, solitary generation.

(a) *Solitary (budding) generation.*—Fig. 20. Body unusually firm and hard, probably more so than in any other species; form regular, of nearly uniform diameter throughout, though slightly larger at posterior end; somewhat quadrilateral, though this perhaps due to shrinkage, and may be characteristic of preserved animals only. Long axis almost perfectly straight. Wholly colorless except for light lemon yellow of nucleus. Maximum length of zooids so far obtained in our area, 35 mm., though a length of 60 mm. is recorded by other observers.

Anterior end strikingly truncate, the orifice being exactly terminal, the usual salpa lips scarcely suggested, and the lateral angles clear cut and almost exactly right angles. The somewhat larger posterior end produced into three ridged, sharp pointed processes, two of which are shorter and dorso-lateral in position, and the third, considerably longer, situated in the median ventral plane and directed somewhat ventrad as well as backward.

Body muscle bands six in number, exceedingly broad, all quite parallel with one another in the course around the body; all interrupted both dorsally and ventrally, and by about the same interval, excepting that the interruption of the sixth on the ventral side is much greater than that of any of the others. Two muscles, the one dorsal, the other ventral, probably representing lip muscles of other species, but rather remote from the branchial orifice, meeting in an acute backwardly directed angle on each side. A short, semi-lunar scrap of muscle on each side, close within the antero-lateral angles. The posterior orifice small, terminal in position, with rather distinct dorsal and ventral lips, each containing a delicate muscle.

Endostyle straight and slender, extending nearly the entire length of the body, but terminating posteriorly somewhat short of the nucleus. Gill likewise peculiarly long and slender, extending back of the nucleus, hence beyond the posterior end of the endostyle. Hypophysis simple, narrowly elliptical, projecting but slightly into the pharyngeal cavity, situated exactly in the sagittal plane. Ganglion rather small and eye spot scarcely pigmented. Nucleus small, situated very far back in the base of the posterior ventro-median process of the body. A pointed outpocketing of the mantel projecting behind the nucleus into the process of test. The stolon beginning far back and extending somewhat backward to wind around the nucleus from right to left.

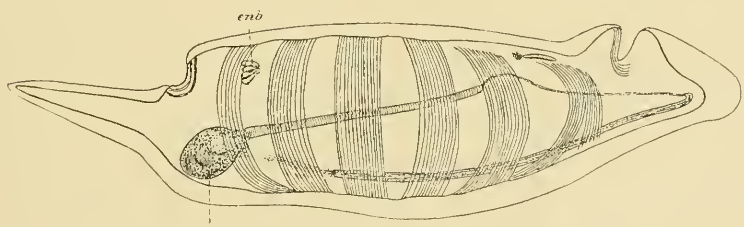


Fig. 21.—*S. zonaria-cordiformis*, aggregate generation.

(b) *Aggregate (sexual) generation.*—Fig. 21. Body firm, from the hardness of the comparatively thin test; irregularly cigar shaped in general outline. Branchial orifice fully on the dorsal side and looking directly upward, its two lips prominent and equal in size. Posterior end produced into a broad process of varying length, in some zooids it equaling half the length of the body, while in others it is much shorter, and in still others almost wholly wanting. In all the specimens that have come under my observation the posterior process, when present, is directed somewhat to the right, with the atrial orifice turned correspondingly to the left; but this is quite surely correlated with the position occupied by the zooid in the salpa chain, and in half the individuals the process is probably situated to the left, with the atrial orifice to the right. Atrial orifice opening somewhat upward, but less so than the branchial. Lips rather prominent here also.

Body muscle bands six, very broad and heavy. First and second interrupted dorsally, the first widely so, and all interrupted ventrally. First and sixth inclined strongly toward the middle of the body on both dorsal and ventral sides. A single muscle in the anterior dorsal lip, but none in the ventral. A few fibres entirely encircling the atrial orifice. First band bifurcates on each side. Sixth band bifurcates on right side (not shown in Fig. 21), but not on left, this being probably correlated with the fact that the post-body process is to the right side. (The asymmetry of this muscle in this species may be compared with that of the muscles of *Cyclosalpa bakeri.)*

Endostyle relatively short, rather stout, somewhat curved to correspond with the gentle convexity of the ventral surface of the zooid; extending from within the prominent extension of the body in front of the branchial orifice to the posterior edge of the fourth muscle band. Gill likewise rather short, the anterior end being in the interval between the second and third muscle bands, and the posterior end at the nucleus on a level with the anterior edge of the sixth band. Hypophysis a considerable distance in front of the anterior end of the gill, narrowly elliptical, projecting but slightly into the pharyngeal cavity. Ganglion situated at the immediate posterior end of the hypophysis.

Nucleus small, ovoid, far back, not projecting from the general surface of the body. Embryos four, situated dorso-laterally in the interval between the fifth and sixth muscle bands.

This is, from its rigidity and angularity, one of the best defined species of Salpa in our fauna. Though not abundant, it cannot be said to be very rare, since it has been taken at least eight times during the last three years, in no instance, however, in any quantity.

Salpa cylindrica Cuvier.

Salpa cylindrica Cuvier, 1817, p. 22, figs. 8 and 9. (Solitary generation.)
Salpa cylindrica Sav. 1816, p. 124, Pl. XXIV, figs. 2_1, 2_2, 2_3. (*Iasis cylindrica* in description of figures.)
Salpa cylindrica Traustedt, 1884, p. 377, Pl. II, figs. 35, 36, 37.
Salpa cylindrica Herdman, 1888, p. 72, Pl. VII, fig. 10.
Salpa cylindrica Brooks, 1893, Pl. III, figs. 5, 6, 7; Pl.VIII, fig. 2.
Salpa cylindrica Apstein, 1894, p. 16.

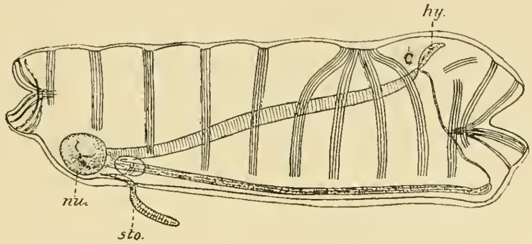


Fig. 22.—*S. cylindrica*, solitary generation.

(a) *Solitary (budding) generation.*—Fig. 22. Body nearly uniform in diameter from end to end, the anterior end slightly larger; long axis quite straight; both orifices terminal. Test for the most part thin and soft, though in some zooids a pair of rather prominent flanges with finely serrated edges situated dorso-laterally at the posterior end. Largest zooid seen, 23 mm. long. Lips of anterior orifice of equal size.

Body muscle bands nine, all interrupted ventrally and uninterrupted dorsally, first four confluent dorsally. All the bands rather broad and heavy. Two narrower bands in dorsal anterior lip and two in ventral; a segment of a circular band behind the angle of the anterior orifice, and a pair of short, longitudinal-oblique bands in the dorsal lip. Several delicate bands in each lip of the posterior orifice, the dorsal and ventral groups coming together on each side in an acute angle. Endostyle nearly straight, extending the entire length of the body; rather slender. Gill likewise unusually long and slender. Hypophysis long, elliptical, situated at the immediate anterior end of the gill. Ganglion with the specially conspicuous eye spot situated a little nearer the hypophysis than the level of the first body muscle band. Nucleus small, spherical, situated a little short of the posterior end of the body, at the angle formed by the junction of endostyle and gill.

Stolon with salpa chain when well developed reaching along the entire ventral side of the zooid, parallel with the endostyle. (In the specimen from which Fig. 22 was drawn the salpa chain was but slightly developed, and hence did not yet present the condition described.)

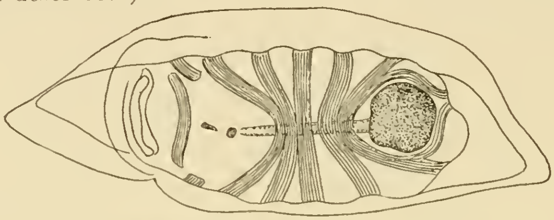


Fig. 22′.—*S. cylindrica,* aggregate generation (after Brooks).

(b) *Aggregate (sexual) generation.*—Fig. 22′, copied from Brooks. Having seen no specimen of this generation, I give a translation of Traustedt's Latin diagnosis: "Body ovate; extremities terminating in conical, scarcely elongate appendages. Apertures dorsal. Body muscles five, all interrupted on ventral side; three anterior and two posterior confluent in median dorsal line; all interrupted ventrally."

This is one of the rarer forms of salpa of the California coast. I find but four lots of it in all the collections that have been made during the last fifteen years, by both the Albatross and the University. Two of these were by the Albatross, one in January, 1889, the other in April, 1904. The other lots, collected by the San Diego station, were taken in July, one of 1903, the other of 1904. All were from the coast of southern California. Curiously enough, all the specimens so far seen, with one doubtful exception, were of the solitary generation.

Salpa confoederata-scutigera Forsk.-Cuvier.

Salpa confoederata Forsk., 1775, p. 115, Pl. 36, fig. A.
Salpa scutigera Cuvier, 1817, p. 18, figs. 4 and 5.
Salpa octofora (?)[1] Cuvier, 1817, p. 20, fig. 7.

[1] While I follow Traustedt in regarding *S. octofora* of Cuvier to belong to the present species, the figure and positive statement of Cuvier as to the elliptical shape of *octofora* make it not improbable that a rather distinct *octofora* variety does exist.

Salpa (Pegea) octofora, Sav., 1816, p. 124, Pl. 24, fig. 1.1 and 1.2.
Salpa ferruginea, Cham., 1819, p. 23, figs. 10A-D.
Salpa scutigera-confoederata Vogt, 1854, p. 6.
Salpa scutigera-confoederata Traustedt, 1885, p. 362, Pl. II, figs. 23, 24.
Salpa scutigera-confoederata Herdman, 1888, p. 84, Pl. IX, fig. 9.
Pegea confoederata Lahille, 1890, p. 12, text, figs. 1, 2, 3A, 3B.
Salpa scutigera Brooks, 1893, pp. 6-16, anatomy; Pl. IV, figs. 1-7.
Salpa confoederata Apstein, 1894, p. 12, Pl. II, fig. 16.

(a) *Solitary (asexual) generation.*—As I have seen but a single small specimen of this generation, I neither figure it nor give a diagnosis of it. But these may be the less disadvantageously omitted from the the fact that the two generations are so very similar. The chief differences between them are that the general body form is relatively shorter and more rotund in the solitary generation, and that the atrial siphon projects farther backward from the level of the nucleus in the solitary than in the aggregate generation.

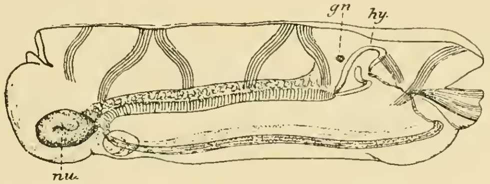


Fig. 23.—*S. confoederata-scutigera*, aggregate generation.

(b) *Aggregate (sexual) generation.*—Fig. 23. Aggregations remaining intact at least until zooids are 25 mm. long, but at this stage falling apart with great ease. Body cylindrical, straight, and regular, the regularity broken only by a slight constriction behind the branchial orifice, by a pair of low, lateral prominences in this constriction; and a pair of low, broader, blunter lateral test tubercles at the posterior end, into which a double outpocketing of the mantle on each side projects. Test rather delicate, without specially thickened areas, transparent, the iron rust colored pigment characteristic of the species being mostly confined to the mantle.

Branchial orifice terminal, lips not very prominent; atrial orifice but little smaller than branchial, directed slightly upward, with well defined lips. Largest zooids, 70 mm. long. A brick red or iron rusty pigment widely present in the mantle, but most pronounced at two ends, and more abundant posteriorly than anteriorly.

Body muscles four, all confined to the dorsal half, the first two bent toward each other and nearly touching in the mid-dorsal line; the last two likewise similarly inclined, sometimes connected by a short ridge in the mid-dorsal line, and sometimes not in contact. A single band in the dorsal lip and two in the ventral. A pair of angular bands on the dorsal side behind the branchial orifice, the apices directed backward, and the dorsal limb of each reaching well into the dorsal lip to serve as a retractor of it. (Dorsal limb unfortunately omitted in Fig. 23.) A short oblique band on each side, near tangential with the apex of these angles. A single band in each of the posterior lips, nearly as strong as the body muscles. Endostyle slender, straight except for a distinct ventral curvature just short of the posterior end, the posterior termination separated from the nucleus by the length of the pericardium. Gill relatively rather short, beginning but little in front of the first body muscle, which is unusually far back, and not reaching to the nucleus posteriorly. Hypophysis large, irregularly triangular, placed vertically, the opening anterior, suspended as a prominent tubercle immediately at the anterior end of the gill, and ventrad of the ganglion, the hypophysis and ganglion being consequently in unusually close relation. Nucleus subglobular, small, slightly compressed dorso-ventrally, projecting but slightly, if at all, from the general ventral surface of the animal, but extending backward fully even with the posterior extremity of the atrial siphon, its color nearly uniform seal brown.

The aggregate generation is not rare in the area, but not a single zooid of the solitary generation has thus far been observed. The species has been taken on the California coast from Monterey Bay southward, and in the months of January, February, March, May, June, July, and August.

Fam. II.—Doliolidae Bronn, 1862.

Thaliacea in which the body form is typically and perfectly that of a barrel; the body muscle bands are complete rings; and the branchial apparatus consists of a membranous partition between the pharyngeal and atrial ends of the animal, pierced by pairs, never very numerous, of stigmata. Both branchial and atrial orifices terminal and at opposite ends; both encircled by lobes; those of the branchial orifice always more prominent. Branchial tentacles and dorsal lamina wanting. Intestinal tract small but never nucleaform; situated on ventral side of body, immediately behind the branchial membrane. Hermaphroditic, the gonads of both sexes always simple; ovary never producing a large number of ova.

In addition to the sexual method of reproduction, in which a larval stage of the typical tunicate tadpole is passed through, a process of gemmation prevails in which three polymorphic generations occur.

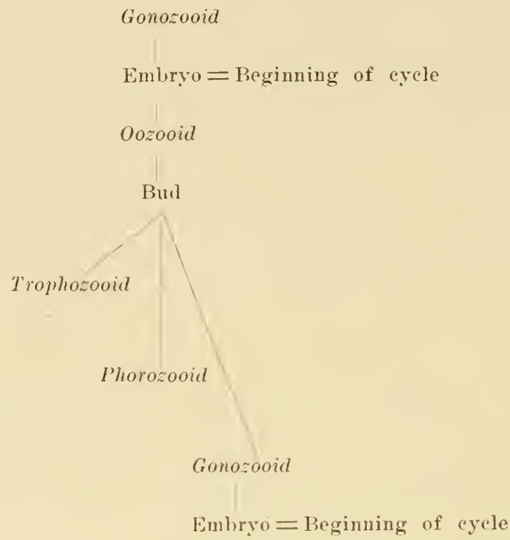
Genus **Doliolum** Quoy et Gaimard, 1835.

With characters of the family. (The genera *Anchinia* and *Dolchinia* not occurring, so far as known, in our area, are not taken into account in the diagnoses.)

Three species, namely, *D. tritonis, D. ehrenbergii* and *D. mülleri*, are here recognized as belonging to our fauna. Whether certain forms of doubtful status, not now treated, belong to one or another of these species, more extended observation in the future must determine.

Owing to the fact that zooids of the generations produced by budding, far advanced in development, rarely reach the hands of the student still attached either to their parent or to one another, the difficulty of arriving at unquestionable conclusions as to how the various forms of the different species go together is great. As to the old "nurses," *i.e.*, oozooids in which the internal organs have wholly disappeared through degeneration, and the muscle bands have become greatly broadened, we are not yet in a position to specify with absolute certainty the specific characters of this form in a single species of the genus. My diagnoses of this generation in each species relates almost wholly to the young zooids before the degradation of the organs has begun.

The relations of the several generations in the life cycle, as now understood, may be indicated by the following scheme, made without regard to theoretical views as to the exact nature of the relationships:



A great variety of nomenclature has been employed by different writers to designate the several generations of *Doliolum*. That here used, though not without objections, appears to me to be the best of any yet proposed. It is in the main from Herdman, 1888 and 1904.

The chief synonyms found in the literature of the subject are as follows:

Gonozooid (Herdman); sexual animal (Krohn, Grobben, Uljanin); sexual generation A (Keferstein und Ehlers).

Ooozooid (Herdman); asexual animal (Krohn, Gegenbaur); generation B (Keferstein und Ehlers); first nurse generation (Grobben); nurse (Uljanin); blastozooid (Herdman, '88).

Trophozooid (Herdman); lateral buds, generation C^1 (Keferstein und Ehlers); lateral buds (Grobben); nutritive animals (Fol. Uljanin).

Phorozooids (Herdman); median buds (Krohn, Gegenbaur, Grobben); generation C^m (Keferstein und Ehlers); foster-animals (Uljanin).

Doliolum tritonis Herdman.

Doliolum denticulatum Herdman, 1883, p. 101, Pls. 18, 19, and 20.
Doliolum tritonis Herdman, 1888, p. 47, Pl. 3, fig. 3.
Doliolum tritonis Traustedt, 1893, p. 4, Pl. I, fig. 10.
Doliolum tritonis Borgert, 1894, p. 19, Pl. 5, figs. 17 and 18.
Doliolum tritonis Borgert, 1901, p. III 3, fig. 3.

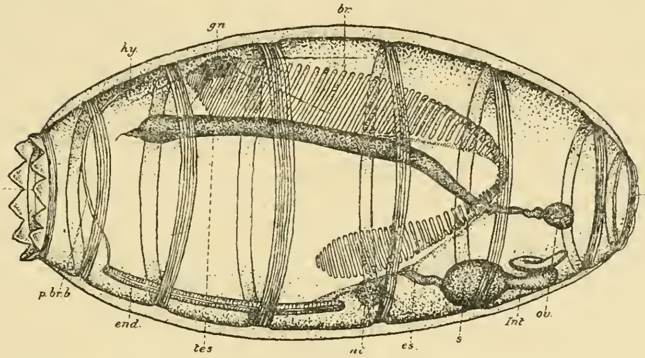


Fig. 24.—*Doliolum tritonis*, gonozooid.

(a) *Gonozooid.*—Fig. 24. Length, 15 mm., 12 mm., 12 mm., 13 mm., 14 mm.; form very regular; test always very thin, and general consistency delicate. Lobes of branchial orifice prominent, rounded, somewhat broader than high, apparently always twelve; those of atrial orifice much less pronounced, usually two. Muscle bands eight, first and eighth considerably smaller, all excepting these two with a narrow line running lengthwise along the middle. Atrial orifice with ten very low, broad lobes, also rounded. Endostyle rather slender, extending from the middle of the second intermuscular space to a little beyond the middle of the fourth space; anterior end pinkish yellow in many specimens. Ganglion in the third intermuscular space, beyond the third muscle band about the width of the band. Hypophyseal duct long and slender, the mouth, which is rather small, situated a little in front of the middle of the second intermuscular space. Peripharyngeal band trending forward from the endostyle on each side in a broad curve which reaches in front of the second muscle band, then running backward again on the dorsal side of the right limb, passing into a broad open spiral behind the hypophyseal mouth. Dorsal limb of the branchial series beginning on a level with the ganglion a little behind the third muscle band, and extending back to a little behind the sixth band. Ventral limb beginning slightly behind the fourth band. About seventy long stigmata on each side in the dorsal limb in the largest individuals, and about fifty in the ventral limb, but the number apparently varying with size and age. Esophageal mouth much nearer the ventral than the dorsal side of the posterior pharyngeal wall, rather large, broad elliptical, its anterior edge on a level with the fifth muscle band. Stomach large, irregularly globose, in the fifth intermuscular space, its posterior end on a level with the sixth muscle band. Intestine compressed dorso-ventrally, in the form of a broad spiral of a little more than one turn, the axis of the spiral directed dorso-ventrad. Anus in the posterior half of the sixth intermuscular space. Stomach and the pyloric enlargement of the intestine brick red in many specimens, but apparently not in all. Ovary latero-ventral, immediately in front of seventh muscle band. Testis long, irregularly cylindrical, situated on the left side; posterior end near the ovary, anterior end on left side, usually in fully developed state slightly behind the second muscle band, but the termination variable in position. Anterior end frequently, though not always, with pronounced hook.

(b) *Oozooid.*—(See Figs. 27, 28, and 29 of *D. ehrenbergii* and *mülleri*, this generation, which have the essential features of the present species.) Body of the usual doliolum form; muscle bands nine, first and ninth relatively very narrow, seventh band alone interrupted and extending into dorsal process. Lobes of branchial orifice prominent, usually ten in number, occasionally eleven or twelve; atrial lobes very low or wholly wanting. Stigmata eight? (surely not more), in four pairs. Endostyle, peripharyngeal band and hypophysis as in gonozooid and phorozooid. Ganglion situated in fourth intermuscular space; otocyst large, on left side in third intermuscular space at anterior edge of third muscle band.

Proliferous stolon on ventral side in fifth intermuscular space; dorsal process varying from short conical in small zooids to long and slender in large ones. Intestinal tract similar to that of gonozooid, excepting that the intestine proper is, as compared with the other parts of the tract, much shorter and forms less of a spiral, the length of the loop of the intestine being scarcely greater than that of the esophagus. Degeneration of the internal organs, with the simultaneous increase in width of the muscle bands apparently beginning considerably earlier in this than in either of the other species—*D. mülleri* and *D. ehrenbergii*, with which it occurs in this region. Old individuals (of this species, probably) reaching a length of 25 mm., with thickness of 7 mm., while length of individuals just before beginning of degeneration of internal organs, 1.38 mm.

While the evidence that the oozooid here described belongs to *tritonis* is not complete, it is sufficient to admit of little doubt; indeed, there is with this, as with other species here treated, an element of uncertainty about the assignment of the oozooids to their proper species, since in no one of them have I seen the origin either of the embryo from the egg, or the production of the phoro- and gonozooids by the oozooid. My chief reliance for the identification has been the intestinal tract. Those oozooids with a tract entirely similar to that of the gonozooid of *D. ehrenbergii* I assume to belong to this latter species. Similarly, those in which the organ is the same as that in *D. mülleri*, it is assumed belong to that species. Now it is true, as indicated in the diagnosis, that although the intestinal tract of the animal at present under notice differs somewhat from that in the gono- and phorozooid of *tritonis*, nevertheless its resemblance to the tract of *tritonis* being closer than it is to that of either *ehrenbergii* or *mülleri*, the only other species thus far found in this area, the conclusion that the animals belongs to *tritonis* seems justified.

Another point that, on the whole, speaks for the same conclusion is the character of the lobes of the atrial orifice. These are so low in both the gono- and phoro- zooids of *tritonis* as to render them scarcely recognizable. This is likewise true of the oozooid now being considered. In fact, only in an occasional specimen have I been able to see anything at all like lobes. True, the atrial lobes are considerably less easily seen in all the species with which I am familiar than are the branchial; but in the present zooid their conspicuousness is less than in the corresponding zooids of any other species. Another consideration that I believe points in the same direction is the great size of an oozooid constantly occurring in our area, which is probably the senescent stage of this generation of *tritonis*. Many of these specimens reach a length of 125 mm., or even more, and a thickness of 7 mm. This is near the maximum size recorded for any *Doliolum*. When it is recalled that the gono- and phoro- zooids of *tritonis* are likewise the largest for these generations, of any species, the reasonableness of the supposition that this large nurse belongs to *tritonis* is apparent. It must be said, however, that this line of consideration really has less weight than it might seem to have, since we are entirely without information as to the size that may be attained by the oozooids of any of the species. Uljanin, '84, has recorded the occurrence in the Mediterranean of a nurse measuring 30 mm. in length, and this he assumes belongs to *D. ehrenbergii*. The identification is, however, by no means certain. As a matter of fact, in the present state of knowledge, I do not believe it possible to assign with certainty any oozooid, after the degeneration of its organs is complete, to its species; and since the degeneration is complete at an early time in all the species, so far as known, the difficulty of disposing of these old nurses is obvious.

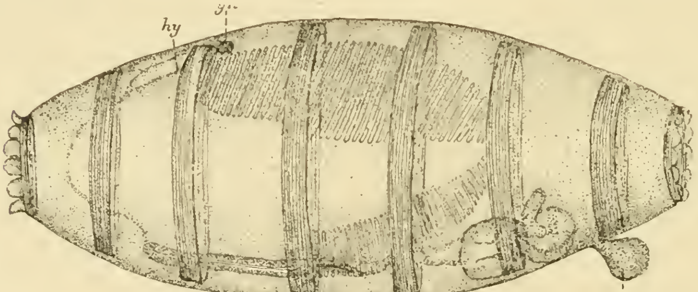


Fig. 25.—*D. tritonis*, Phorozooid.

(c) *Phorozooid.*—Fig 25. This differs in no particular from the sexual generation except in the absence of the sexual glands and the presence of the ventral process. This latter is short and thick, is situated in the median ventral line in the sixth intermuscular space a little in front of the seventh muscle band. The following lengths of the zooids are typical: 12 mm., 11 mm., 11 mm., 11.5 mm., 12.5 mm., 13 mm. The gonozooids and phorozooids have been taken together in great numbers off San Diego, particularly in May and June. The following table shows the number of each generation in lots taken at random from collections made in May, June, and July, 1904.

Phorzooid.	Gonozooid.	Phorzooid.	Gonozooid.
2	35	7	40
3	35	4	31
3	42	5	37
2	33	10	90
5	35	7	35
6	30	17	83
9	38		

In view of the constant great preponderance in individuals of the sexual generation here, and the entire absence of any other than the sexual generation in the vast quantities of specimens taken by the "Triton" in the north Atlantic, it would seem that this generation is normally more abundant in individuals than is the phorozooid generation. Borgert, 1894, reports both generations from the Plankton Expedition, but gives no information as to the relative numbers of each.

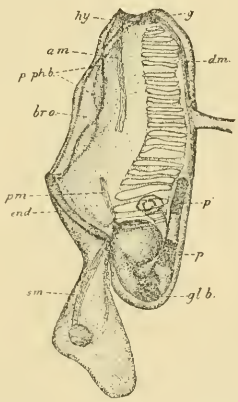


Fig. 26.—*D. tritonis*, Trophozooid.

(d) *Trophozooid.*—Fig. 26. General form, the peduncle disregarded, that of a truncated cone with an oblique base; intestinal tract extending prominently behind the level of the endostyle. A maximum, so far as known, of 25 pairs of branchial stigmata. Peduncle very broad at distal end and narrowing toward the body of the zooid; length of largest specimens seen, 3 mm.; 2 mm. broad in broadest part. Endostyle forming considerably less than a right angle with the main axis of the body. A single short, blunt test process on the anterior half of the dorsal edge of the body.

The above are the characters which seem to distinguish this from any hitherto described trophozooid. I am unable to find lobes about the branchial orifice, but, owing to the slight development of these in other species, and to the fact that I have had only preserved specimens to examine, and but few of these, I assume that they are present but escape observation.

Although no mantle muscles are present that are not found in some, at any rate, of the other described species, they all would appear to be particularly well developed here. This is especially true of the anterior, *a.m.*, and posterior, *p.m.* prebranchial bands. The sharply cut-off ending of these muscles is deserving of notice. The dorsal muscle, *d.m.*, extends back to about the middle of the length of the body and terminates, not in a sharp cut-off, but in a point by a gradual running out. The stalk, or peduncle muscle, is also well developed. The ganglion, *g.*, and hypophysis, *hy.*, need no special comment for the present purpose. The peripharyngeal band, *p.ph.b.*, is very close to the branchial orifice, and, from the great size of the orifice, is very long. At the great bend of the intestine there occurs a patch on the intestinal wall, made up of round bodies, probably large cells, *gl.b.* These are presumably glandular, though they may be excretory. Two other well defined patches, of different structure, however, from the one just described, occur on the rectal portion of the intestine, *p.* and *p′*. The nature of these is unknown. Many points in the structure, and particularly the physiology, of this generation of *Doliolum* are in urgent need of further study.

The only specimens of fully grown trophozooids detached from their nurse thus far taken in our area were the ones here described. They were secured by Professor H. B. Torrey at San Clemente on June 9, 1896. A piece of dorsal process 8 or 10 cm. long, bearing the trophozooids, was secured. The evidence, therefore, that it belongs to *D. tritonis* is not direct. I infer that it does from the following considerations: It clearly does not belong to *ehrenbergii* or *mülleri*, as comparison with published descriptions of the trophozooids of these species shows. *D. tritonis* being the only other species known to occur in the area, and at the same time the most abundant of all the species, would be the one to which it would seem most likely to belong. The large size of the zooids and the length of the dorsal process, as intimated by the fragment secured, tends to support the same conclusion.

D. tritonis is the most abundant, as it is the largest, species in the area. The gono- and phoro- zooids were taken in great abundance at San Diego in May and June of 1904. The giant oozooids, which I have supposed to belong to this species, occurred in particularly large numbers at Avalon in July, 1901. The gonozooids and oozooids have also been taken, though in less quantity, in March, October, and November.

Doliolum Ehrenbergii Uljanin (not Krohn).

Doliolum Gegenbauer, 1856, Pl. XVI, figs. 12 (?) and 13 (?), and fig. 15.

Doliolum Gen. 2B and 4B, Keferstein und Ehlers, 1861, p. 68, Pl. IX, figs. 5 and 7; and Pl. X, fig. 4.

Doliolum denticulatum Grobben, 1882, pp. 23-41, Pl.1, figs. 3, 4, and 5; Pl. 2, figs. 7 and 8.

Doliolum ehrenbergii Uljanin, 1884, pp. 132-133, Pl. 5, figs. 1 and 3; Pl. 12, fig. 8. (Numerous other figures are assigned to *ehrenbergii*, but I here refer to only those that undoubtedly represent the species as here understood.)

Doliolum ehrenbergii Herdman, 1886, p. 46, Pl. III, figs. 5 and 7.

Doliolum ehrenbergii Lahille, 1890, p. 65, figs. 47, 48, 49, and 50.

(a) *Gonozooid*. Unknown.

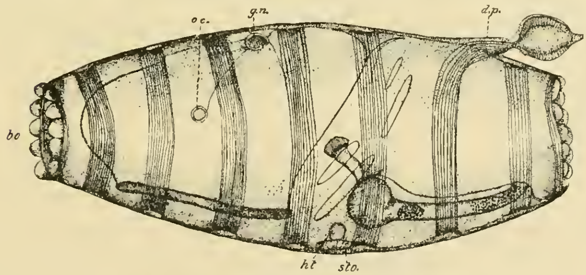


Fig. 27.—*D. ehrenbergii*, oozooid, before loss of internal organs.

(b) *Oozooid.*—Fig. 27. Length from .925 mm. to 2.77 mm., between disappearance of larval characters and beginning of degeneration of intestinal tract. Form variable, from strongly bulged in middle region to relatively narrow here. Muscle bands nine, first and ninth so much smaller than the others, both as to size of muscle and diameter of ring, and so near the adjacent muscle as to be easily overlooked. Branchial orifice with from eight to ten moderate lobes of unequal size; atrial with usually twelve lobes. Endostyle rather thick, extending from near the second muscle to the fifth. Stigmata eight, large, in two sets of two pairs each, one set dorsad of esophageal mouth, the other ventrad; dorsal stigmata between sixth and seventh bands, ventral opposite fifth. Esophageal mouth large, with thick lips; situated near center of posterior end of the pharynx, in the space between the fifth and sixth muscle bands. Stomach globular, situated under and extending in front of the sixth muscle band. Intestine rather long, extending back nearly to eighth muscle; slightly curved, the convex side turned ventrad. Ganglion large, between fourth and fifth muscles; hypophyseal duct running forward, its mouth between third and fourth muscles. Otolith sac on left dorsal side in third intermuscular space. Dorsal process before beginning of degeneration of internal organs generally short, with a constriction which sets off a top-shaped terminal portion. Proliferous stolon, without distinctive features so far as examined.

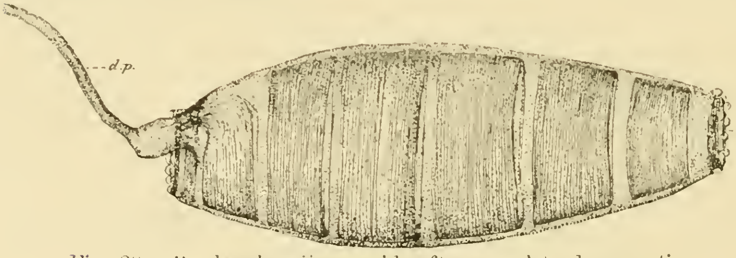


Fig. 28.—*D. ehrenbergii*, oozooid, after complete degeneration of internal organs.

The degeneration of the viscera appears to be inaugurated relatively considerably later in this oozooid than in that of *tritonis* and *mülleri*, and this accounts for the fact that while *tritonis* oozooids are much more abundant than those of the present species, one finds fewer by considerable of them with the organs still intact than he does of the *gegenbaurii* zooids in the same condition. The following table shows the length of the animal and the width of the muscle bands, and the state of the viscera, in seven specimens observed at the San Diego laboratory in June, 1904:

No.	Lengh of Zooid.	Width of Muscle.	Condition of Intestine.
1	2.22 mm.	.20 mm.	organs intact
2	2.59 mm.	.18 mm.	organs far degenerated
3	2.60 mm.	.129 mm.	organs intact
4	2.77 mm.	.148 mm.	organs intact
5	3.33 mm.	.27 mm.	organs nearly gone
6	4.25 mm.	.37 mm.	organs wholly gone
7	5.00 mm.	.55 mm.	organs wholly gone

While, owing to the difficulty in getting accurate measurements, and of expressing in precise terms the stage of degeneration of the organs, and probably, more than all, to individual variation, such data as this are not very significant, they show in a general way what is undoubtedly true; *viz.*, that the degeneration begins relatively late here, and then, that the increase in size of the zooid and width of the muscle bands go on pari passu with the rather gradual degeneration and resorption of the internal parts.

A few remarks must be made concerning my position with reference to the status of *D. ehrenbergii* and the representatives of the four generations assigned to it. First, in regard to the name. I agree with the proposal of Borgert, '94, and the practice of Lahille, '90, that if such a species as *ehrenbergii* is to be recognized at all, it should be Uljanin's, and not Krohn's. Krohn, '56, proposed this specific name for what he regarded as Quoy et Gainard's *D. denticulatum*, on the wholly arbitrary and unpermissable ground that Quoy et Gainard's name was "unpassend," since other species as well as this are denticulated about the branchial orifice. Since no author, so far as I am aware, between Krohn and Uljanin applied the name *gegenbaurii* either to *D. denticulatum* or to any form supposed to belong to this species, the real question is, Do all the forms assumed by Uljanin to belong to *D. denticulatum*, and hence called by him *gegenbaurii*, actually belong to one species, or was he in reality dealing with generations representing two species, one of which was *denticulatum* and the other an undescribed, or at least an unnamed species? I agree with Borgert that the latter is the case. Since, consequently, *D. gegenbaurii* Uljanin is only in part a synonym, the canon of nomenclature, "once a synonym, always a synonym," does not apply, and the name may stand for the unnamed forms with which Uljanin was dealing. That this unnamed oozooid which he had was the same as the "*Doliolum sp.*" of Gebenbaur, '56, and shown in his Pl. XVI, fig. 15, I have little doubt. I am strongly of the opinion, too, that "Gen. 2B and 4B" of Keferstein und Ehlers, and shown in their Pl. IX, figs. 5 and 7, and Pl. X, fig. 4, likewise belong to the same species, as do also Grobben's *D. denticulatum*, shown in his Pl. I, figs. 3 and 4, particularly, and pretty certainly also in fig. 5. As to his fig. 7, Pl. II, I am in considerable doubt.

The species is by no means uncommon off San Diego during the summer months, though it has not been taken in "swarms," as has *D. tritonis*. So far it has not been taken in the fall and winter months, unless some of the few old oozooids at present in doubt as to species belong here.

(c) *Phorozooid*. Probably similar to the gonozooid, with the exception of the absence of sexual organs and presence of the ventral process, but it is doubtful if fully developed specimens of this generation are known.

(d) *Trophozooid*. Not known with certainty in the fully grown state, but probably shown by Grobben, '82, as he himself believed, in his Pl. II, fig. 8. As I have not seen specimens of this generation except as very young buds still attached to the dorsal process of the oozooid, I do not give a diagnosis and figure of it, but refer to the above mentioned figure by Grobben, assigned by him to *D. denticulatum*. The form described and figured by this author apparently differs from the trophozooid assigned by me to *D. tritonis*, fig 26, in the following particulars: It is somewhat broader in proportion to its length, particularly at the anterior end; it has a somewhat less number of branchial stigmata, the maximum reported for it being eighteen (Gegenbauer, '56), while the *tritonis* zooid has at least twenty-three; it has test processes at the posterior end as well as at the anterior, where alone, so far as we know, one is present in *tritonis;* and these processes are more filiform than in *tritonis*.

Doliolum mülleri Krohn.

D. mülleri Krohn, 1852, p. 58, Pl. II, fig. 4.
D. nordmanni Krohn, 1852, p. 59, Pl. II, fig. 6.
Doliolum sp. Gegenbauer, 1856, Pl. XV, fig. 8.
Doliolum Gen. 3B, Keferstein und Ehlers, 1861, p. 68, Pl. X, fig. 3.
Doliolum mülleri Grobben, 1882, pp. 55-65, Pl. II, figs. 9 and 10; Pl. III, figs. 14, 15, 16, 17, and 18; Pl. IV, figs. 21 and 22.
Doliolum mülleri Uljanin, 1884, pp. 127-130, many figures of anatomical and developmental detail, and in addition the following of special importance for identification: Pl. 4, figs. 1, 3, 4, and 5, larvæ; Pl. 7, fig. 11; Pl. 8, fig. 10; Pl. 9, fig. 6; Pl. 11, fig. 9; Pl. 12, figs. 2, 3, and 4.

This is the least common of the three species of *Doliolum* thus far observed in our area. Hardly more than a dozen specimens all told have been taken. These have all been oozooids, and as only a portion of them were still in possession of their internal organs, my material for study has been scant. Since, however, the other generations are sure to turn up some time, as collecting goes on, I give the diagnosis of all the generations, relying on Uljanin, the most recent writer, chiefly, for all the generations except the oozooid, this being made mainly from my own observations.

(a) Gonozooid.—Length about 3.5 mm., sometimes reaching 4 mm.; mantel soft and sticky, in consequence of which surface is always covered with foreign particles; muscle bands extremely small; gill membrane extending from above opposite the fifth muscle band downward and forward into fourth intermuscular space; pierced by from ten to twelve branchial stigmata. Endostyle extending from slightly in front of third muscle band to a little in front of the fifth band. Intestinal tract U-shaped, esophageal opening near the center of the branchial membrane, the entire loop being situated in the fifth intermuscular space. Testes pear-shaped, in fully developed state thrusting out the body wall into a hillock; situated alongside the intestinal tract. Ovary close behind the testes, containing but very few ova; ova maturing earlier than the sperm.

Color markings: Intestine violet or rose; orange red pigment spots on the edge of both branchial and atrial orifices.

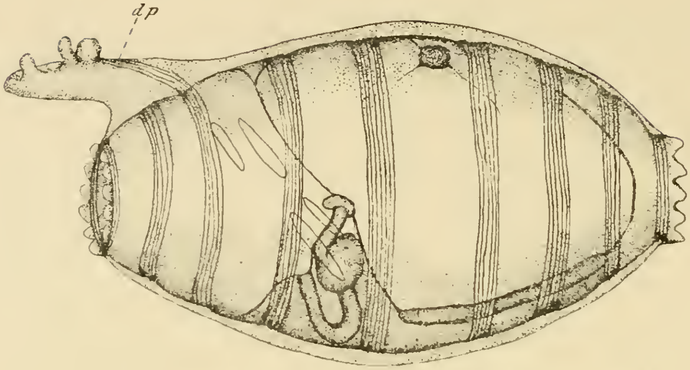


Fig. 29.—*D. mülleri*, oozooid, before degeneration of internal organs.

(b) *Oozooid.* Fig. 29. Maximum length before beginning of degeneration of intestine, something less than 2 mm.; test relatively thick and soft; muscle bands nine, without distinctive characters as compared with same generation of other species. Branchial orifice with normally ten lobes; atrial with twelve, the former distinctly more prominent. Branchial membrane with its stigmata, endostyle, peripharyngeal band, ganglion, hypophysis, and otocyst differing in no easily recognizable way from the corresponding parts in *D. ehrenbergii*. Intestinal tract U-shaped, esophageal mouth very near the center of the branchial membrane, whole tract in fifth intermuscular space.

Dorsal process short and thick, with but few buds, sometimes having a pronounced kink near the base, but never, so far as observed, with the top-shaped terminal piece characteristic of *D. ehrenbergii*.

In this, as in the other species, little of positiveness is known about the old "nurses." Several times catches containing oozooids with internal organs intact have also contained several scenescent specimens of medium size and having the form of the old-style, bell-mouthed cannon shown by Keferstein und Ehlers, "Gen. 1B," Pl. X, fig. 1. These I suspect belong to the present species. I do not imagine this peculiar form to be wholly distinctive. It is probably due to contraction; but it certainly does not occur frequently in old nurses of what I suppose to be *tritonis and ehrenbergii.*

(c) *Phorozooid.*—Entirely similar to gonozooid except for absence of gonads and presence of ventral process which is relatively long and cylindrical.

(d) *Trophozooid*—Small, but long in proportion to breadth, and with a relatively long peduncle.

As already said, *D. mülleri* is the least abundant of our species. Thus far it has been taken in mid-summer only, off San Diego.

Order II.—ASCIDIACEA de Blainville, 1827.

Pelagic or sedentary urochorda, with proportionally very large branchial sac having many stigmata. Branchial and atrial openings not at opposite ends of body, except in *Pyrosoma*. Test in most cases large in quantity and forming a common matrix in which the zooids are embedded in most colonial forms. A free swimming larval or "tadpole" stage in the life career of nearly all species, this undergoing a profound metamorphosis to give rise to the adult. An asexual reproduction by budding in many, but no true alteration of generations or polymorphism, as in the Thaliacea.

Fam. Pyrosomidae T. Rupert Jones, 1848.

Pelagic colonial Ascidiacea, with the colony in the form of a hollow cylinder closed at one end. Zooids embedded in the thick test constituting the greater part of the wall of the cylinder, and so arranged that the branchial orifice opens on the external surface of the cylinder, while the atrial orifice opens into its interior; branchial and atrial orifices consequently at opposite ends of the zooid. Branchial sac very large, the stigmata placed perpendicularly to the endostyle, each extending from the endostyle to near the mid-dorsal line. No peribranchial chamber present, the atrial orifices opening directly into the great common cloaca, which constitutes the hollow of the cylinder of the colony, as above indicated. Embryo arising from the egg, known as the "cyathozooid," giving origin, by a peculiar process of transverse fission, to the first four blastozooids, from which as the starting point the remainder of the colony arises by typical ascidian budding. Species all, so far as known, highly phosphorescent.

Genus **Pyrosoma** Peron.

But one genus in the family, hence generic characters same as those of the family.

Pyrosoma Peron, 1804, p. 437, Pl. 72, and all succeeding writers.

Pryosoma giganteum Lesueur. Fig. 30.

P. giganteum Lesueur, 1815, p. 70, Pl. I, figs. 1-15.
P. giganteum Savigny, 1816, p. 207, Pl. IV, fig. 7, and Pls. XXII and XXIII, many figures.
P. giganteum Keferstein und Ehlers, 1861, pp. 72-77, Pl. XII, figs. 4, 5, 7, and 8.
P. giganteum Panceri, 1872, pp. 1-25, Pls. I and II.
P. giganteum Herdman, 1888, pp. 26-29, Pl. I, figs. 4-21.
P. giganteum Seeliger, 1895, pp. 61-62, Pls. I and II; Pl. IV, figs. 3 and 4. Fig. 30.

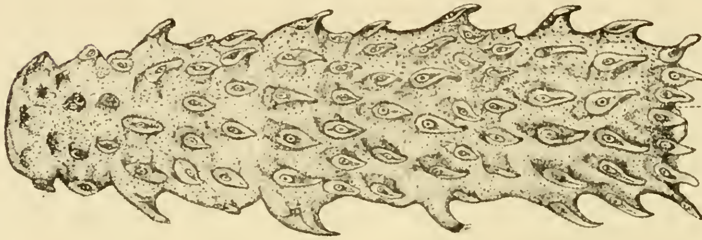


Fig. 30.—*Pyrosoma giganteum* colony, 4.5 cm. long.

Colony cylindrical, or narrowing slightly toward the closed end; quite rigid from the firmness of the test; surface bearing prominent test processes, these varying much in number, size and form, but on the whole inclined somewhat toward the open end of the colony, the atrial orifices of the zooids corresponding to the processes being on the more convex side of the processes. The processes, as a rule, with an oblique, more or less distinct plane, with finely serrate edges at their summits. A velum or diaphragm of test shutting off to a variable extent the opening of the colony. Measurements of three largest preserved colonies: first, length 25 cm., greatest thickness near open end 2.5 cm.; second, length 25 cm., greatest thickness 3.5 cm.; third, length 19 cm., greatest thickness about middle of length, 3 cm.; largest colonies observed, measured in life, 60 cm. long, 40 cm. long, and 35 cm. long. Thickness of wall of largest colonies about 6 mm. Color varying from an entire absence of pigment and extreme transparency to livid pink, due to pigment in the oozoids.

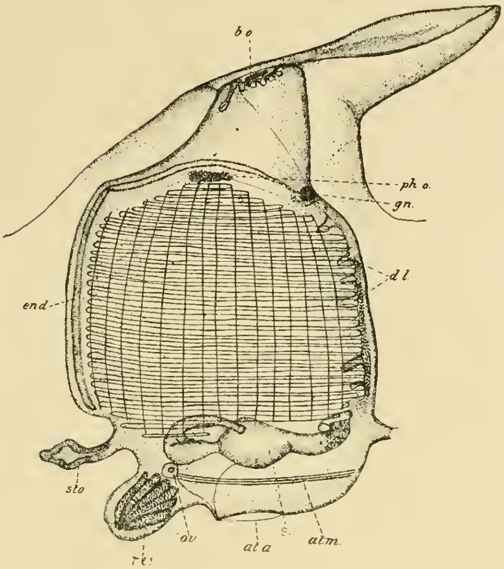


Fig. 31.—Single zooid of *P. giganteum*, with the test process on which the branchial orifice opens.

Ascidiozooids.—Fig. 31. Varying in length, depending on the length of the branchial siphon, but branchial sac in full grown zooids quite constantly about 3 mm.; length, including both siphons, 5 mm. to 6 mm. The large branchial sac much compressed, varying in form from approximately square with somewhat rounded angles, to pronouncedly elongate. Branchial orifice in some zooids but slightly above the general level of the test surface; while in others it is high up on the above described oblique planes of the test processes. In these latter zooids the branchial siphon is long and narrow. Branchial tentacles close within the branchial orifice, however long this may be; tentacles few and short, a single one on the ventral side distinctly longer.

Largest number of branchial stigmata seen, thirty-two, on each side of sac; maximum number of internal branchial vessels, fifteen. Dorsal languets, six to eight. Intestinal tract projecting but little behind branchial sac; esophageal mouth at the dorso-posterior angle of the branchial sac, esophagus nearly as long as the loop of the intestine proper; stomach globular or egg-shaped; intestinal loop narrow, the anus situated on left side of the stomach.

Testis rosette shaped, with about ten lobes; when fully ripe projecting prominently from the surface of the body on the ventral side, a short distance behind the proliferous stolon, which is between it and the endostyle; in younger zooids the testis not projecting thus from the body surface. The ovary, with its one large ovum, closely associated with the testes.

Although I have decided, after much perplexity, to call our one species of *Pyrosoma*, *P. giganteum*, I must confess that the decision as between *giganteum* and *atlanticum* has little more value to my mind than it would have had it been made by throwing dice. Having no examples of *atlanticum* at hand for comparison, I have been obliged to depend upon published descriptions of this species, and at almost all points at which authors make specific differences between *atlanticum* and *giganticum* I find, among the large number of specimens at my disposal, agreements with both, and complete gradations from one to the other; in the case of the zooids, often within the same colony. In fact, I am compelled to question the actual existence of both *atlanticum* and *giganteum* as distinct species. For example, Savigny, 1816, was first to emphasize difference in form of the colony as being distinctive of the two species, he stating the *atlanticum* colony to be conical, and that of *giganteum* cylindrical. This difference appears to have been chiefly relied upon by Herdman, '88, '92, for distinguishing the two species. I find colonies that would certainly have to be described as cylindrical, and others that would as surely be regarded as conical. But there are numerous others, again, that the narrowing toward the closed end is so exceedingly gradual and slight that to say they are conical would be no more apt than to describe the trunk of one of our tallest silver fir trees as conical. Again, as to the structure and arrangement of the test processes, I find, even in the same colony, essential agreement with those said by Seeliger, '95, to be characteristic for *P. atlanticum* var. *tuberculosum;* and at the same time with those described and figured by various writers for *P. giganteum.*

Turning to the ascidizooids, I have not had much better luck than with the colony as a whole. Thus the branchial siphons are said by Seeliger (''Schlundrohr'' of this writer) to reach a much greater length in old zooids of *giganteum* than they ever do in *atlanticum*. In the same colony I find old zooids with long siphons, but others again, certainly equally old, as judged by position in the colony and development of the gonads, with the siphons decidedly short and wide. Of course it may not be Seeliger's meaning that the siphon becomes elongate with age in *all* zooids. Indeed, this has been one of the considerations that has influenced my decision to call this *giganteum*. The other point that has had weight with me concerns the arrangement of the zooids in the younger colonies. Seeliger states that in colonies of *giganteum* 8-9 mm. long three whorls of zooids, regularly placed above one another, are present; while in colonies of *atlanticum* of the same size the zooids are more numerous and smaller, and are not disposed with the same regularity. My young colonies agree entirely with Seeliger's account of the young *giganteum*.

So far as concerns the branchial sac, the testes, and the musculature, upon which some reliance is placed by various writers for separating the two species, I am of the opinion that individual variation is so great here that the value of differences can be determined only by extensive quantitative studies, careful regard being had to the age of the zooids.

The color variation is also great, this ranging from deep pink to an entire absence of the color. No intimation of blue has been observed. On the whole, it seems that the older colonies are the more deeply colored. In fact, I have not seen any highly colored colonies less than 8 or 10 cm. long. It is, however, true that one sees colonies of say 20 mm. length some of which are highly colored, while others of the same size are almost if not wholly without pigment.

The species occurs in abundance throughout our area, at least from March on through the summer and autumn months. I have records for December also, but a few only. It must be remembered, however, that we have thus far done but little winter collecting.

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These abbreviations are used in the text figures as well as in those of the plates.

an.—anus.
at. o.—atrial orifice
br.—branchae.
br. o.—branchial orifice.
coe.—Cecum of intestine of sexual zooid.
el.—eleoblast.
end.—endostyle.
emb.—embryos.
es.—esophagus.
d. p.—dorsal process of nurse.
gn.—ganglion.
gl.—"gill."
ht.—heart.
hy.—hypophysis.
i. c.—Intestinal appendages.
int.—intestine.
nu.—"nucleus."
oc.—otocyst.
or.—ovary.
p. a.—post abdomen.
p. br. b.—peripharyngeal band.
pd.—peduncle for attachment of sexual zooid to stolon.
ped.—peduncle.
pla.—placenta.
s.—stomach.
sto.—stolon.
tes.—testis.
v. p.—ventral process of phorozooid.

PLATE II.

All figures of Plates II and III are of *Cyclosalpa bakeri.*

Figs 1, 2, 3.—Lateral, dorsal, and ventral views, respectively, of the solitary generation, all drawn mainly from preserved specimens.

Fig. 4.—Outline of same, lateral view, made from a living, actively swimming specimen.

Fig. 5.—Intestinal tract, ''gill,'' endostyle, peripharyngeal band, hypophysis, and ganglion with its sense organ, seen from left side.

Fig. 6.—Anterior end of ''gill,'' with hypophysis.

FIG. 1.

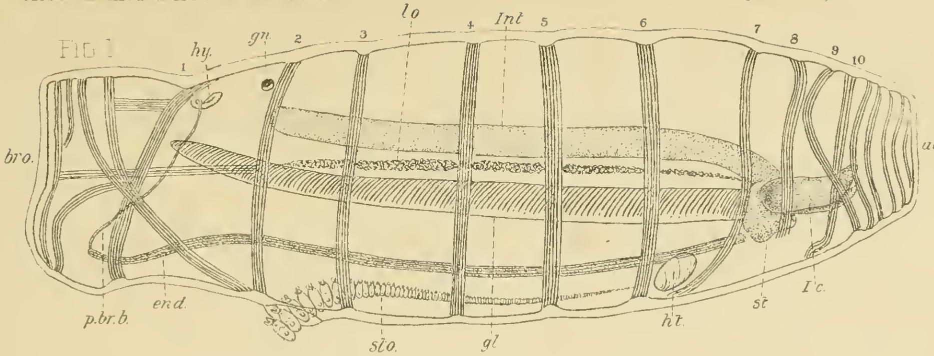


FIG. 2.

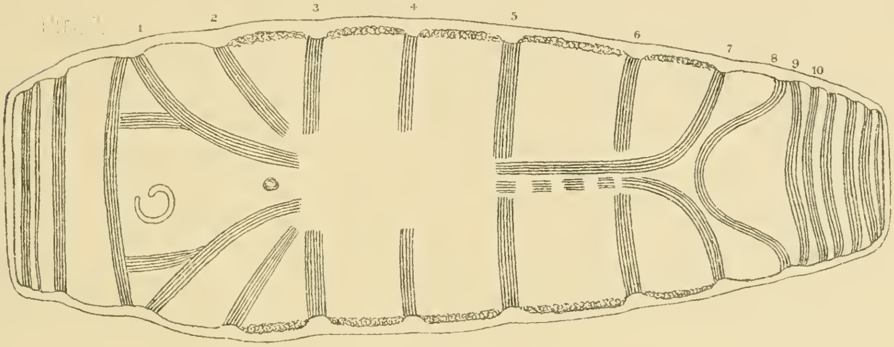


FIG. 3.

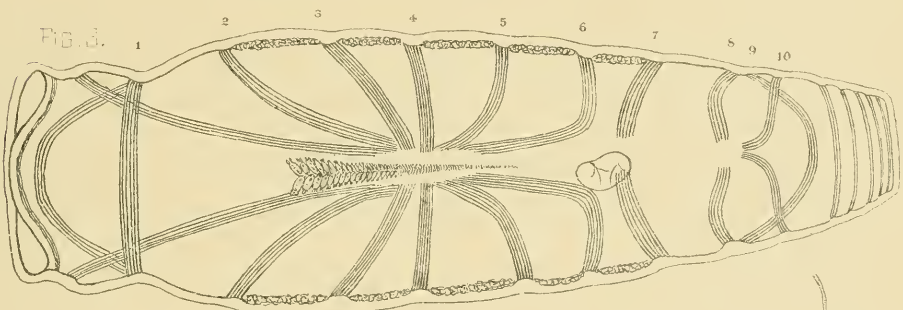


FIG. 4.

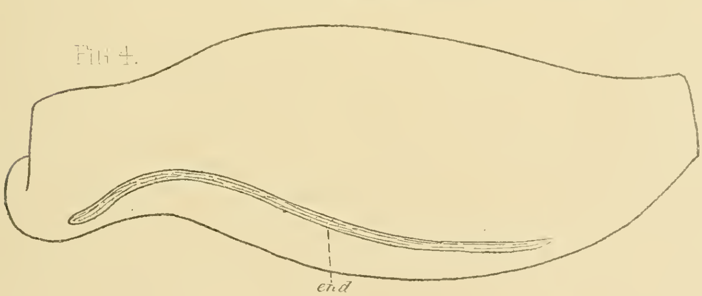


FIG. 6.

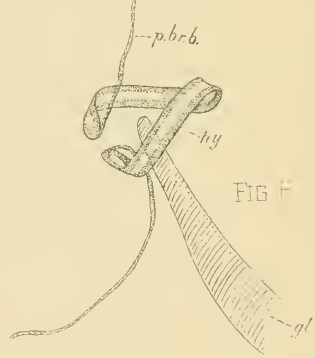


FIG. 5.

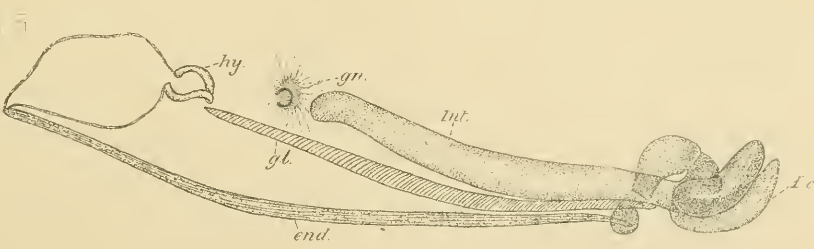


PLATE III.

Figs. 7 and 8.—Left and right side views, respectively, of zooids of sexual generation, taken from the stolon.

FIG. 7.

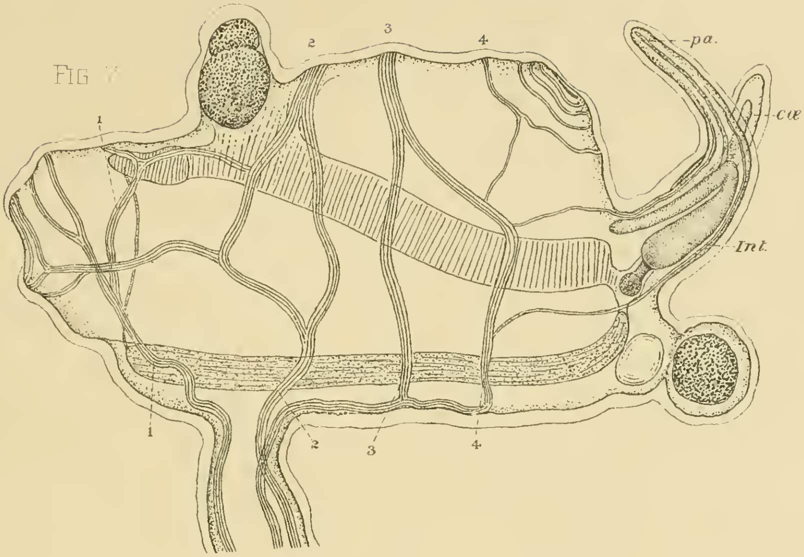
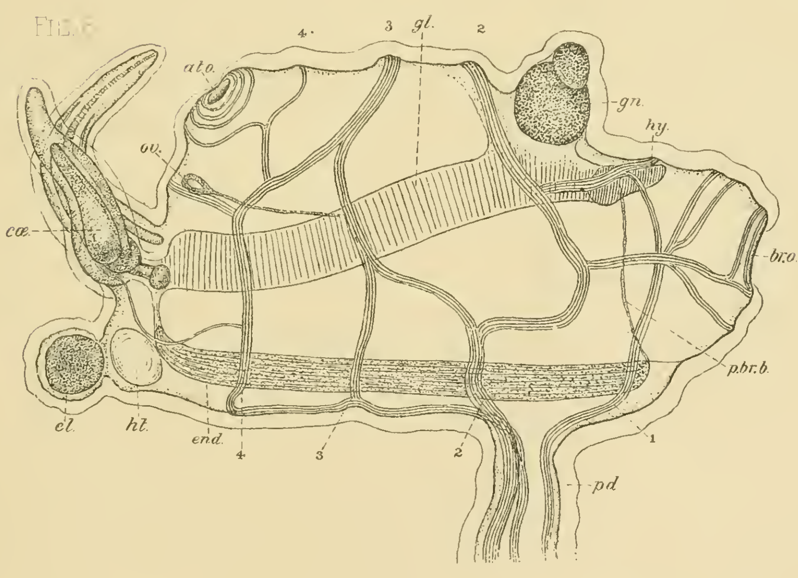


FIG. 8.



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Vol. 2, No. 4, pp. 113-233, Figs. 1-62. October 14, 1905

CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO

IV

THE PELAGIC COPEPODA OF THE SAN DIEGO REGION

BY

C. O. ESTERLY

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IV.

THE PELAGIC COPEPODA OF THE SAN DIEGO REGION.

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C. O. ESTERLY.

The present paper is the result of a study of the pelagic Copepoda collected in the San Diego region during one month of the summer of 1903, nearly two months of 1904, and during December and January, 1903. Likewise, there have also been examined a few collections taken during the fall of 1904. Such time as has been spent on the subject serves to convince the writer that a good deal of further study is necessary, and that, taking the field as a whole, this report is incomplete. Such forms as are described here seem well established. Without doubt there are others which are new, but for lack of proper material they are not now dealt with.

The work was commenced at the San Diego Marine Laboratory connected with the University of California, and completed at Harvard University. It is a pleasure to express my appreciation of the helpful suggestions and advice of Professor W. E. Ritter of the University of California, and Professor E. L. Mark of Harvard University.

In the body of a free-swimming Copepod two regions are readily distinguishable, a cephalothorax and an abdomen. In the first suborder, *Gymnoplea*, the cephalothorax consists of the head and five thoracic segments, though the head is often fused with the first thoracic segment, and the fourth with the fifth. In the second suborder, *Podoplea*, the last thoracic segment is drawn into the abdominal portion; this, then, loosely speaking, contains one thoracic segment.

In typical groups the abdomen proper consists of five segments in the male, and always less than five in the female; fusions often reduce the number of segments to as few as one or two. The first segment of the abdomen in each sex bears the orifices of the sexual organs, and is called the *genital segment;* the last segment contains the opening of the alimentary canal, and is called the *anal segment.* The *furca* is a paired appendage, borne on the anal segment and carrying usually a fringe of six bristles of various lengths. The anterior portion of the head segment is known as the *front*, and terminates ventrally in the *rostrum.* The latter may consist of one or two strong, pointed projections, or of the same number of long, slender filaments.

The appendages of the cephalic segments in order are, from front to rear: (1) The *anterior antennae;* (2) The *posterior antennae;* (3) The *mandibles;* (4) The *maxillae;* (5) The *anterior maxillipeds* (second maxillae); (6) The *posterior maxillipeds* (maxillipeds). The thoracic segments bear the swimming feet (four pairs), and also a fifth pair of feet which usually are modified in both sexes, and at times are absent in the female. The cephalic appendages from 3 to 6, inclusive, are the mouth parts. All the appendages except the anterior antennae are typically biramous; each consists of a two-jointed basal part (*basipodite*), which bears the inner and outer rami (respectively *endopodite* and *exopodite*). Neither ramus is more than three-jointed, and in many forms the number of joints is reduced by fusions.

The anterior antennae in the *Gymnoplea* consist of 25 joints, but this number may be reduced by fusion. The joints carry bristles and sense organs, or *aesthetasks.* The joints in an appendage, or a part of one, are numbered from the base to the tip. Among the *Gymnoplea* one of the anterior antennae of the male may be modified to form a grasping organ; this is usually on the right side, but both appendages may be so modified. The grasping organ may be recognized by its want of symmetry. The joints on either side of the geniculation are often provided with teeth. In many of the *Gymnoplea* the fifth feet in the male form grasping organs; the fifth feet are always asymmetrical in the male, whether they form grasping organs or not. In the *Podoplea* some of the males have anterior grasping antennae; in others this function is performed by the posterior antennae or posterior maxillipeds.

The main axis of the appendages (excepting the anterior antennae) may be considered as parallel to the dorso-ventral diameter of the animal; accordingly anterior and posterior faces are distinguished in an appendage as well as proximal and distal portions, and inner or outer margins of the various joints. This nomenclature is useful, especially since most appendages are flattened. The form, arrangement and number of the bristles on the appendages are used a great deal in identification, and for that reason the appendages must usually be dissected off.

It is of importance to have only adult animals for study. The adult male in most genera has noticeable sexual peculiarities in the structure of the fifth feet or in the grasping antenna. The females are certainly adult if carrying eggs or spermatophores. In large animals it is a comparatively easy task to dissect off the appendages, but in the majority of the *Podoplea* and the smaller *Gymnoplea* it requires a good deal of patience and a steady hand. A dissecting microscope is indispensable, and it is a good plan to use fine needles, which may be ground down to an edge. Farrant's fluid makes a good mounting medium for permanent preparations. If it is spread thin over the slide the appendages may be placed in order in it and the cover glass put on without disturbing the arrangement. For the determination of the genus of an individual the feet especially must be removed and examined.

Most of the drawings in this paper were made with the aid of the Abbé camera. The keys, and descriptions of all but new species, are translated from Giesbrecht's works of 1892 and 1898. In the general key for the *Gymnoplea* the plan adopted in the Tierreich (1898) has been followed, but only those genera are included which from their distribution might be expected to occur in the San Diego region. Species keys are given in some cases, but include only the species actually found; however, if one sex of a form occurs, and the other has not been obtained, a description of the latter is given in most cases.

It may be remarked that little defense is needed for translating bodily from Giesbrecht, in view of the fact that whatever could be written concerning any form known to him has been so well stated that one could not improve upon it.

Following is a list of the species treated in this paper:

I Sub-order.—GYMNOPLEA.

Gymnoplea (sub-order) Giesbrecht, 1892, p. 41.
Gymnoplea (tribe) Giesbrecht, 1898, p. 7.

The genital orifices lie in the first segment of the posterior division of the body; they are ventral and paired in the female, unpaired and lateral in the male. The fifth pair of feet in the female are like the preceding pairs, retrograded or lacking; in the male a pairing organ always present. The first segment of the posterior division of the body (abdomen) never bears appendages. The abdomen of the male is 5 segmented (fig. 3*a*), and the female seldom carries the eggs in sacks hanging from the genital orifice. The anterior antennae in the male may be symmetrical, or one may form a grasping organ; in the female the antennae are symmetrical.

KEY TO THE GENERA OF THE GYMNOPLEA.

(The genera marked with an asterisk have been found in the San Diego region.)

1. Inner ramus of third and fourth feet 3-jointed, figs. 12*a*, 19*b*..... 2
1. Inner ramus of third and fourth feet 2-jointed, fig. 44*d*.......... 19
2. Inner ramus of first foot 3-jointed.......................... 3
2. Inner ramus of first foot 2-jointed.......................... 32
2. Inner ramus of first foot 1-jointed, fig. 15*d* 38
3. A black or brown knob on the first segment of the cephalothorax in the antero-lateral angle, on the right or left side; figs. 33*a*, 34*a* .... ***Pleuromamma**
3. This knob absent 4
4. First joint of inner ramus of second foot with proximally curved hooks on the inner margin; fig. 35*b*..................***Metridia**
4. This joint, like the rest, bearing a bristle...................... 5
5. Terminal joint of outer ramus of third and fourth feet with two spines or thorns on outer margin, and one terminal bristle; fig. 1*d* 6
5. Terminal joint as above, but with three spines on outer border; figs. 17*b*, 19*b* 6*a*
6. Terminal bristle of outer ramus of third and fourth feet with broad, smooth border; fig. 1*d* ....***Calanus**
6*a*. Terminal bristle bearing teeth or spines on outer border; figs. 35*a*, 39*a* 7
7. One bristle of left ramus of furca much longer and thicker than the other furcal bristles 8
7. Furcal bristles symmetrical 9
8. Mandibular blade with three or four teeth, the ventral one hooked and separated from the others by a wide space; fig. 38*f* .... ***Heterorhabdus**
8. Mandibular blade with at least 8 teeth......................**Disseta**
9. Anterior antennae symmetrical 10
9. Anterior antennae asymmetrical 14
10. Rami of fifth feet 3-jointed; fig 32*c*......................... 11
10. Rami of fifth feet 2-jointed.........................***Augaptilus♀**
10. Outer ramus 3-jointed, inner ramus 2-jointed...........**Isochaeta♀**
10. Outer ramus 3-jointed, inner ramus 1-jointed...............**Isias♀**
10. Outer ramus 3-jointed, inner ramus lacking.............***Phyllopus♀**
10. Outer ramus 1-jointed, inner ramus rudimentary; fig. 42*b* ***Arietellus♀**
11. Middle joint of outer ramus of fifth foot with a thorn-like process which is fused with the joint; fig 32*c*..........***Centropages♀**
11. This joint with an awl-shaped or rudimentary bristle on the inner border; figs. 36*b*, 38*e* 12
12. Terminal joint of inner ramus of fifth foot with five bristles; fig. 36*b* .... ***Lucicutia♀**
12. This joint with at least six bristles.......................... 13
13. Abdomen with 4 segments .... **Haloptilus♀**
13. Abdomen with 3 segments ....***Augaptilus♀**

14. Grasping antenna on right side 15
14. Grasping antenna on left side 17
15. Inner rami of both feet of fifth pair 3-jointed, with plumose bristles; fig. 40*a* 16
15. Inner rami rudimentary, without plumose bristles .... **Isias♂**
16. Inner rami of feet of fifth pair unlike, the right foot with a forceps .... ***Centropages♂**
16. Inner rami alike; figs 41*c*, 41*d*...................... ***Augaptilus♂**
17. Both rami of each foot of fifth pair 3-jointed................. 18
17. Both outer rami 3-jointed, the inner rudimentary........ ***Arietellus♂**
17. Rami of left fifth foot 3-jointed, of the right 2-jointed.. ***Lucicutia♂**
18. Inner ramus of maxilla present, distal bristles of anterior maxilliped naked or set with spines..................... **Haloptilus♂**
18. Inner ramus of maxilla lacking; distal bristles of anterior maxilliped with mushroom-shaped appendages (cf. fig. 41*b*) .... ***Augaptilus♂**
19. Inner ramus of first foot 3-jointed.......................... 20
19. Inner ramus of first foot 2-jointed 25
19. Inner ramus of first foot 1-jointed .... **Eurytemora**
20. Head without dorsal cuticular lenses or lateral hooks............ 21
20. Head with one or two pairs of cuticular lenses and hooks on each side 23
21. Rami of posterior antennae about equal in length....... **Parapontella**
21. Inner ramus much the shorter 22
22. Abdomen with asymmetrical outgrowths .... **Pontellopsis**
22. Abdomen symmetrical .... **Pontellina**
23. Head with two pairs of eye lenses.................... **Anomalocera**
23. Head with but one pair of lenses 24
24. Last two thoracic segments distinct; anterior antennae of female 24-jointed; terminal portion of grasping antennae of male 4-jointed .... **Pontella**
24. Last two thoracic segments fused; anterior antennae of female 22-jointed; terminal portion of grasping antennae of male 4-jointed .... **Ivellopsis**
25. Head with one pair of cuticular lenses; fig. 48*a*.......... ***Labidocera**
25. Head without dorsal cuticular lenses 26
26. Inner rami of fifth feet jointed...................... ***Centropages**
26. Inner rami of fifth feet 1-jointed or absent.................. 27
27. Second maxilliped longer than the first 28
27. Second maxilliped shorter than the first 29
28. Furca long and narrow, at least six times as long as broad.... **Temora**
29. First joint of maxillipeds with few short bristles; fig. 47*h*.. ***Candacia**
29. This joint bearing long bristles set with spines................. 30
30. Outer ramus of posterior antennae less than half as long as the inner ramus .... ***Acartia**
30. Outer ramus more than half as long as the inner............... 31
31. Posterior maxilliped 6- 7- jointed........................ **Calanopia**
31. Posterior maxilliped 3-jointed .... **Tortanus**
32. Both feet of fifth pair with inner rami, which are 2- or 3- jointed, bristles plumose .... ***Lucicutia**

32. Inner rami without plumose bristles, or lacking; the entire foot may be absent on one or both sides........................ 33
33. Furca long and narrow, at least six times as long as broad....**Temora**
33. Furca at most three times as long as broad.................... 34
34. Middle joint of outer ramus of third and fourth feet with two bristles; terminal joint with seven; fig. 12*a*................ 35
34. Middle joint with one, terminal with five...................... 37
35. Outer border of outer ramus of swimming feet not denticulate.. .... **Calocalanus**
35. Outer border on rear pairs denticulate; fig. 12*a*................ 36
36. Fifth foot lacking in female, or knob-like; in the male only the left fifth foot present ....**Acrocalanus**
36. Fifth foot in female 2-jointed (fig. 12*e*); in the male the right is 2-jointed, the left 5-jointed (fig. 12*e*)...............*__Paracalanus__
37. Outer ramus of first foot 3-jointed; fifth foot absent in female... .... *__Eucalanus__
37. Outer ramus of first foot 2-jointed; fifth foot present in female (fig. 10*b*) ....*__Rhincalanus__
38. Inner ramus of second foot 3-jointed.................*__Mecynocera__
38. Inner ramus of second foot 2-jointed (fig. 28*b*).................. 39
38. Inner ramus of second foot 1-jointed (fig. 25*c*) 51
39. Terminal joint of outer rami of second to fourth feet with five bristles on inner margin ....**Spinocalanus**
39. Terminal joint with four bristles on inner margin (fig. 14*b*)..... 40
40. Surfaces of rami of second to fourth feet without very large spines; appendages of anterior maxillipeds have the form of bristles or hooks 41
40. Surfaces of outer rami and of the two terminal joints of the inner rami of the third and fourth feet with larger spines (as in fig. 28*b*); part of the appendages of the anterior maxilliped vermiform (fig. 30*d*) or pencillate 49
41. Basals and outer rami in second and third feet broader than in the fourth pair, the second basal irregularly toothed on the distal border (fig. 13*b*)......................... *__Clausocalanus__
41. Second and third feet not differing as above from fourth foot... 42
42. Outer marginal thorns of terminal joint of outer ramus of third and fourth feet comb-like and placed in deep indentations in the margin ....**Ctenocalanus**
42. These of the usual shape 43
43. Fifth pair of feet symmetrical or lacking...................... 44
43. Fifth pair of feet asymmetrical or lacking 47
44. Anterior part of head with a spine in the dorsal median line.... .... **Gaetanus♀**
44. Head without this spine 45
45. Fifth foot lacking ....**Pseudocalanus♀**
45. Fifth foot 2-jointed, with a thick, curved bristle at the end..... 46
46. Terminal bristle of fifth foot much longer than the basal joint .... **Drepanopus♀**
46. Terminal bristles not as long as, or but little longer, than basal joint .... **Stephus♀**

47. Fifth feet, especially the left, with several apical appendages... .... **Stephus**♂
47. Fifth feet slender, stylet-like, with a few short needles or with but one needle or hook-like appendage...................... 48
48. Fifth feet slender, stylet-shaped, about as long as the abdomen... .... **Pseudocalanus**♂
48. These shorter than the abdomen, the right foot with a terminal hook .... **Drepanopus**♂
49. Cephalothorax broad to globular .... **Phaenna**
49. Cephalothorax elongate, ellipsoidal (figs. 26*a*, 29).............. 50
50. Head distinct from thorax ....**Xanthocalanus**
50. Head fused with thorax (figs. 26*a*, 27).................***Scolecithrix**
51. Fifth foot lacking 52
51. Fifth foot present 59
52. Last thoracic segment prolonged laterally into a long, pointed process (figs. 14*a*, 15*a*)................................... 53
52. Lateral angles of last thoracic segment rounded or slightly pointed (figs. 16*a*, 19*a*) 56
53. Bristles of the sixth joint from the last in the anterior antennae thick and transversely ringed ....**Bradyidius**♀
53. These bristles of the usual form 54
54. Rostrum with two heavy teeth (fig. 14*a*)...............***Aetideus**♀
54. Rostrum with one point (fig. 15*b*) or lacking.................. 55
55. Outer ramus of first foot 3-jointed ....**Chiridius**♀
55. Outer ramus of first foot 2-jointed (fig. 15*d*).............***Gaidius**♀
56. Rami of posterior antennae about equal in length........***Euchaeta**♀
56. Outer ramus at least 1½ times as long as the inner ramus (fig. 20*c*) 57
57. Inner border of first basal of fourth foot naked or feathered..... 58
57. Inner border with teeth or spines (figs. 19*b*, 20*d*).......***Euchirella**♀
58. Head with or without crest (figs. 16*a*, 17*a*); last thoracic segment not produced into spines or blunt processes........***Undeuchaeta**♀
58. Head with median crest, last thoracic segment produced into blunt processes (not spines) ....**Chirundina**♀
59. Last thoracic segment on each side with a strong point (fig. 14*a*) .... ***Aetidius**♂
59. Last thoracic segment rounded (fig. 20*a*)...................... 60
60. Right fifth foot with forceps (figs. 20*b*, 21*b*)............**Euchirella**♂
60. Right fifth foot ends in a stylet without forceps (fig. 23*a*).... 61
61. Inner rami of posterior antennae at most equal in length to the outer ....**Euchaeta**♂
61. Inner rami of posterior antennae over half the length of the outer ....***Undeuchaeta**♂

Fam. CALANIDAE.

Dana (subfamily), 1852.
Claus, 1863, p. 166.
Giesbrecht, 1892, p. 41; 1898, p. 12.

First antennae of male symmetrical or nearly so, not geniculate; aesthetasks more numerous than in female. Fifth feet of female either like the preceding ones or in various stages of degeneration, often resulting in complete loss. The males vary from the females in the segmentation and form of abdomen, in structure, number of joints, and appendages of the anterior antennae, and in the form of the fifth foot. Head usually distinct from thorax: the two last thoracic segments usually fused. Rostrum with one or two joints, sometimes lacking. Abdomen of female usually with 4 (fig. 1*a*), seldom with 3 or 2 segments; that of the male with 5, often with very short anal segment. Anterior antennae of female, 16- to 25-jointed. Outer ramus of second antennae one-half to four times as long as the inner, 5- to 8-jointed, middle joints short, end ones usually elongate. Six to eight teeth on blade of mandible, outer ramus 5-, inner ramus 2-jointed. Maxilla with at least two lobes on inner margin and one on outer; outer ramus always present, inner 1- to 3-jointed, seldom fused with second basal. Proximal and distal curved bristles of first maxilliped usually equal in length, the former sometimes modified into delicate saclike appendages (fig. 30*b*). Second maxilliped elongate, terminal portion (inner ramus) 5-jointed, from one-third to one and one-half times the length of the second basal. Outer rami of first to fourth feet 3-jointed (that of first foot occasionally 2-jointed); inner ramus of first and second pairs 1- to 3-jointed, of third and fourth 3-jointed; terminal bristle of outer rami at times with smooth border (fig. 1*d*), not serrate. Inner rami of fifth pair of male rarely 3-jointed, mostly rudimentary or lacking: the outer ramus forms hooks or shears; occasionally the entire appendage of one side may be absent.

Sub-fam. CALANINAE.

Calanina Giesbrecht, 1892, p. 44.

Fifth pair of feet in the female in all respects like the preceding pairs; in both sexes all five pairs are provided with 3-

jointed inner and outer rami, and the number of outer marginal bristles on the outer ramus is the same in all the feet. The number of bristles on the inner ramus of the first pair is: one on the first joint, two on the second, six on the third (one on outer margin); on the terminal joint of the second and third pairs there are eight (two outer marginals). The fifth pair of feet in the male is always modified to form an accessory sexual organ: the right foot has a 2-jointed basal and is biramous, each ramus with three joints; the left foot has also a 2-jointed basal, and a 3-jointed outer ramus, while the inner ramus is reduced and may be entirely absent.

1. Genus **Calanus** Leach.

Monoculus Gunner, 1765.
Calanus Leach, 1819, p. 539.
Undina Dana, 1852, p. 1047.
Cetochilus Claus, 1863, p. 169.
Calanus Brady, 1883, p. 30.
Calanoides Brady, 1883, p. 74.
Undina Brady, 1883, p. 52.
Calanus Giesbrecht, 1892, pp. 45, 88, 725.
Calanus Dahl, 1894*b*, p. 61.
Calanus Dahl, 1898, p. 13.
Calanus Wheeler, 1899, p. 164.

♀ Head free, or fused with thorax; fourth and fifth thoracic segments not fused. Abdomen with 4 segments, genital segment symmetrical, furca occasionally asymmetrical. Anterior antennae 25-jointed, terminal joints with long, plumose bristles; the antennae vary in length, in some cases not reaching the posterior end of the body, in others extending beyond the furca (fig. 5*a*). Rami of posterior antennae of about equal lengths, outer ramus 7-jointed. Inner ramus of maxilla 3-jointed. Anterior maxilliped with long, curved bristles on inner border, outer border with a plumose bristle. Inner ramus of posterior maxilliped long, 5-jointed, bristles long and stiff, usually not plumose. Outer and inner rami of first to fourth pairs of feet 3-jointed, first, second and third joints of outer rami of all with 1, 1, 2 marginal spines, respectively, terminal bristle scalpelliform, its margin smooth (fig. 1*d*). Inner ramus of first foot with 1, 2, 6 bristles on the first, second and third joints in order; terminal joint of inner ramus of second and third feet with eight bristles. Fifth foot like the others.

♂ Abdomen with 5 segments, genital orifice on left side of genital segment. Number of joints in the anterior antennae reduced, at least by fusion of the first and second joints. Mouth parts often retrograded; swimming feet usually as in the female. Fifth feet in some cases similar to the swimming feet, in others asymmetrical pairing organs (fig. 1*b*, *c*), 2 basals on each side, right foot (fig. 1*b*) with 3-jointed outer and inner rami, the left (fig. 1*c*) with 3-jointed outer ramus without plumose bristles, inner ramus reduced or lacking.

KEY TO THE SPECIES.

♀1. Anterior antennae extend beyond end of cephalothorax for at least half its length (fig. 5*a*) 2
1. Anterior antennae do not extend beyond end of cephalothorax, or only for a few joints at most 4
2. Bristles of furca symmetrical .... **C. tenuicornis**
2. Furca with an elongated bristle on left side 3
3. Ventral surface of genital segment very strongly convex (fig. 5*c*) .... **C. robustior**
3. Ventral surface of genital segment rather slightly convex (fig. 4*a*) .... **C. gracilis**
4. Head not fused with thorax: cephalothorax with six segments (fig 1*a*) .... **C. finmarchicus**
4. Head fused with thorax: cephalothorax with five segments (fig. 2) .... **C. minor**
♂1. Anterior antennae longer than body by at least six joints.......... .... **C. tenuicornis**
1. Anterior antennae not longer than body, or but slightly so....... 2
2. Outer margin of terminal joint of outer ramus of second to fourth feet denticulate 3
2. Outer margin of same smooth or feathered...................... 4
3. Inner rami of fifth feet similar in structure..............**C. gracilis**
3. Inner ramus of left foot of fifth pair shortened and without bristles .... **C. robustior**
4. Outer ramus of right fifth foot with plumose bristles on inner margin .... **C. minor**
4. Outer ramus of right fifth foot without bristles on inner margin (fig. 1*b*); outer ramus of left foot (fig. 1*c*) less than twice as long as that of the right ....**C. finmarchicus**

1. **Calanus finmarchicus** Gunner.

Monoculus finmarchicus Gunner, 1765, p. 175, figs. 20-30.
Calanus perspicax Dana, 1852, p. 1071; 1855, pl. 74, figs. 1*a-c*.
Cetochilus helgolandicus Claus, 1863, p. 171, pl. 26, figs. 2-9.
Calanus finmarchicus Brady, 1883, p. 32, pl. 1, figs. 1-10.
Calanus finmarchicus Giesbrecht, 1892, pp. 89, 218, pl. 6, fig. 19; pl. 7, figs. 32, 33; pl. 8, figs. 3, 15, 21, 31, 33; 1898, p. 14.
Calanus finmarchicus Wheeler, 1899, p. 164, fig. 1.

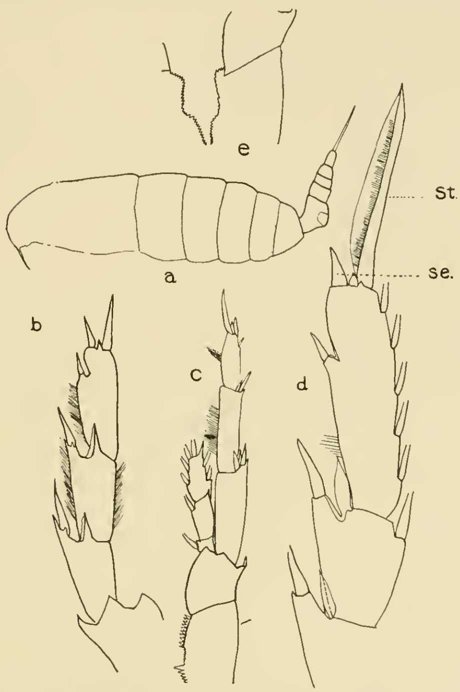

Fig. 1.—*Calanus finmarchicus.* (*a*) Female, lateral, ×18. (*b*) Outer ramus of right fifth foot of male ×195. (*c*) Left fifth foot of male ×140. (*d*) Outer ramus of third foot of male ×140. *St.*, terminal bristle. *Se.*, outer marginal bristle. (*e*) Basals of fifth foot of female ×195.

♀ Head not fused with thorax, front and lateral portions of fifth thoracic segment rounded, furcal bristles symmetrical. Anterior antennae extending about to end of abdomen, aesthetasks not doubled on any joint. Distal margin of second basal of second to fourth feet with a tooth; the proximal spine of the outer margin of terminal joint of outer ramus divides the margin in these pairs (respectively) into portions as 2:1, 2:1, 3:1.

First basal of fifth pair with concave dentate inner border (fig. 1*e*).

♂ Head not fused with thorax, anterior antennae straight; outer ramus of right fifth foot without bristles on inner margin (fig. 1*b*), terminal bristles sometimes dentate, thorn-like. Basals and proximal joint of outer ramus of left foot (fig. 1*c*) elongate, terminal joint of outer ramus shortened. Outer ramus of right foot (excluding terminal bristle) reaches at most to the distal end of the second joint of the outer ramus of the left foot. Inner rami of both feet similar in structure.

Coloration: Rather transparent, with variably distributed red pigment. In some cases this is found only in one of the anterior antennae, in others in the thorax and appendages, while the entire body of some animals is brightly colored.

Length: Both sexes, 2.6-3.1 mm.

Occurrence: Probably the commonest species in the San Diego region, occurring abundantly in nearly all collections with the larger nets; in some cases *C. finmarchicus* is almost the only species, and is very often predominant.

2. **Calanus minor** Claus.

Cetochilus minor Claus, 1863, p. 172, pl. 26, figs. 1-8.
Calanus valgus Brady, 1883, p. 33, pl. 3, figs. 1-7.
Calanus minor Giesbrecht, 1892, p. 90, pl. 6, figs. 3, 16, 22; pl. 7, figs. 6-22; pl. 8, figs. 1, 9, 19, 30; 1898, p. 15.
Calanus minor Wheeler, 1899, p. 165, fig. 2.

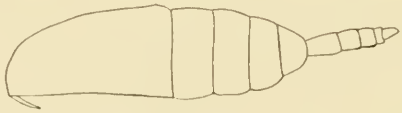

Fig. 2.—*Calanus minor.* Female, lateral, ×31.

♀ Head fused with thorax, forehead and lateral edges of last thoracic segment rounded. Anterior antennae not as long as the body. Distal margin of second basal in second to fourth pairs of feet with a tooth; the proximal outer marginal spine of the terminal joint of the outer ramus, in the second to fourth pairs, respectively, divides the margin into portions as 5 : 4, 10 : 7, 2 : 1. Inner margin of first basal of fifth feet straight, more coarsely dentate than in *C. finmarchicus.*

♂ Anterior antennae bent into S-shape; joints 3, 4 and 5, and 24 and 25 fused. Right fifth foot with 2 bristles on inner margin of third joint of outer ramus, terminal bristle short; terminal joint of left foot with three small bristles.

Coloration: About as in *C. finmarchicus.*

Length: Female, 1.8-2 mm.; male slightly smaller.

Occurrence: Not at all abundant, but coming in most catches with *C. finmarchicus.*

3. **Calanus tenuicornis** Dana.

Calanus tenuicornis Dana, 1849, p. 278; 1852, p. 1069; 1855, pl. 73, figs. 10*a*, 10*b*.

Calanus tenuicornis Giesbrecht, 1892, pp. 90, 129, pl. 6, figs. 12, 13; pl. 7, figs. 5, 16, 23; pl. 8, figs. 18, 27; 1898, p. 18.

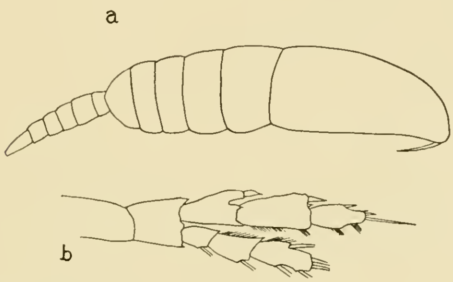

Fig. 3.—*Calanus tenuicornis.* (*a*) Male, lateral, ×31. (*b*) Left fifth foot of male ×83.

♀ Head not fused with thorax; forehead and angles of last thoracic segment rounded; bristle of furca asymmetrical, outer marginal minute. Anterior antennae at least 1½ times as long as the body. Proximal outer marginal spine of terminal joint of outer ramus in second to fourth feet, respectively, divides the margin into portions as 5:4, 10:7, 7:4.

♂ Anterior antennae as in ♀, except for fusion of joints 1 and 2, 3 to 5, 7 and 8, 9 and 10, 24 and 25. Mouth parts reduced; no bristle on inner margin of outer ramus of either of the fifth feet; terminal bristle of right thorn-shaped, that of the left slender; inner rami of both feet similar. Basal portion and two proximal joints of outer ramus of right elongate, terminal joint shortened.

Coloration: A variable amount of red or orange in antennae and mouth parts and oil drops of the same color in body.

Length: Female, 1.8-2 mm.; male, 1.5-1.8 mm.

Occurrence: Fairly abundant, both in summer and winter collections.

4. **Calanus gracilis** Dana.

Calanus gracilis Dana, 1849, p. 278; 1852, p. 1078; 1855, pl. 74, fig. 10.

Cetochilus longiremis Claus, 1863, p. 171, pl. 26, fig. 1.

Calanus gracilis Brady, 1883, p. 35, pl. 5, figs. 1-6; pl. 6, fig. 10.

Calanus gracilis Giesbrecht, 1892, pp. 90, 128; pl. 6, fig. 1; pl. 7, fig. 26; pl. 8, figs. 2, 4, 6-8, 12, 16, 26; 1898, p. 17.

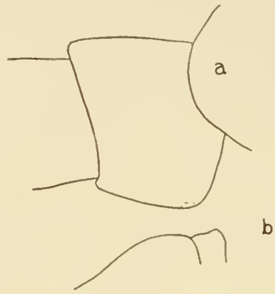

Fig. 4.—*Calanus gracilis.* (*a*) Genital segment of female, lateral, ×83. (*b*) Outer margin of first basal of anterior maxilliped of female ×140.

♀ Head fused with thorax; forehead and sides of last thoracic segment rounded. Left side of furca with one elongated bristle. Anterior antennae at least 1½ times as long as the body. There is a process at the base of the inner marginal bristle of the second basal of the second foot (cf. fig. 5*d*). The proximal outer marginal spine of terminal joint of outer ramus in second to fourth feet, respectively, divides the margin into portions as 1 : 1, 4 : 3, 4 : 3 in length. First basal of fifth pair with feathered inner margin.

♂ Head separate from thorax, anterior antennae straight, joints 1 and 2, 24 and 25 fused. Mouth parts greatly reduced. Outer border of third joint of outer ramus denticulate in second to fourth feet. Right foot of fifth pair and inner ramus of the left as in the preceding pairs; basals and first two joints of left foot elongate, third joint shortened, no bristle on inner border of outer ramus.

Coloration: Transparent, with little or no pigment in body.

Length: Female, 2.4 mm.

Occurrence: San Diego, July 14, 1903, one female; December 23, 1903, 14 females.

5. **Calanus robustior** Giesbrecht.

Calanus robustior Giesbrecht, 1888, p. 332; 1892, pp. 91, 129; pl. 7, figs. 15, 19, 25, 30; pl. 8, fig. 34; 1898, p. 18.
Calanus comptus Scott, T., 1893, p. 26, pl. 5, figs. 46-50; pl. 6, figs. 1-5.

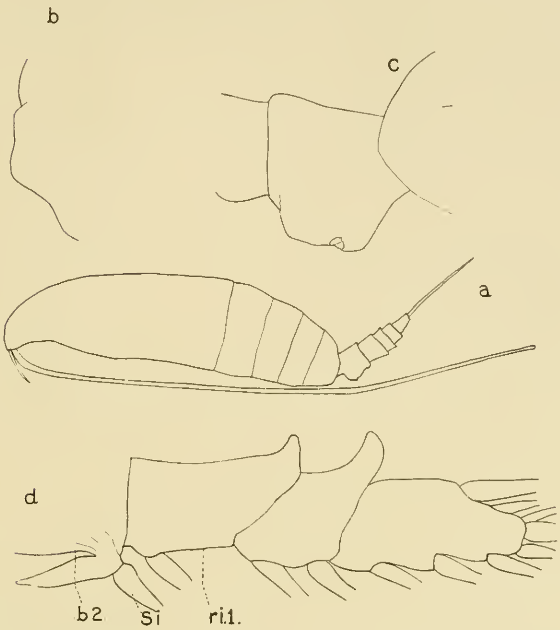

Fig. 5.—*Calanus robustior.* (*a*) Female, lateral, ×36. (*b*) Outer margin of first basal of anterior maxilliped of female ×140. (*c*) Genital segment of female, lateral, ×83. (*d*) Inner ramus of second foot of female ×185. *B*.2, second basal of foot. *Ri*.1, first joint of inner ramus. *Si*., inner marginal bristle.

Allied to *C. gracilis,* but in the female the ventral surface of the genital segment is much more convex (cf. figs. 4*a* and 5*c*), and the first basal of the anterior maxilliped has a bulging protrusion on the outer border (cf. figs. 4*b* and 5*b*).

♂ Bristles on anterior maxilliped longer than in *C. gracilis,* inner ramus of left fifth foot stylet-like, jointed and without bristles, outer ramus much elongated.

Coloration: As in *C. gracilis.*

Length: Female, 3.17 mm.

Occurrence: San Diego, July 14, 1903, one female; December 21, 1904, December 29, 1904, one female each day.

Sub-fam. Eucalaninae.

Eucalanina Giesbrecht, 1892, p. 45.

♀ Body elongate, head for the most part much lengthened (figs. 6*a*, *b*) and seldom distinct from the first thoracic segment. Rostral filaments slender, abdomen usually with three segments, seldom with four; furca often fused with the anal segment. First and second and eighth and ninth joints of anterior antennae fused. The swimming feet, and especially the rami, are short in comparison with the length of the body; inner ramus of first pair 1- or 2- jointed, 3-jointed in the following pairs. Terminal bristle of outer rami with smooth edge, that of the first pair as in the succeeding three pairs; fifth pair absent or uniramous; if present, with from three to five joints.

♂ Body, especially the head, shortened (fig. 6*c*); anterior antennae without reduction in number of joints; furca as in the female. The mouth parts may be stunted. Fifth pair of feet not well developed, left foot uni- or biramous, right uniramous or lacking.

1. Genus **Eucalanus** Dana.

Calanus Dana, 1848, p. 11; 1849, p. 278.
Eucalanus Dana, 1852, p. 1047.
Eucalanus (in part) Lubbock, 1856, p. 13; 1860, p. 160.
Calanella Claus, 1863, p. 174; *not Eucalanus* Claus, 1881, p. 325.
Eucalanus Brady, 1883, p. 37.
Eucalanus Giesbrecht, 1888, p. 333; 1892, pp. 46, 131, 739; 1895, p. 246; 1898, p. 19.
Eucalanus Wheeler, 1899, p. 166.

Anal segment and furca fused, latter asymmetrical; head triangular, often elongate, fused with thorax; abdomen short, that of female with three or four segments, of the male with 5. Anterior antennae longer than body, 23-jointed in female, terminal bristles plumose and colored. Outer ramus of mandible 7- or 8- jointed and shorter than inner. Mandible of female longer than maxilla; second basal of mandible makes with the outer ramus a cylindrical body on which the inner ramus articulates proximally to the outer ramus (fig. 7*c*). Inner ramus of posterior maxilliped with long bristles. Swimming feet short; outer rami 3-jointed, inner ramus of first pair 2-jointed, of second to fourth pairs 3-jointed. Fifth pair absent in female; in male (fig. 6*d*) both are uniramous. The left 4-jointed, the right 1- to 4- jointed or lacking. Head appendages of male retrograded and modified, body shortened.

KEY TO SPECIES.

Abdomen with 3 or 4 segments .... ♀
Abdomen with 5 segments .... ♂
♀1. Two segments between anal and genital segments (fig. 6a) .... **E. elongatus**
1. One segment between genital and anal segments (fig. 7*b*) 2
2. Inner border of second basal of mandible divided into two approximately equal portions by the insertion of the inner ramus (fig. 7*c*) .... **E. attenuatus**
2. Proximal portion much longer than distal 3
3. Two terminal bristles of left side of furca longer but hardly thicker than on the right side; genital segment (fig. 8*d*) much broader than long, onion-shaped .... **E. crassus**
3. Two terminal bristles of left side of furca longer and much thicker than on the right side. Second basal of maxilla with four inner marginal bristles; forehead (fig. 9*a*) triangular, rounded in front .... **E. subtenuis**
♂1. Both feet of fifth pair present 2
1. Right foot of fifth pair absent 3
2. Outer ramus of posterior antenna does not extend by far to the distal border of the first joint of the outer ramus..... **E. elongatus**
2. Outer ramus reaches almost to the distal border of first joint of inner .... **E. attenuatus**
3. Terminal joint of fifth foot at least as long as the apical bristle; outer border of second joint of inner ramus of second to fourth (as in fig. 8*a*) feet without tooth................ **E. crassus**
3. Terminal joint of fifth foot shorter than apical bristle... **E. subtenuis**

1. **Eucalanus elongatus** Dana.

Calanus elongatus Dana, 1848, p. 18; 1849, p. 278; 1852, p. 1079; 1855, pl. 75, figs. 1*a*, *b*.

Eucalanus elongatus Giesbrecht, 1892, pp. 131, 149, pl. 11, figs. 2, 7, 12, 20, 25, 32, 36; 1895, p. 246; 1898, p. 20.

♀ Two free segments between genital and anal, former longer than broad (fig. 6*a*, *b*). Forehead of regular triangular shape. First and second joints of outer ramus of posterior antennae not fused, first joint of inner ramus little longer than the second and over three times as long as broad. Inner margin of second basal of mandible with three bristles. End of inner ramus does not reach distal end of second basal by about the length of the ramus; its first joint with 2, the second with 5 bristles. Second lobe of inner margin of maxilla present, third lobe with four, second basal with 5 bristles. First joint of inner ramus of posterior maxilliped with 3 bristles, second with 4.

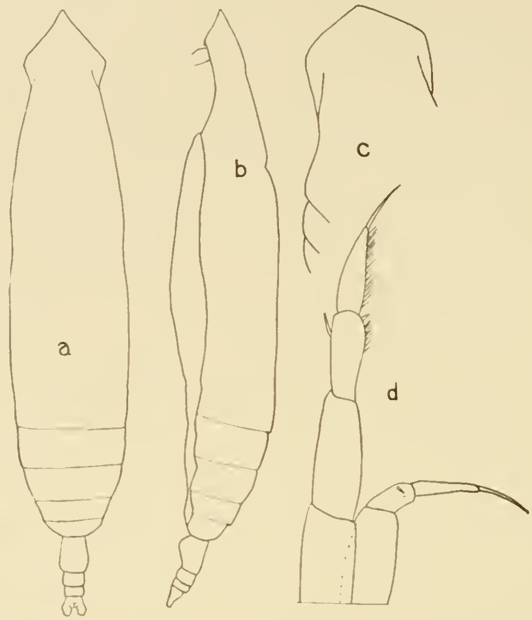

Fig. 6.—*Eucalanus elongatus.* (*a*) Female, dorsal, ×15. (*b*) Female, lateral, ×15. (*c*) Head of male, dorsal, ×37. (*d*) Fifth foot of male, ×40; left foot at left of figure.

♂ Pronounced secondary sexual characters: right fifth foot present, left as long as the fourth foot exclusive of terminal bristle.

Coloration: Very transparent, with a small though varying amount of red in the body, usually limited to a single oil-drop near the posterior end of the thorax. (See note also.)

Length: Female, 4.4-7.5 mm.; male, 4 mm.

Occurrence: A very common species, present in practically all hauls with the 000 net, both in winter and summer.

The most numerous specimens belong to a variety of *E. elongatus* as in Giesbrecht's monograph (1892), in which the last thoracic segment is rounded instead of pointed. But Giesbrecht, 1895, p. 246, calls attention to this difference. The typical form with pointed thoracic segment occurs in the San Diego region, and so far one specimen has been taken, a female, length 7½ mm. The bristles on the posterior maxillipeds and the maxilla are faintly orange, those on the feet a rich orange, as far as seen, the feet being badly broken.

2. **Eucalanus attenuatus** Dana.

Eucalanus attenuatus Dana, 1848, p. 18; 1849, p. 278; 1852, p. 1080; 1855, pl. 75, figs. 2*a-e*.
Calanus mirabilis Lubbock, 1856, p. 16, pl. 5, figs. 1-6.
Calanella mediterranea Claus, 1863, p. 176, pl. 28, figs. 6-11.
Eucalanus attenuatus Giesbrecht, 1892, pp. 131, 150, pl. 3, fig. 1; pl. 11, figs. 1, 11, 13, 16, 18, 24, 40; pl. 35, figs. 3, 6, 17, 25, 34, 37; 1898, p. 20.

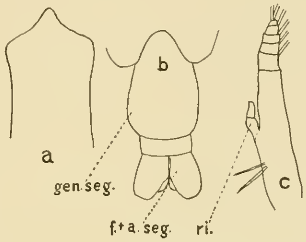

Fig. 7.—*Eucalanus attenuatus.* (*a*) Head of female, dorsal, ×20. (*b*) Abdomen of female, ×31. *Gen. seg.*, genital segment. *F.+a. seg.*, furca and anal segment. (*c*) Mandibular rami, female, ×31. *Ri.*, inner ramus.

♀ Forehead (fig. 7*a*) triangular, indented on each side, much tapering. Genital segment longer than broad, between it and anal segment but one free segment (fig. 7*b*). First joint of inner ramus of posterior antenna 4 times as long as broad and 1⅓ times as long as the second; two inner marginal bristles on second basal of mandible (fig. 7*c*), end of inner ramus distant from distal end of second basal more than the length of the ramus. Maxilla as in *E. elongatus;* first joint of inner ramus of posterior maxilliped with 3 bristles, second with four.

♂ Pronounced secondary sexual characters; right fifth foot present, left considerably shorter than the fourth foot.

Coloration: Similar to that of *E. elongatus;* I have never seen animals with the plumes at the ends of the antennae entire; in Wheeler's specimens they were colorless; in Giesbrecht's at times orange and iridescent.

Length: Female, from 4 to less than 5 mm.; male, under 3.5 mm.

Occurrence: A few come in the hauls with *elongatus,* but are not nearly so common. They were especially abundant in June and July, 1903.

3. **Eucalanus crassus** Giesbrecht.

Eucalanus crassus Giesbrecht, 1888, p. 333; 1892, pp. 132, 151; pl. 11, figs. 8, 10, 17, 21, 22, 38; pl. 35, figs. 4, 20, 26-28; 1898, p. 22.

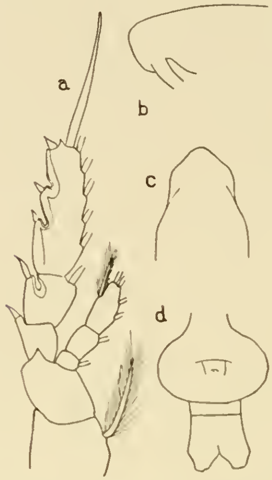

Fig. 8.—*Eucalanus crassus.* (*a*) Fourth foot of female ×83. (*b*) Head of female, lateral, ×18. (*c*) Head of female, dorsal, ×18. (*d*) Abdomen of female, ventral, ×83.

♀ Genital segment (fig. 8*d*) much broader than long, onion-shaped; between it and anal segment but one free segment. Forehead (fig. 8*c*) flatly rounded, furca and second terminal bristle slightly asymmetrical. First two joints of outer ramus of posterior antennae fused, first joint of inner ramus shorter than second and about twice as long as broad. Inner ramus of mandible reaches the distal margin of second basal; first joint of inner ramus with two bristles, second joint with four. Second lobe on inner margin of maxilla absent, third lobe with three, second basal with 4 bristles; first and second joints of inner ramus of posterior maxilliped with 3 bristles.

♂ Secondary sexual characters not pronounced; right foot of fifth pair absent.

Coloration: Transparent; there was no pigment in my specimen.

Length: Female, 3 mm.

Occurrence: San Diego, June 16, 1904, one female.

4. **Eucalanus subtenuis** Giesbrecht.

Eucalanus subtenuis Giesbrecht, 1888, p. 333; 1892, pp. 132, 150, pl. 11, figs. 4, 23, 42; pl. 35, figs. 9-11, 18, 29, 30; 1898, p. 21.

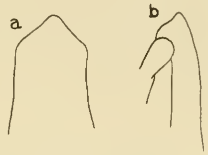

Fig. 9.—*Eucalanus subtenuis.* (*a*) Head of female, dorsal, ×20. (*b*) Head of female, lateral, ×20.

♀ Genital segment somewhat longer than broad, between it and anal segment one free segment; forehead (fig. 9*a*) as in *E. attenuatus,* but less prolonged and not indented on sides. First joint of outer ramus of posterior antennae fused with second, first joint of inner ramus 3 times as long as broad, and as long as second joint; second basal of mandible with 2 bristles on inner border, first joint of inner ramus with 2 bristles, second with 4; second inner lobe of maxilla absent, third with 4 bristles, second basal with 4; same number on first joint of inner ramus of posterior maxilliped.

♂ Secondary sexual characters not pronounced; right fifth foot absent.

Coloration: Transparent, without pigment.

Length: Female, 2.7 mm.

Occurrence: San Diego, June 16, 1904, one female.

2. Genus **Rhincalanus** Dana.

Calanus Dana, 1848, p. 11; 1849, p. 278.
Rhincalanus Dana, 1852, p. 1082; 1855, pl. 76, figs. 2*a-d*.
Rhincalanus Brady, 1883, p. 40.
Rhincalanus Giesbrecht, 1888, p. 334; 1892, pp. 47, 152, 761; 1898, p. 22.
Rhincalanus Scott, T., 1893, p. 30.

♀ Five segments in cepalothorax (head and thorax fused), fourth and fifth thoracic segments distinct. Head similar to *Eucalanus attenuatus,* but produced into a snout-like process (fig. 10*a*). Abdominal and thoracic segments with spines; abdomen with 3 segments, furca fused with last segment, and asymmetrical. Anterior antennae much longer than body, 23-jointed (joints 1 and 2, 8 and 9 fused); rami of posterior antennae equal in length; mandible not longer than the maxilla. Swimming feet short, rami of first pair 2-jointed, of second to fourth pairs 3-jointed. Fifth foot (fig. 10*b*) uniramous, present on both sides, each 3-jointed; second joint with one plumose bristle, third with two; a thicker bristle at end of third joint, plumose on inner border.

♂ Anterior antennae shortened; fifth foot on the left side 2-jointed.

Left fifth foot biramous............................ ♂
Both feet of fifth pair uniramous.................... ♀

1. Rhincalanus nasutus Giesbrecht.

Rhincalanus nasutus Giesbrecht, 1888, p. 334; 1892, pp. 152, 160; pl. 3, fig. 6; pl. 9, figs. 6, 14; pl. 12, figs. 9-12, 14, 16, 17; pl. 35, figs. 46, 47, 49; 1898, p. 22.

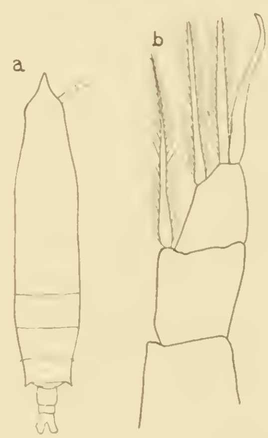

Fig. 10.—*Rhincalanus nasutus.* (*a*) Female, dorsal, ×18. (*b*) Fifth foot of female ×260.

♀ Front of head elongated; indented on the sides (fig. 10*a*); rostral filaments ventral, not visible from above. Fifth foot with one bristle on second joint, three on third (fig. 10*b*.)

♂ Right fifth foot with strongly curved bristle at end; left with long outer ramus reaching almost to end of inner ramus.

Coloration: Transparent; small amount of red on sides of body and faint yellowish tinge to whole, distinct from the glass-like clearness of *Eucalanus*.

Length: Female, 3 mm.; male, 2.7 mm.

Occurrence: A female was first seen, San Diego, June 10, 1904, but two or three occur in most catches when *Eucalanus* is abundant.

3. Genus **Mecynocera** I. C. Thompson.

Leptocalanus Giesbrecht, 1888, p. 334.
Mecynocera Thompson, I. C., 1888*a*, p. 150.
Mecynocera, Giesbrecht, 1892, p. 160; 1898, p. 23.
Mecynocera Wheeler, 1899, p. 167.

Furca symmetrical, articulating with anal segment; mandible shorter than maxilla and less than half as long as the fourth pair of feet, similar in structure to that of *Calanus*, but inner ramus is nearly as long as second basal and twice as long as outer ramus; inner ramus of posterior maxillipeds at least as long as first or second basal. First pair of feet with outer ramus of three joints, inner of one joint; fifth pair present, with five joints on either side. ♂ Unknown.

♀ Head distinct from thorax; rostral threads delicate; abdomen short, with three segments; genital segment and furca symmetrical. Anterior antennae of unequal length, more than twice as long as the body, with 23 joints, bristles few and very long. Inner ramus of posterior antennae nearly twice as long as outer ramus. The succeeding appendages, similar to those of *Calanus:* feet short, outer rami with three joints, inner ramus of first pair with one joint, of second to fourth with three; fifth pair with basals, outer ramus with three joints, inner ramus lacking.

1. **Mecynocera clausi** I. C. Thompson.

Mecynocera clausii Thompson, I. C., 1888*a*, p. 150, pl. 11, figs. 1-4.
Leptocalanus filiformis Giesbrecht, 1888, p. 334.
Mecynocera clausii Giesbrecht, 1892, p. 160, pl. 5, fig. 1; pl. 11, figs. 43, 45; pl. 35, figs. 21, 22; *M. clausi*, 1898, p. 23.
Mecynocera clausii Wheeler, 1899, p. 167, fig. 5.

The only species of the genus.

Coloration: Exceedingly transparent, without pigment in my specimens.

Length: Female, 0.9-1 mm.

Occurrence: The only specimens I have were collected December 30, 1903, on the "Banks" off Point Loma.

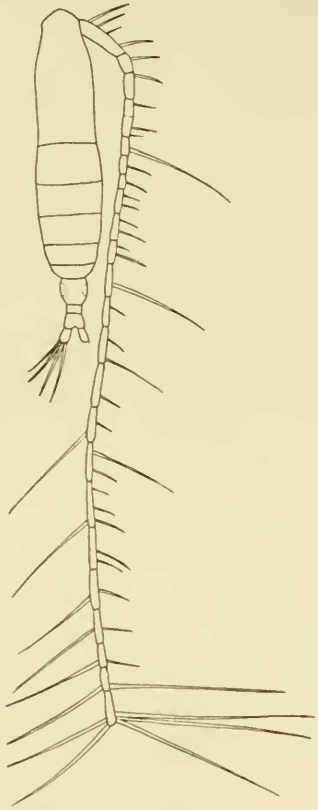

Fig. 11.—*Mecynocera clausi*. Female, dorsal, ×45.

Sub-fam. PARACALANINAE.

Paracalanina Giesbrecht, 1892, p. 48.

♀ Cephalothorax with four segments, abdomen with from two to four; rostrum ends in two soft filaments. Anterior antennae 25-jointed, with long terminal joints, but the division between the first and second and eighth and ninth joints may not be clear. Outer ramus of posterior antennae at most as long as the inner ramus; the mouth parts like those of *Calanus*. Terminal bristle of outer rami of feet with smooth border; basals and rami set with spines; fifth foot rudimentary (2- 4- jointed) or lacking.

♂ Characters as in the male of *Calanus;* the number of joints in the anterior antennae more reduced, the end-joint always shortened, and sometimes fused with the preceding one; fifth pair of feet weakly developed, the left 5-jointed, the right 4- or 2-jointed, or lacking.

1. Genus **Paracalanus** Boeck.

Calanus Claus, 1863, p. 172.
Paracalanus Boeck, 1864, p. 8.
Paracalanus Claus, 1881, p. 326.
Paracalanus Bourne, 1889, p. 145.
Paracalanus Giesbrecht, 1892, pp. 48, 164, 757; 1898, p. 23.
Paracalanus Dahl, 1893, p. 21.
Paracalanus Wheeler, 1899, p. 168.

Second basal of first pair of feet with an inner marginal bristle; proximal division of outer border of third joint of outer ramus of fourth pair (fig. 12*a*) over twice as long as the distal; outer border of the second joint not dentate; proximal division of the outer border of third joint of outer ramus in the third and fourth feet dentate; scalpelliform terminal bristle of the outer ramus in the third pair longer than the end joint; second joint of inner ramus of first pair with 5, third of same in second pair with 7 bristles. The abdomen of the female (fig. 12*b*) with 4 segments; the last joint of anterior antennae less than 1½ times as long as the next to the last. Fifth foot of female short, 2-jointed (fig. 12*c*); right foot of male with 2 joints, left with 5 (fig. 12*e*).

♀ Head fused with first thoracic segment, and fourth thoracic segment with fifth. Rostrum produced into two thin filaments. Genital segment and furca symmetrical, latter without bristle on outer margin. Anterior antennae with 25 joints. Outer ramus of posterior antennae shorter than inner; mandible with broad blade, the sack-like appendage on the first joint of the inner ramus small. Maxilla with obscure segmentation of inner ramus, without bristle on the second lobe of outer border, and with but one on the first inner marginal lobe. Anterior maxilliped with outer marginal bristle. Inner ramus of the first swimming foot with 2 joints, of the second to fourth foot with 3 joints.

♂ Abdomen with 5 segments. Number of joints of anterior antennae reduced through fusion of joints 1 to 6 and 7 to 8, end joint shortened but free. Aesthetasks enlarged and numerous.

Mandibular blade, appendages on inner border of maxilla and anterior maxilliped stunted, those of posterior maxilliped less so, its outer marginal bristles long and richly plumose. The swimming feet show slight peculiarities.

1. **Paracalanus parvus** Claus.

Calanus parvus Claus, 1863, p. 173, pl. 26, figs. 10-14; pl. 27, figs. 1-4.

Paracalanus parvus Claus, 1881, p. 327, pl. 3, figs. 1-16.

Paracalanus parvus Bourne, 1889, p. 145, pl. 11, figs. 1-3.

Paracalanus parvus Giesbrecht, 1892, pp. 164, 170; pl. 1, fig. 5; pl. 6, figs. 28-30; pl. 9, figs. 5-11, 25, 27, 31, 32; 1898, p. 24.

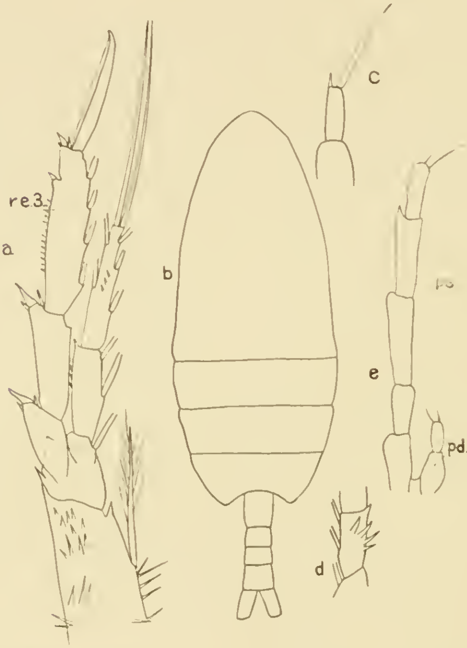

Fig. 12.—*Paracalanus parvus.* (*a*) Fourth foot of female ×195. *Re.*3, third joint of outer ramus. (*b*) Female, dorsal, ×83. (*c*) Fifth foot of female ×410. (*d*) Second joint of inner ramus of second foot of female ×195. (*e*) Fifth foot of male. *Ps.*, left foot. *Pd.*, right foot.

♀ Inner bristle of furca barely longer than the furca. Anterior antennae reach, when brought to the sides of the body, perhaps to the posterior border of the third abdominal segment.

First joint of inner ramus of maxilla with two bristles on anterior face. Third lobe of second basal of posterior maxilliped with two bristles. Inner margin of first basal of the fourth pair of feet ends in one or two points (fig. 12*a*); anterior and posterior faces of first basal of second to fourth pairs set with hairs and spines; surfaces of first and second joints of outer ramus of the third pair and of second joint of the fourth, naked. Fifth foot rudimentary, symmetrical.

♂ Fifth foot asymmetrical (fig. 12*e*); compare also generic description.

Coloration: Rather transparent, with red pigment in varying amounts and distribution, never very abundant.

Length: Both sexes within 0.8-1.2 mm.

Occurrence: Fairly common in hauls with smaller nets, both sexes being present summer and winter.

Sub-fam. Clausocalaninae.

Clausocalanina Giesbrecht, 1892, p. 49.

♀ Head usually fused with the first thoracic segment, fourth thoracic always fused with the fifth; rostrum ends in two short, soft filaments or is lacking; abdomen with four segments, furca symmetrical. Eighth and ninth joints of anterior antennae fused; terminal joint short, seldom fused with the preceding one. Outer ramus of posterior antennae 6-jointed and always longer than the inner ramus. The other appendages of the head for the most part as in *Calanus*. Inner ramus of the first pair of feet 1-jointed, of the second pair 2-jointed, of the third and fourth 3-jointed; terminal bristle of the outer rami with dentate border; third joint of outer ramus in second to fourth pairs with three bristles on outer border. Fifth pair rudimentary on each side, 3-jointed or lacking.

♂ Unknown in *Spinocalanus* and *Ctenocalanus*. Abdomen with shortened anal segment; anterior antennae and head appendages in some cases like those of the female, in others as in the *Paracalaninae*. Fifth pair of feet: the right, 1- to 5-, the left 5- jointed.

1. Genus **Clausocalanus** Giesbrecht.

Calanus Dana, 1849, p. 278; 1852, p. 1047.
Calanus Claus, 1863, p. 172.
Eucalanus Claus, 1881, p. 325.
Drepanopus (in part) Brady, 1883, p. 76.
Clausocalanus Giesbrecht, 1888, p. 334; 1892, pp. 50, 185, 733; 1898, p. 27.

Rostrum with two points; second basal of second and third swimming feet with toothed distal margin and broad outer ramus. Mouth parts and number of segments of anterior antennae reduced.

♀ Head fused with thorax and the fourth with the fifth thoracic segment. Abdomen with four segments, genital segment and furca symmetrical. Anterior antennae extend beyond the thorax, 23-jointed. Outer ramus of posterior antennae 1½ times as long as the inner, the former 6-jointed, with short bristles on the proximal joints. First joint of inner ramus of mandible with a very small, sack-like appendage. Maxilla and maxillipeds as in *Calanus*, outer marginal bristle lacking on anterior maxillipeds. Outer rami of swimming feet with 3 joints; inner ramus of first foot 1-jointed, of second 2-jointed, of third and fourth 3-jointed. End joint of outer ramus with finely dentate terminal bristle, and four bristles on inner border in second to fourth pairs; fifth pair uniramous, 3-jointed.

♂ Head fused with first thoracic segment, and elongated at expense of free thorax rings. Rostrum suppressed; abdomen with five segments, anal very short. Anterior antennae with joints 8-10, 13-16, 20-21, 24-25 fused. Outer ramus of posterior antennae twice as long as inner. Blade of mandible, appendage of inner border of maxilla, and anterior maxilliped suppressed; less so the posterior maxilliped, the outer marginal bristle of which is not enlarged. Swimming feet elongated. Left fifth foot (fig. 13*c*) long, uniramous and with 5 joints, right short, 1- to 3-jointed.

1. **Clausocalanus arcuicornis** Dana.

Calanus arcuicornis Dana, 1849, p. 278; 1852, p. 1056; 1855, pl. 72, fig. 9*a-b*.
Calanus mastigophorus Claus, 1863, p. 173, pl. 27, figs. 5-8.

Clausocalanus arcuicornis Giesbrecht, 1888, p. 334; 1892, pp. 186, 193; pl. 1, fig. 14; pl. 2, fig. 7; pl. 10, figs. 3-8, 14, 16, 17, 19; pl. 36, figs. 29-31, 34; 1898, p. 27.
Clausocalanus arcuicornis Wheeler, 1899, p. 171, fig. 9.

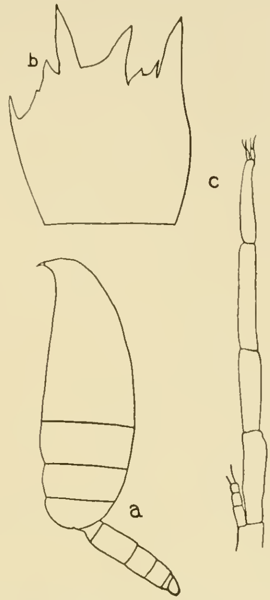

Fig. 13.—*Clausocalanus arcuicornis.* (*a*) Male, lateral, ×45. (*b*) Second basal of second foot to show toothed distal margin, ×410. (*c*) Fifth foot of male ×83.

♀ Genital segment longer than the two following. Furca about as long as broad. No aesthetask on fourth, sixth, eighth, eighteenth or twenty-second joints of the anterior antennae.

♂ Second segment of abdomen at least as long as the third and fourth together (fig. 13*a*) ; right foot of fifth pair with three joints (fig. 13*c*).

Coloration: Not very transparent, with red pigment in various places on the posterior part of the body and on genital segment.

Occurrence: San Diego, June 25, 1904, one male.

Sub-fam. AETIDIINAE.

Aetidiina Giesbrecht, 1892, p. 52.
Aetidiinae Wolfenden, 1903, p. 263.

♀ Head sometimes distinct from first thoracic segment; otherwise the cephalothorax always has four segments, as has the abdomen invariably. Rostrum strongly chitinized, usually with one point, seldom with two or lacking. Genital segment and furca usually symmetrical. In the anterior antennae the eighth and ninth and twenty-fourth and twenty-fifth joints are fused. Outer ramus of posterior antennae at least fully as long as the inner, and usually longer; the second and third joints of the outer ramus are distinct. Mandible as in *Calanus,* with strong blade, and occasionally shortened inner ramus. Maxilla with well developed lobes on inner margin and usually with hooked bristles even on the second basal and the inner ramus; outer ramus relatively small. Bristles of anterior maxilliped short but strong, those of the inner ramus relatively slender and sparsely plumose; the articulation of the inner ramus is rather on the posterior surface of the second basal than at the end. Inner ramus of posterior maxillipeds at most ⅔ as long as the second basal. Inner ramus of first swimming feet always 1-jointed; that of the second almost always 1-jointed, while in the second and third the inner ramus is 3-jointed; the form of the swimming feet as in the Clausocalaninae; inner marginal bristle of first basal long and plumose.

♂ Known in *Aetideus, Euchirella* and *Undeuchaeta.* Characters like those of *Clausocalanus;* occasionally the twentieth and twenty-first joints of one of the anterior antennae are fused. Left foot of fifth pair 5-jointed (if the right is lacking, or stylet-like, in which case the right is claw-like).

1. Genus **Aetideus** Brady.

Aetidius Brady, 1883, p. 75.
Aetidius Thompson, 1888b, p. 142.
Aetidius Giesbrecht, 1892, pp. 53, 213.
Aetideus Wolfenden, 1903, p. 266; 1904, p. 116.
Aetideus Giesbrecht, 1898, p. 31.

♀ Cephalothorax and abdomen with four segments, symmetrical; rostrum large, prolonged into two thick chitinous prongs; last thoracic segment produced into a spine on each side. Anterior antennae 23-jointed, reaching about to the end of body. Rami of posterior antennae about equal in length, outer ramus 7-jointed. Outer rami of all swimming feet 3-jointed, inner ramus of first and second pairs 1-jointed, of third and fourth 3-jointed. Fifth pair of feet absent.

♂ Anal segment very short, abdomen with five segments. Anterior antennae 20-jointed, joints 8-10, 12 and 13, 20 and 21, 24 and 25 fused. Blade of mandible, appendages of inner border of maxilla and anterior maxilliped stunted. Left fifth foot uniramous, 5-jointed; right lacking; swimming feet as in female.

1. **Aetideus armatus** Brady.

Aetidius armatus Brady, 1883, p. 75, pl. 10, figs. 5-16.
Aetidius armatus Giesbrecht, 1892, p. 213, pl. 2, fig. 6; pl. 14, figs. 1-13; pl. 36, figs. 6-9.
Aetideus armatus Giesbrecht, 1898, p. 31.
Aetideus armatus Wolfenden, 1903, p. 266.

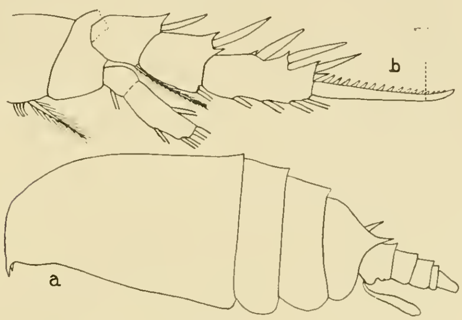

Fig. 14.—*Aetideus armatus.* Female. (*a*) Animal from side ×20. (*b*) Second foot ×83. *St.*, terminal bristle of outer ramus.

With the characters of the genus.

Coloration: Rather transparent; there was no pigment in my specimens, but Giesbrecht says that red may occur in the body.

Length: Female, 3 mm.

Occurrence: San Diego, June 9, 1904, one female; June 14, two females.

2. Genus **Gaidius** Giesbrecht.

Gaidius Giesbrecht, 1895, p. 249; 1898, p. 32.
Gaidius Wolfenden, 1902, p. 365; 1903, p. 266; 1904, p. 114, pl. 9, figs. 7, 8.

Rostrum short, one point (fig. 15*b*), sides of last thoracic segments produced into a sharp spine (fig. 15*a*). Inner ramus of posterior antennae three-fourths as long as outer. Outer ramus of first foot 2-jointed, of the second to fourth 3-jointed, inner ramus of first and second feet 1-jointed, of the third and fourth 3-jointed.

May be distinguished from *Actideus* by the form of the rostrum, relatively shorter inner ramus of the posterior antennae, and by the fusion of the proximal joints of the outer ramus of the first foot (fig. 15*d*).

1. **Gaidius pungens** Giesbrecht.

Gaidius pungens Giesbrecht, 1895, p. 249, pl. 1, figs. 1-4; 1898, p. 32.

Gaidius pungens Wolfenden, 1903, p. 266.

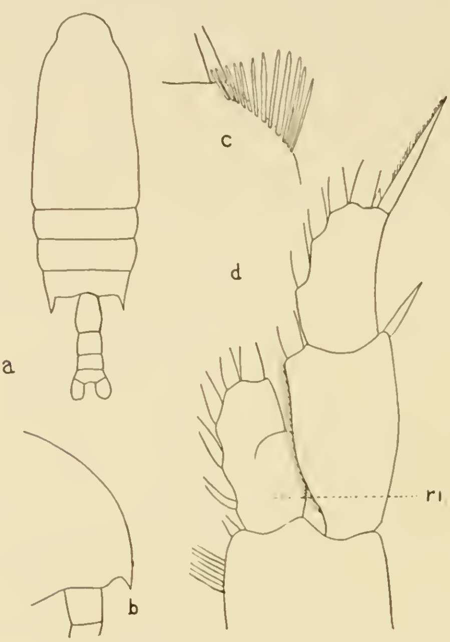

Fig. 15.—*Gaidius pungens.* Female. (*a*) Dorsal, ×18. (*b*) Head, lateral, ×45. (*c*) Tube-like processes on inner distal portion of second basal of fourth foot ×195. (*d*) First foot ×195. *Ri.*, inner ramus.

♀ Anterior antennae reaching at least to posterior border of thorax. The processes on the inner border of the first basals of the fourth feet are heavier and stiffer than in the preceding pairs, being almost tube-like (fig. 15*c*).

♂ Unknown.

Coloration: Transparent, with little or no pigment.

Length: Female, 3 to 3.5 mm.

Occurrence: San Diego, May 31, 1904, eight females; two males which seem to be of this species were taken also at this time, but they are distinctly immature.

3. Genus **Undeuchaeta** Giesbrecht.

Euchaeta (in part) Brady, 1883, p. 57.
Undeuchaeta Giesbrecht, 1888, p. 335; 1892, pp. 54, 227, 766; 1898, p. 33.
Undeuchaeta Sars, 1900, p. 58, pls. 15, 16.
Undeuchaeta Wolfenden, 1903, p. 267.

♀ Abdomen with four segments, the first with the genital opening on the convex ventral surface, at least as long as the second and longer than the last segment. Lateral angles of last thoracic segment rounded, or at least not produced into spines. Anterior antennae 23-jointed, outer ramus of first foot 2-jointed, inner ramus 1-jointed. Outer ramus of posterior antennae at least 1½ times as long as the inner; outer ramus of maxilla (fig. 16*e*) small, middle bristles shorter than the distal and proximal ones, outer marginal lobe with much elongated middle bristles.

♂ Anterior antennae 21-jointed, cephalo-thorax with four segments, abdomen with five, anal segment very short. Head with rather high crest (fig. 16*d*), last thoracic segment prolonged into angles, but not pointed. Inner ramus of posterior antennae ¾ as long as the outer. Mandible, maxilla and maxillipeds much reduced. Outer ramus of first foot indistinctly 3-jointed. Left foot of fifth pair uniramous (inner ramus reduced to a very small, rod-like projection), outer ramus (fig. 16*f*) ending in a short style (terminal joint of ramus). Right foot biramous. Terminal joint of outer ramus produced into a long stylet, inner ramus as in *Euchaeta* (cf. fig. 23*a*); outer ramus of each foot 3-jointed. The second joint of the outer ramus of the left foot (fig. 16*f*. *Re*. 2) bears a toothed process (fused with the joint) which flares distally; at the base of this and on the second joint is articulated a process, which together with the terminal joint of the ramus and the toothed process forms a forceps.

The abdominal segments are densely covered with fine spines or hairs, and the posterior margins of the segments are toothed.

In the structure of the fifth pair of feet these male animals very closely resemble the males of the genus *Euchaeta*, but seem to be distinct from the latter in bearing an *articulating* process on the second joint of the outer ramus of the left foot. There is a muscle attached to the process which serves to move it.

The relative lengths of the rami of the posterior antennae distinguish the animals from *Euchirella*, as does the division (though indistinct) of the outer ramus of the first foot into three joints. In *Euchaeta*, the outer ramus of the first foot is distinctly 3-jointed in the male, and the rami of the posterior antennae are about equal in length. In several female specimens also the outer rami of the first feet are indistinctly divided into three joints, and the sexes correspond in this respect.

Sars (1900, p. 59-63) has described the male and female of *Undeuchaeta spectabilis*. So far as I know, his is the first record of the male of the genus. In his specimens the anterior antennae of the female are 24-jointed, while in Giesbrecht's the number of joints is 23. In his description of the male, Sars gives the number of joints of the anterior antennae as 22, but in his drawing (pl. 16, fig. 2) there are but 21. The fifth pair of feet in the male of *U. spectabilis* is very different from that in the San Diego specimens, a striking point being that both the right and left feet are biramous.

The description of the male of the genus given above is based upon the San Diego specimens.

1. **Undeuchaeta major** Giesbrecht.

Euchaeta australis Brady, 1883, p. 65, pl. 21, figs. 5-11.
Undeuchaeta major Giesbrecht, 1888, p. 336; 1892, pp. 227, 232, pl. 37, figs. 56, 57, 59; 1898, p. 34.

♀ Head with median crest, genital segment with protrusion on right side and a hooked pointed appendage at the right of the genital opening (fig. 16*a*).

♂ (new) Compare generic description.

Coloration: Female not especially transparent, with red pigment on basals of posterior maxillipeds, and in mouth region. Male: plumose bristles of furca steel-blue; those of posterior antennae and mandible red; on the feet the bristles are faintly red on the outer ends.

Length: Female, 4.5-5.5 mm.; male, 6-6.5 mm.

Occurrence: Four females were taken from May 18 to June 23, 1904; five on December 23, 1904, on the "Banks." One male was taken in July, 1904; another on November 1, 1904, off Point Loma.

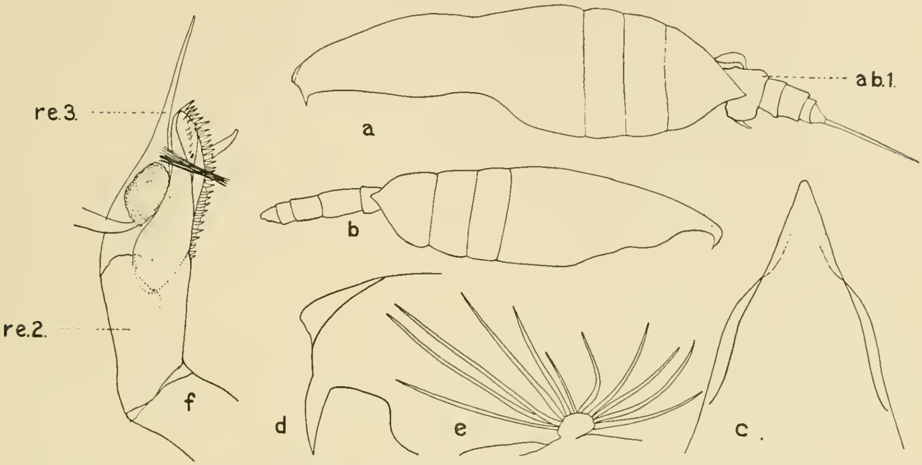

Fig. 16.—*Undeuchaeta major.* (*a*) Female, lateral, ×20. *Ab.*1, first abdominal segment. (*b*) Male, lateral, ×9. (*c*) Head of male, dorsal, ×83. (*d*) Head of male, lateral, ×83. (*e*) Outer ramus of maxilla of female ×195. (*f*) Distal portion of left fifth foot of male. *Re.*2, *Re.*3, respective joints of outer ramus.

2. **Undeuchaeta minor** Giesbrecht.

Undeuchaeta minor Giesbrecht, 1888, p. 335; 1892, pp. 228, 232, pl. 14, figs. 31-34; pl. 37, figs. 55, 58; 1898, p. 34.

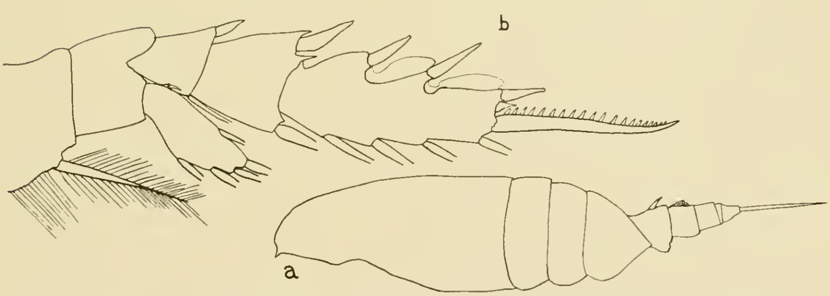

Fig. 17.—*Undeuchaeta minor.* Female. (*a*) Lateral, ×20. (*b*) Second foot ×83.

♀ Head without crest (fig. 17*a*), genital segment with a spine on the dorsal surface.

Coloration: Similar to that of *U. major*. The digestive tract of the single specimen was filled with orange red material.

Length: Female, 3.18 mm.

Occurrence: San Diego, June 14, 1904.

4. Genus **Euchirella** Giesbrecht.

Undina (in part) Lubbock, 1856, p. 21.
Calanus (in part) Lubbock, 1856, p. 15.
Undina Claus 1863, p. 186.
Euchaeta (in part) Brady, 1883, p. 59.
Euchirella Giesbrecht, 1888, p. 336; 1892, pp. 54, 233, 743; 1898, p. 34.
Euchirella Cleve, 1900, p. 4.
Euchirella Wolfenden, 1903, p. 267.

Rostrum present in most species, simple; lateral angles of last thoracic segment not pointed. Inner ramus of posterior antennae ½ to ¼ as long as the outer ramus, the two proximal joints of which are fused. Inner and outer rami of the maxilla short, the former provided with heavy hooked bristles. Outer ramus of the first pair of feet 2-jointed, that of the second to fourth pairs 3-jointed. Inner ramus of first and second pairs 1-jointed, of the third and fourth 3-jointed. Right foot of fifth pair of male with shear-like formation of distal portion, the left foot stylet-like (cf. figs. 18*d*, 19*b*).

♀ Head not always distinct from thorax, last two thoracic segments fused. Abdomen with four segments, genital segment and furcal bristles symmetrical or asymmetrical. Anterior antennae with 23 joints, reaching to the end of the thorax or somewhat beyond. Second basal of posterior maxillipeds twice as long as the 5-jointed inner ramus. Feathering on the inner margin of the proximal basal joint of the fourth pair of feet replaced by spines. Fifth pair of feet absent.

♂ Head occasionally with a median crest; abdomen with five segments, anal segment very short. Joints 20 and 21 of right anterior antennae fused, inner ramus of posterior antenna relatively longer than in the female. Blade of mandible, appendages on inner border of maxilla, and anterior maxillipeds reduced;

posterior maxilliped slender. Spines on second basal of fourth foot unusual. Right foot of fifth pair biramous, with forceps; left stylet-like, with rudimentary inner ramus.

KEY TO SPECIES.

Fifth foot absent .... ♀
Fifth foot present .... ♂
♀1. Head without crest, and rostrum one-pointed (fig. 19*a*) 2
1. Head with crest, rostrum present (fig. 20*a*) 4
2. Outer ramus of posterior antenna about twice as long as inner.. .... **E. rostrata**
2. Outer ramus nearly four times as long as inner (fig. 20*c*) 3
3. Genital segment with long sac-like appendage on left side (fig. 18*b*) .... **E. messinensis**
4. Head with low crest (fig. 20*a*) ....**E. pulchra**
4. Head with high crest (fig. 22*a*) .... **E. galeata**
♂ Head with low crest (fig. 18*c*) 2
Head without crest (fig. 21*a*) 3
2. Forceps-like terminal portion of right fifth foot longer than the basal portion (fig. 18*d*) .... **E. messinensis**
2. Terminal portion (forceps) of right fifth foot shorter than the basal portion (fig. 20*b*) ....**E. pulchra**
3. Fifth foot short, the right about four times as long as the second basal is broad (fig. 21*b*) ....**E. amoena**
3. Right fifth foot six times as long as the second basal joint. .**E. rostrata**

1. **Euchirella messinensis** Claus.

Undina messinensis Claus, 1863, p. 187, pl. 31, figs. 8-18.
Euchirella messinensis Giesbrecht, 1892, pp. 232, 244; pl. 15, figs. 12, 16, 21, 24; pl. 36, figs. 14, 15, 18, 24, 25; 1898, p. 35.

♀ Forehead with rostrum, without crest (fig. 18*a*); genital segment asymmetrical, with sac-like appendage on left side of dorsal surface (fig. 18*b*); third terminal bristle on right side of furca elongated. Inner ramus of posterior antenna ¼ as long as outer, second joint of former with 5-4 bristles. First basal of fourth pair of feet with one or two spines on inner border, the longer of which reaches beyond the end of the joint.

♂ Forehead with a low and rather long crest (fig. 18*c*); fifth foot slender, the right foot (fig. 18*d*) over seven times as long as the second basal is broad, the forceps longer than the basals.

Coloration: Not very transparent; red pigment in body and on bristles of posterior antennae, and basals of swimming feet.

Length: Female, 4.5 mm.; male, 4 mm.

Occurrence: July 9, 1903, one male; July 22, 1903, one female.

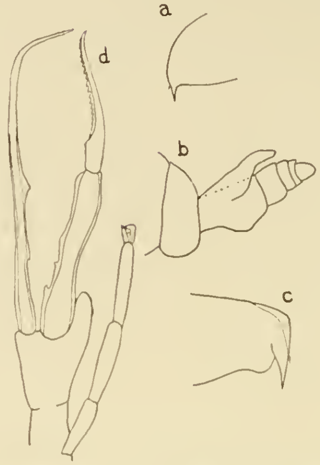

Fig. 18.—*Euchirella messinensis.* (*a*) Head of female, lateral, ×15. (*b*) Abdomen of female ×15. (*c*) Head of male ×30. (*d*) Fifth foot of male ×20.

2, **Euchirella rostrata** Claus.

Undina rostrata Claus, 1866, p. 11, pl. 1, fig. 2.
Euchaeta hessei Brady, 1883, p. 63, pl. 20, figs. 1-13; pl. 23, figs. 11-14.
Euchirella rostrata Giesbrecht, 1892, pp. 233, 245, pl. 15, figs. 3, 13, 25; pl. 36, figs. 19, 20; 1898, p. 36.
Euchirella rostrata Cleve, 1900, p. 4, pl. 2, figs. 1-12.

♀ Front without crest, with rostrum, abdomen symmetrical. Inner ramus of posterior antennae ½ as long as outer ramus; second joint of inner ramus with 8-6 bristles. First basal of fourth pair of feet (fig. 19*b*; B. 1) with 6 or 7 triangular lamellae on the inner border. Bristle on outer margin of second joint of outer ramus of the second pair reaches at least to the point of the first bristle on the outer border of the third joint of the ramus.

♂ Head without crest, with rostrum. Fifth foot six times as long as its second basal joint. Margin of second joint of outer ramus not denticulate, third joint smooth. Inner ramus of posterior antenna ½ as long as outer. First basal of fourth foot without triangular lamellae. (Cleve 1900).

The male was described by Cleve, 1900, and is identical with *Euchaeta hessei* Brady.

Coloration: Red pigment as in *E. messinensis*, but more abundant, especially on swimming feet.

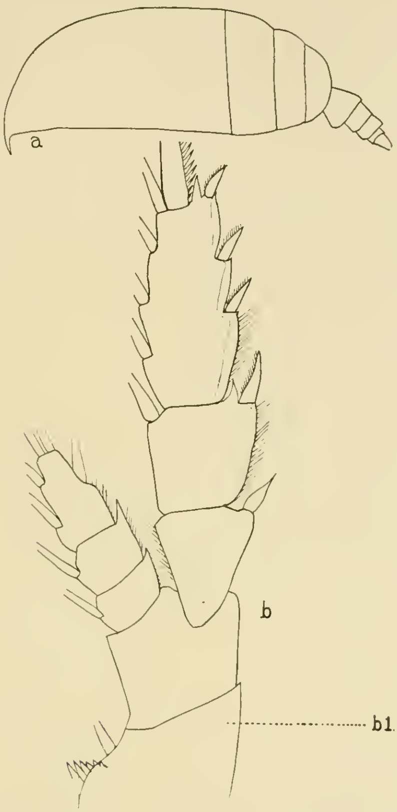

Fig. 19.—*Euchirella rostrata.* (*a*) Female, lateral, ×18. (*b*) Fourth foot, female, ×83. *B.*1, first basal, showing lamellar processes.

Length: Female, 2.97-3.1 mm.

Occurrence: San Diego, July 14, 16, 21, 1903, females; May 24, 1904, two females; June 2, 1904, one female.

3. **Euchirella pulchra** Lubbock.

Undina pulchra ♂ Lubbock, 1856, p. 26, pl. 4, figs. 5-8; pl. 7, fig. 6.
Calanus latus ♀ Lubbock, 1856, p. 15, pl. 2, fig. 12; pl. 11, figs. 8-11.

Euchaeta pulchra Brady, 1883, p. 63, pl. 14, fig. 7; pl. 20, figs. 15, 17, 19.

Euchirella pulchra Giesbrecht, 1892, pp. 233, 244, pl. 15, figs. 22, 23, pl. 36; figs. 13, 27; 1898, p. 36.

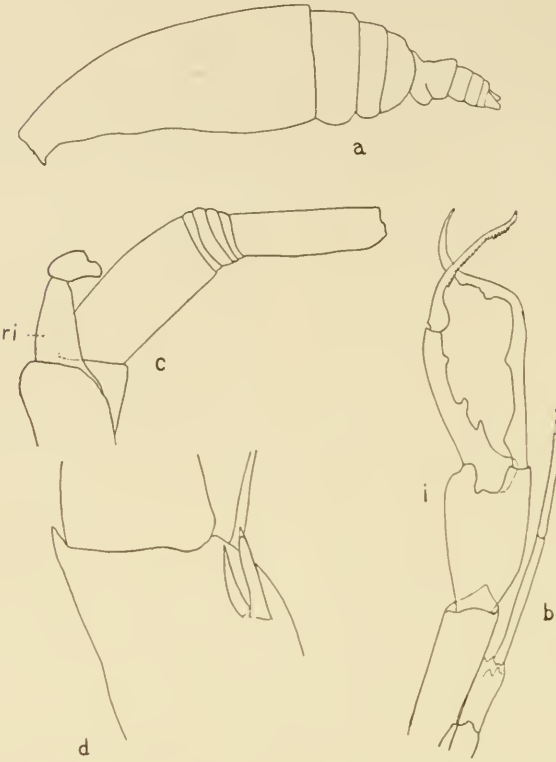

Fig. 20.—*Euchirella pulchra.* (*a*) Female, lateral, ×9. (*b*) Fifth foot of male ×45. (*c*) Rami of posterior antennae, to show relative lengths; bristles omitted, ×83. *Ri.*, inner ramus. (*d*) First basal of fourth foot of female ×140.

♀ Front with low crest (fig. 20*a*) and small rostrum. Genital segment asymmetrical; left side strongly convex in front of the middle of the segment, right side indented. Inner ramus of posterior antennae about ⅔ as long as outer ramus; second joint of inner ramus with 6-5 bristles. First basal of fourth pair of feet (fig. 20*d*) with one or two thorns about equal in length on the inner border, which do not reach the distal margin of the joint. Outer bristle of the second joint of the outer ramus of the second pair at most as long as the first outer bristle of the third joint.

♂ Considerably like *E. messinensis,* the chief difference being in the structure of the fifth pair of feet (fig. 20*b*). The claw of the right foot is shorter than the basal (in *messinensis* longer).

Coloration: About as in *E. messinensis.*

Length: Female, 3.4-4 mm.; male, 3.5 mm.

Occurrence: San Diego, May 31, 1904, two immature males, one female; June 23, 1904, one female adult; December 23, 1904, "Banks," eleven females, all adult; one male adult, December 30, 1904, on the "Banks."

4. **Euchirella amoena** Giesbrecht.

Euchirella amoena Giesbrecht, 1888, p. 336; 1892, pp. 233, 244; pl. 15, fig. 20; 1898, p. 36.

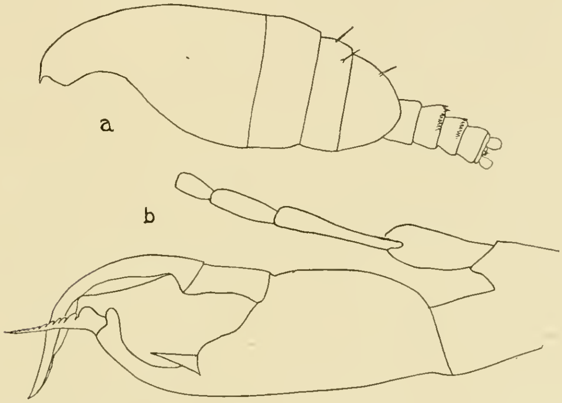

Fig. 21.—*Euchirella amoena.* Male. (*a*) Lateral ×20. (*b*) Fifth foot ×45.

♀ Unknown.

♂ Front without crest. Fifth pair of feet shortened, the right about four times as long as the second basal is broad.

Length: Male, 3.02 mm.

Occurrence: San Diego, May 28, 1904, one male.

5. **Euchirella galeata** Giesbrecht.

Euchirella galeata Giesbrecht, 1888, p. 336; 1892, p. 233, 244; pl. 15, fig. 18; pl. 36, figs. 22, 26; 1898, p. 36.

♀ Head with high crest, and rostrum; genital segment asymmetrical, strongly protruding on the posterior portion of the dorsal surface. Inner ramus of posterior antennae about ⅖ as long as the outer; basals of fourth foot about as in *E. pulchra,* the spines not reaching to the distal border of the joint.

♂ Head as in the female.

Coloration: Opaque, without pigment.

Length: Female, 6.5 mm.

Occurrence: San Diego, November 18, 1904, one adult female, two immature males.

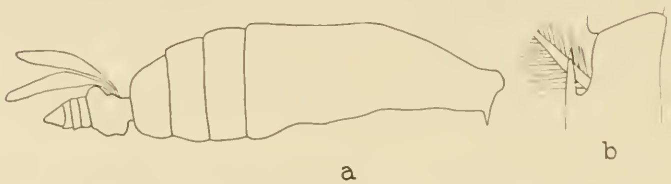

Fig. 22.—*Euchirella galeata.* Female. (*a*) Lateral ×9. (*b*) First basal of fourth foot ×83.

Sub-fam. EUCHAETINAE.

Euchaetina Giesbrecht, 1892, p. 55.

♀ Rostrum with one point; a pouch-like appendage in front of the upper labium. Inner marginal bristle of furca very long. Distal hooked bristles of anterior maxillipeds longer than the proximal. Outer ramus of first pair of feet 2-jointed, of the second to fourth 3-jointed; inner ramus of first and second pairs 1-jointed, of the third and fourth pairs 2-jointed.

♂ Abdomen as in the *Clausocalaninae.* Outer ramus of first pair of feet 3-jointed; fifth foot on each side with 2-jointed basal, and biramous; inner ramus of left stylet-like, of right truncate; left outer ramus 3-jointed, right 2-jointed.

1. Genus **Euchaeta** Philippi.

Euchaeta Philippi, 1843, p. 54, pl. 4, fig. 5.
Euchirus Dana, 1846, p. 183.
Euchaeta Dana, 1848, p. 20; 1849, p. 279; 1852, p. 1084.
Euchaeta Claus, 1863, p. 163.
Euchaeta Giesbrecht, 1892, pp. 55, 245, 740; 1895, p. 251; 1898, p. 37.

♀ Cephalothorax with five segments, the last two thoracic segments fused; abdomen with four segments, genital segment more or less asymmetrical. Anterior antennae of varying relative lengths, but of characteristic form, with 23 joints. Rami of posterior antennae about equal in length, outer ramus with seven joints. Blade of mandible with few but strong teeth. Second basal joint of the posterior maxilliped at least three times as long as the inner ramus of five joints. Inner marginal bristle of first basal of the swimming feet long and richly plumose, terminal bristle of outer rami finely toothed; fifth pair absent.

♂ Head fused with thorax; abdomen with five segments, anal segment short; innermost bristle of furca shortened and bent at an angle. Blade of mandible, appendage of inner border of maxilla, and anterior maxilliped stunted; less obvious differences also in the posterior antennae and maxillipeds and swimming feet; outer ramus of first pair of feet 3-jointed. Feet of fifth pair long, strongly built, and of rather complicated structure (fig. 23*a*).

KEY TO SPECIES.

Fifth foot absent .... ♀
Fifth foot present .... ♂
♂1. Terminal joint at each foot of fifth pair, with long straight or slightly curved stylet; elevation for frontal organ not protruding .... **E. acuta**
♀1. Hairs of frontal organ on a low elevation (fig. 25*b*) 2
1. Hairs of frontal organ on an elevation which extends toward the front (fig. 24*b*) 4
2. Genital segment with asymmetrical outgrowths (figs. 25*c*, *d*); no bristle in middle of outer border of first joint of outer ramus of the first foot; terminal bristles of furca about equal in length, the dorsal (inner) bristle much longer and thicker (fig. 25*g*) 3
3. Genital segment with a knob-like protuberance in front on the left side .... **E. acuta**
3. Genital segment without such an outgrowth .... **E. media**
4. Middle spine on outer border of terminal joint of second foot longer than the others, and the distal indentation in the border deeper (fig. 24*c*) 5
5. Anterior antennae longer than body .... **E. spinosa**

1. **Euchaeta acuta** Giesbrecht.

Euchaeta acuta Giesbrecht, 1892, pp. 246, 262, pl. 16, figs. 6, 10, 14, 18, 21, 27, 39 ;pl. 37, figs. 47, 48, 52; 1898, p. 38.

♀ Elevation on front of head flat; genital segment asymmetrical, more strongly convex on the right side than on the left, and with more prominent process at the right of the opening; a knob-shaped outgrowth on anterior part on left side. Furca with four terminal bristles nearly equal in length, inner bristle of furca much thicker than end bristles. Anterior antennae reach a little beyond the posterior end of the thorax.

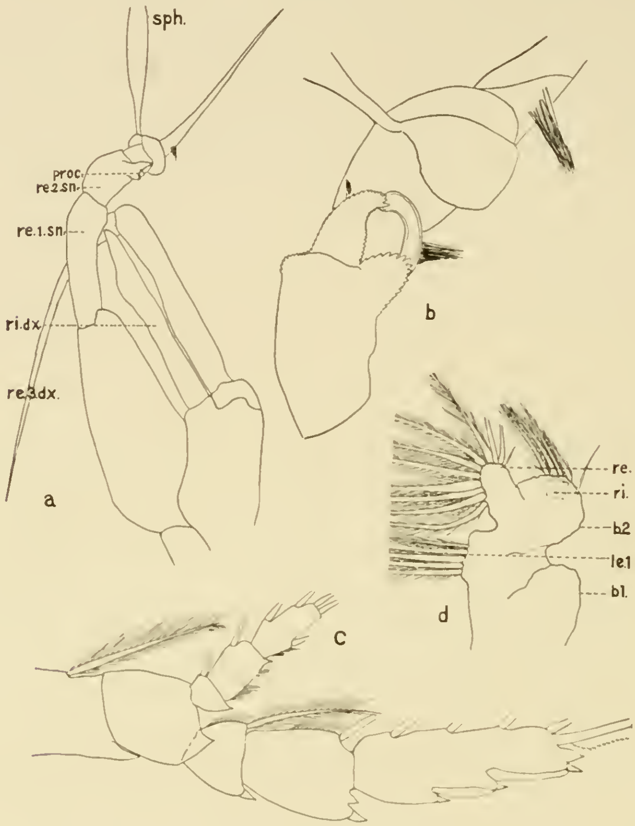

Fig. 23.—*Euchaeta acuta.* (*a*) Fifth foot of male ×37. *Ri. dx.*, inner ramus of right foot. *Re.* 3, *dx.*, third joint of outer ramus. *Re.* 1, 2, *sn.*, first and second joints of outer ramus of left foot. *Proc.*, process. *Sph.*, spermatophore. (*b*) Second and third joints of outer ramus of left fifth foot of male ×140. Parts as in *a.* (*c*) Second foot of male ×60. (*d*) Maxilla of male ×60. *B.*1, first basal. *B.*2, second basal. *Le.*1, first lobe of outer margin. *Ri.*, inner ramus. *Re.*, outer ramus.

First lobe of outer border of maxilla (*cf.* fig. 25*f*) with six bristles(one very small). second basal with three, fused second and third joints of inner ramus with four. Outer border of first joint of outer ramus of first pair of feet concave; outer border of third joint of outer ramus of second pair and its outer bristles different than in the following pairs of feet; outer marginal bristle of second joint of outer ramus reaches almost to end of the first outer marginal bristle of the third joint. Third joint of outer ramus of left fifth foot of male (fig. 23*a*) with a stiletto-like process; second joint with a finely dentate, pyramidal and pointed process (*proc.*).

Coloration: Rather opaque, a fleck of red pigment in the mouth; most of the pigment is found on the back and sides of the cephalothorax, and on the posterior maxillipeds.

Length: Female, 4 mm.; male, 3.5-4 mm.

Occurrence: July 31, 1903, one male; June 23, 1904, one male and one female. A good many (12-15) males were taken at one time on December 23, 1903, on the "Banks."

2. **Euchaeta spinosa** Giesbrecht.

Euchaeta spinosa Giesbrecht, 1892, pp. 246, 263, pl. 16, figs. 12, 26, 34, 47; pl. 37, figs. 31, 34, 35, 50; 1898, p. 39.

♀ Elevation in front of head (fig. 24*a*) produced anteriorly; genital segment almost symmetrical, with large, flap-like projection at each side of the orifice (fig. 24*b*). Second terminal bristle of the furca longer than the other terminal bristles, dorsal bristle much thicker than the terminal ones. Anterior antennae reach beyond the end of the furca by more than the end joints. First outer marginal lobe of maxilla with eight bristles, second basal with three, fused second and third joints of inner ramus with four. Outer border of first joint of outer ramus of first foot concave; outer border of third joint of outer ramus of second pair and its outer bristles different than in the following pairs; outer marginal bristle of second joint reaches to the end of the first marginal bristle of the third joint (fig. 24*c*). Basals and rami of posterior pairs of feet covered in places with short spines (fig. 24*d*).

♂ Unknown.

Coloration: Red in cephalothorax, sometimes on furca. plumose bristles of maxillipeds same color. Eggs blue.

Length: Female, 6 mm. or over.

Occurrence: July 21, 1903, one female; May 26, 1904, one female; July 5, 1904, four females; May 28, 1904, two females, one with egg cases, one without.

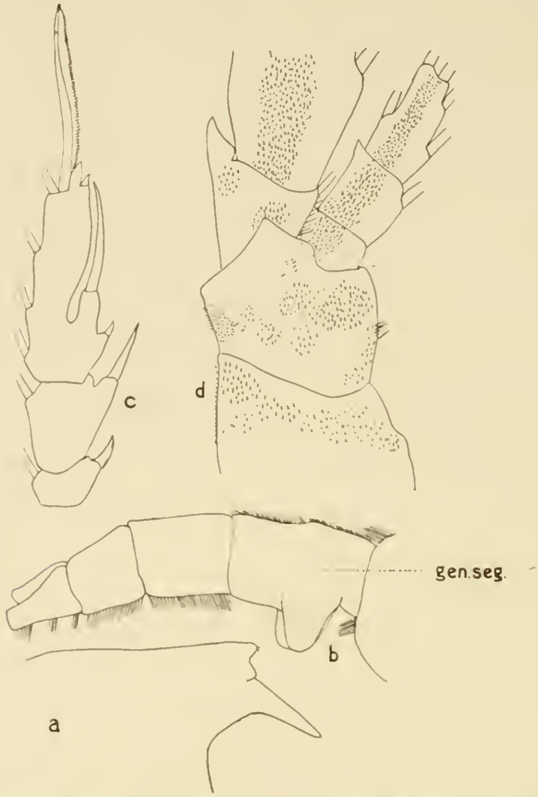

Fig. 24.—*Euchaeta spinosa.* Female. (*a*) Head, lateral, ×15. (*b*) Abdomen, lateral, ×48. *Gen. seg.*, genital segment. (*c*) Outer ramus of second foot ×45. (*d*) Basals, inner ramus, proximal joints of outer ramus of fourth foot ×45.

3. **Euchaeta media** Giesbrecht.

Euchaeta media Giesbrecht, 1888, p. 337; 1892, pp. 246, 263, pl. 16, figs. 13, 36; pl. 37, figs. 39, 40; 1898, p. 39.

♀ Elevation on front of head low (fig. 25*b*); genital segment asymmetrical with processes in the region of the orifice and a flap on the right side of the segment behind the orifice (figs. 25*c*, *d*); furca (fig. 25*g*) as in *E. acuta.* Anterior antennae extend a little beyond the posterior border of the genital segment.

First outer marginal lobe of the maxilla (fig. 25*f*) with eight bristles, second basal with three, fused second and third joints of the inner ramus with four. Outer border of first joint of outer ramus of first foot concave; outer border of third joint of second pair and its outer bristles different than in the following pair.

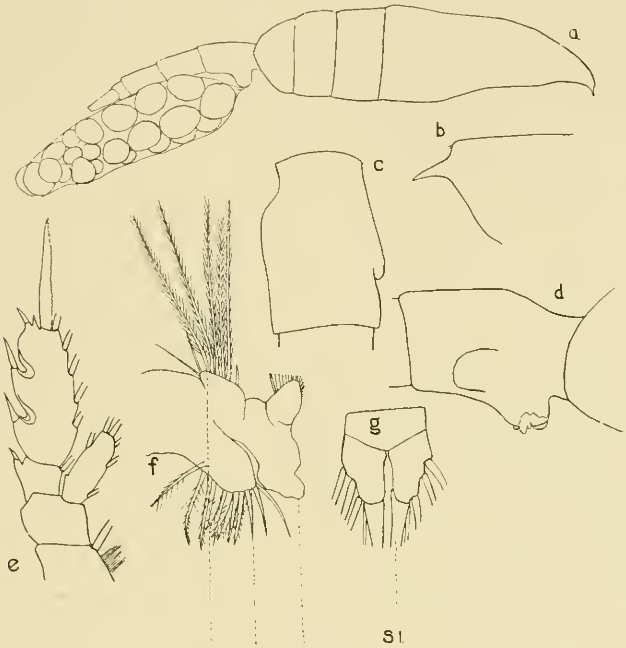

Fig. 25.—*Euchaeta media.* Female. (*a*) Lateral, ×18. (*b*) Head, lateral, ×83. (*c*) Genital segment, dorsal, ×45. (*d*) Genital segment, from right side ×45. (*e*) Second foot ×83. (*f*) Maxilla ×83. *Le.*1, first lobe of outer margin. *Li.*1, first lobe of inner margin. *Ri.*2, 3, fused second and third joints of inner ramus, bristles not shown. (*g*) Furca, dorsal, ×45. *Si.*, inner marginal bristle.

♂ Unknown.

Coloration: Rather transparent; there is no pigment in the preserved specimens I have seen.

Length: Females average about 3.3 mm.

Occurrence: Forty or fifty females, many with eggs, were taken December 23, 1903, on the "Banks" with males of *E.*

acuta. Three or four females were taken during June and July, 1904.

The specimens which I have placed in this species correspond to Giesbrecht's descriptions; but the females have hairs on the ventral sides of the abdominal segments, and Giesbrecht does not mention these nor figure them (1892, pl. 37, figs. 39, 40). The outer marginal lobe of the maxilla is always provided with eight bristles, but one of these is very inconspicuous and much shorter than the others. As these animals correspond very closely in other respects to Giesbrecht's specimens, especially in the form of the genital segment, I have thought best to include them under his species, even though there are slight differences.

Sub-fam. Scolecithricinae.

Scolecithricina Giesbrecht, 1892, p. 55.

♀ Head commonly fused with first, and fourth with fifth thoracic segment; rostrum with two usually soft filaments; abdomen with four segments, symmetrical. Eighth and ninth joints of anterior antennae always fused, and occasionally other joints. Outer ramus of posterior antennae 6-jointed. Blade of mandible with weak teeth; inner ramus of maxilla fused with second basal. The distal bristles of the anterior maxillipeds are modified into sac-like structures (fig. 30*b*), which occasionally are pencillate at the end; lobes of appendages closely crowded together. Inner ramus of posterior maxillipeds at most only as long as the second basal. Inner rami of swimming-feet jointed as in the *Clausocalaninae* and set with spines: fifth foot rudimentary or absent.

♂ Abdomen with shortened anal segment, number of joints of anterior antennae reduced, the twentieth and twenty-first often fused only in one. Other head appendages like those of the female, or specifically modified. Left fifth foot 5-jointed, occasionally with inner ramus, the right 4-jointed (rudiment of inner ramus sometimes present) or lacking.

1. Genus **Scolecithrix** Brady.

Undina (in part) Lubbock, 1856, p. 21.
Scolecithrix Brady, 1883, p. 56.
Scolecithrix Giesbrecht, p. 337; 1892, pp. 56, 265, 264; 1898, p. 41.
Lophothrix Giesbrecht, 1895, p. 254.
Amallophora (in part) Scott, T., 1893, p. 54.
Neoscolecithrix Canu, 1896, p. 426.
Scolecithrix Wolfenden, 1904, pp. 119, 120.

Cephalothorax ellipsoidal, head fused with thorax, abdomen of female with four segments, of male with five; anal segment commonly short. Anterior antennae in female 19- to 24- jointed, in male 17- to 24- jointed, end joints (24 and 25) fused or distinct, aesthetasks well developed, more numerous in male. Biting part of mandible and maxilla rather weak, inner ramus of maxilla mostly unsegmented and fused with the second basal. Distal bristles of anterior maxilliped thick, soft, in appearance something like the aesthetasks of the antennae; these may be vermiform, end in tufts (pencillate), or be pestle-shaped, and are usually present in both sexes. Head appendages of male like those of the female, but may in special cases be modified in particular ways. Outer rami of first four feet 3-jointed, inner ramus of first foot 1-jointed, of second 2-jointed, of third and fourth 3-jointed; surfaces of both often set with spines and points. Fifth foot in female uniramous, 1- to 3-jointed, seldom absent; fifth foot of male uniramous on each side, or the left biramous and the right uniramous, or both biramous.

KEY TO SPECIES.

1. Head without crest 2
1. Head with crest (fig. 28*a*) 4
2. Anterior antennae of female 19-jointed; right of the male 17-, the left 18-jointed 3
2. Anterior antennae of female 23-jointed................ **S. subdentata**
2. Number of joints unknown; for characters compare description and fig. 30 .... **S. pacifica**
3. First joint of outer ramus of first foot with a thorn-like bristle on outer margin (fig. 26*c*) .... **S. danae**
3. This joint without the bristle .... **S. bradyi**
4. Anterior antennae of female 23-jointed; fifth foot (fig. 26*e*); right antenna of male 17-jointed, left 18-jointed; fifth foot (figs. 26*c*, *d*) .... **S. persecans**

1. **Scolecithrix danae** Lubbock.

Undina danae Lubbock, 1856, p. 21, pl. 4, figs. 6-9.
Scolecithrix danae Brady, 1883, p. 57, pl. 17, figs. 1-12.
Scolecithrix danae Giesbrecht, 1888, p. 333; 1892, pp. 265, 283, pl. pl. 13, figs. 4, 9, 14, 17; pl. 37, fig. 6; 1898, p. 42.

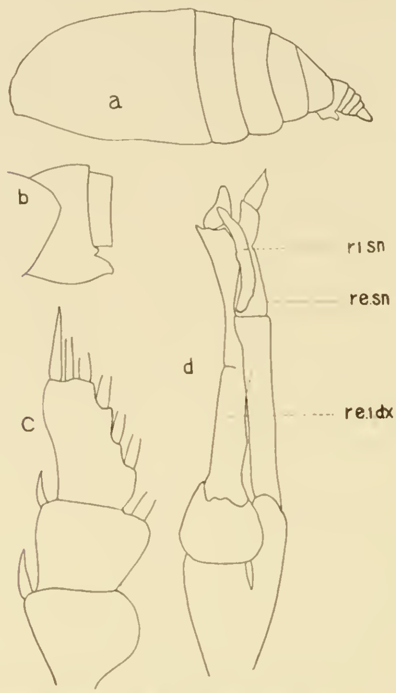

Fig. 26.—*Scolecithrix danae*. (*a*) Female, lateral, ×20. (*b*) Genital segment, female, lateral, ×83. (*c*) Outer ramus of first foot of female ×140. (*d*) Fifth foot of male ×83. *Re.*1 *dx.*, first joint of outer ramus of right foot. *Re.sn.*, outer ramus of left foot. *Ri.sn.*, inner ramus of left foot.

♀ Fourth thoracic segment separate from fifth, latter with rather flat, rounded lateral angles. Third and fourth segments of the abdomen broader than long, genital segment with ventral, shovel-shaped process (fig. 26*b*), anal segment short. Anterior antennae with nineteen segments, reaching beyond posterior border of the thorax but little. Outer ramus of posterior antennae 9/7 as long as the inner ramus, seventh joint of outer ramus without proximal bristle. Second basal of maxilla with five, inner ramus with six, outer with five bristles (cf. fig. 29*c*). First basal of fourth pair without inner marginal bristle, first joint of outer ramus of first pair (fig. 26*c*) with outer marginal bristle. Fifth pair of feet absent.

♂ Mouth parts not retrograded; left fifth foot biramous, right uniramous, terminal joint very short (fig. 26*d*).

Coloration: In formalin, both males and females have a light red or pink color.

Length: Both sexes, 2-2.2 mm.

Occurrence: June 28, 1904, one female; December 29, 1903, one female, surface tow at 2 a.m. One male, October 20, 1904.

2. **Scolecithrix bradyi** Giesbrecht.

Scolecithrix bradyi Giesbrecht, 1888, p. 337; 1892, pp. 266, 283, pl. 4, fig. 7; pl. 13, figs. 1, 3, 7, 11, 21, 28; pl. 37, figs. 1, 2, 9; 1898, p. 42.

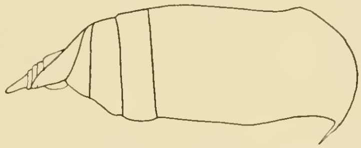

Fig. 27.—*Scolecithrix bradyi.* Female ×31.

♀ Line of separation between fourth and fifth thoracic segments visible only on the back; lateral portions of last thoracic segment elongated into two flaps, on the right more than on the left. Third and fourth segments of the abdomen much broader than long, genital segment asymmetrical, anal segment as long as the preceding ones, furca twice as long as broad. Anterior antennae 19-jointed, not reaching the posterior end of the thorax. Outer ramus of posterior antennae longer than the inner, seventh joint of the outer ramus without a proximal bristle. Maxilla as in *S. danae,* except that outer ramus has four bristles. First basal of fourth pair without bristle on inner margin, first joint of outer ramus of first pair without outer marginal bristle; fifth foot very small.

♂ Right anterior antennae with 18 joints, left with 17. Left fifth foot longer than the right by the last joint. Third joint of the outer ramus of the right large and with a prong.

Coloration: Yellowish pigment in body, mouth region, and on feet.

Length: Female, 1.4 mm.

Occurrence: June 14, 1904, one female.

3. Scolecithrix persecans Giesbrecht.

Scolecithrix persecans Giesbrecht, 1895, p. 253, pl. 3, figs. 6-12; 1898, p. 48, fig. 9.

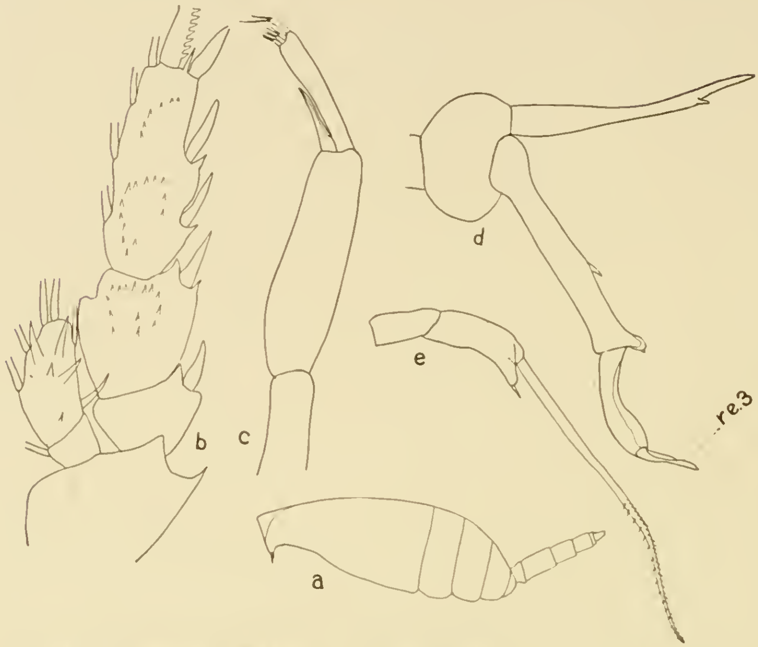

Fig. 28.—*Scolecithrix persecans.* (*a*) Male, lateral, ×9. (*b*) Second foot, male, ×45. (*c*) Left fifth foot of male ×83. (*d*) Right fifth foot, male, ×83. *Re.*3, third joint of outer ramus. (*e*) Fifth foot of female.

♂ Head with rather high crest (fig. 28*a*), last two thoracic segments fused; left anterior antenna 18-jointed, right 17-jointed, reaching beyond cephalothorax. Outer ramus of posterior antennae at least 1¼ times as long as inner; second basal of maxilla with five, outer ramus with eight, inner with seven bristles, appendages of anterior maxilliped in part penicillate. First basal of fourth foot with feathered inner border; middle of outer border of first basal of second and third feet with a small tooth, outer border of second basal of second to fourth feet with a tooth (fig. 28*b*); spines on outer margin of the two proximal joints of outer ramus of first foot shorter and more slender than on the third joint; terminal saw of outer ramus of third foot indented at base, inner ramus of foot with three spines on posterior surface of second and joints; no spines on posterior surface of inner ramus of fourth foot. Anterior surface of outer ramus of second to fourth feet without spines, few on the anterior face of the inner ramus. Fifth foot fig. 28*c*, *d*.

♀ Anterior antennae 23-jointed, reaching to end of furca; abdomen symmetrical, ventral surface of genital segment convex. Posterior antennae mandible, maxilla and maxilliped and swimming feet as in the male. Fifth foot symmetrical, rather well developed (fig. 28*e*).

Coloration: Opaque white in formation, eye spots red.

Length: Male, 5.3 mm.; female, 4.6 mm. Giesbrecht gives the length of the male as 4.5 mm.

Occurrence: Two males, one female collected at San Diego, May 31, 1904; obtained also May 18 and June 23, 1904.

The female was not obtained by Giesbrecht, and has not since then been described, as far as I am aware. There can be little doubt that the outer ramus of the right fifth foot in the male is 3-jointed, and that the terminal joint in Giesbrecht's single specimen was broken off. I have seen a considerable number of males, and in all the outer ramus is 3-jointed as shown (fig. 28*d*).

4. **Scolecithrix subdentata** n. sp.

♀ Last two thoracic segments fused, each side with a small indentation in the lateral margin. Anterior antennae 23-jointed, not much longer than the cephalothorax. Inner ramus of the posterior antenna ¾ as long as the outer; second basal of maxilla with four bristles, rami each with five (fig. 29*c*). Appendages of anterior maxilliped vermiform. First basal of fourth foot with a small, non-plumose bristle on inner margin; inner marginal bristle of second basal of third and fourth pairs long and plumose; outer margin of first basal of first, second and third pairs with a small tooth in the middle, inner margin with prominent rounded process bearing the inner marginal bristle. First joint of outer ramus of first pair with outer marginal bristle. Fifth foot 2-jointed, leaf-like; terminal joint broad, oval, with a short distal spine on the outer border, and a longer proximal spine in the middle of the outer border (fig. 29*b*).

♂ Unknown.

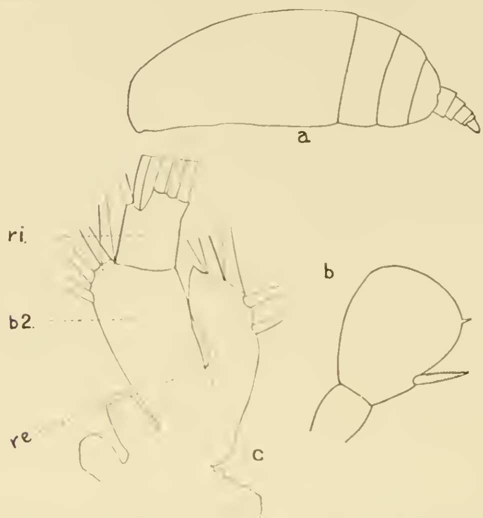

Fig. 29.—*Scolecithrix subdentata*, *n. sp.* (*a*) Female, lateral, ×31. (*b*) Fifth foot, female, ×195. (*c*) Maxilla ×140. *B.2*, second basal. *Ri.*, inner ramus. *Re.*, outer ramus.

Approaches *S. dentata* Giesbrecht in form of last thoracic segment, but the indentation is not as deep as in that species. The fifth foot is much as in *dentata*, but more oval and rounded. Distinct from *dentata* in possessing an outer marginal bristle on the first joint of outer ramus of first foot, and in the number of joints of the anterior antennae. The bristles of the maxilla distinguish *S. subdentata* most sharply. *S. subdentata* has the same number of joints in the antenna as *S. longicornis* Scott and *S. auropecten* Giesbrecht.

Length: Female, 1.48 mm.

Occurrence: San Diego, May 31, June 14, June 23, 1904.

5. **Scolecithrix pacifica** n. sp.

♀ Fourth and fifth thoracic segments fused, rounded laterally. First segment of abdomen about as long as second and third together; the latter two are equal in length. Outer ramus of posterior antenna a little longer than the inner ramus. Second basal of maxilla with five bristles, inner ramus with eight, outer with five (fig. 30*d*). First basals of fourth feet without inner marginal bristle, inner border of second basal in second to fourth pairs ending in a sharp point. First joint of outer ramus of first foot with short, curved outer marginal bristle; first joint of outer ramus of fourth pair without outer marginal bristle. Fifth foot (fig. 30*c*) 2-jointed, with a short distal bristle and a very long proximal one.

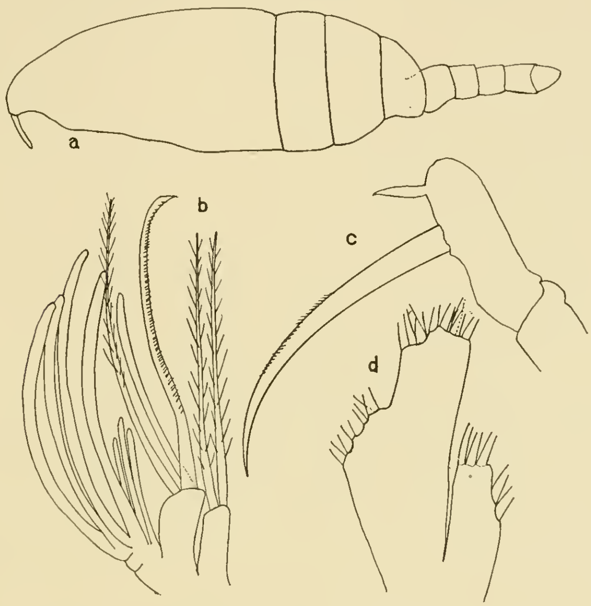

Fig. 30.—*Scolecithrix pacifica, n. sp.* (*a*) Female, lateral, ×31. (*b*) Anterior maxilliped ×140. (*c*) Fifth foot ×195. (*d*) Maxilla ×83, parts as in fig. 29*c*.

♂ Unknown.

This specimen approaches *S. porrecta* closely in general character, but is distinct in the length of the rami of the posterior antennae, form of the maxilla, bristle on outer margin of first joint of the outer ramus of the first foot, and in the form of the fifth feet. The anterior antennae are broken, but have probably not over twenty joints.

Length: Female, 2.3 mm.

Occurrence: June 23, 1904, San Diego, one female.

6. **Scolecithrix similis** T. Scott.

Amallophora dubia var. *similis* Scott, T., 1893, p. 56, pl. 4, figs. 19-23.
Scolecithrix similis Giesbrecht, 1898, p. 46.
S. similis (?) Wolfenden, 1904, p. 119, pl. 9, figs. 5, 6.

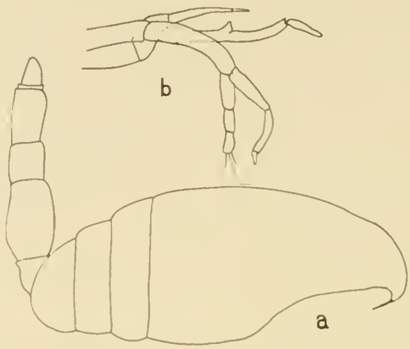

Fig. 31.—*Scolecithrix similis.* (*a*) Male, lateral, ×31. (*b*) Fifth foot, male, ×45.

♂ First abdominal segment short, second long, twice the length of the third, which is shorter than the fourth. Right anterior antenna 18-jointed, left 23-jointed (Scott). Last two thoracic segments fused. First basal of fourth foot with a plumose inner marginal bristle; both feet of fifth pair biramous (fig. 31*b*).

Length: Male, 2.6 mm.

Occurrence: San Diego, June 23, 1904.

The antennae of the single specimen were broken, but the form of the abdomen and fifth feet warrant one in identifying it with Scott's species, at least provisionally.

Fam. CENTROPAGIDAE.

Centropagidae Giesbrecht, 1892, p. 58; 1898, p. 52.

♀ Head always distinct from thorax; rostrum with two, usually soft, filaments, sometimes plumose. Anterior antennae as in the *Calanidae*, but the second joint is more often divided into two parts, never less than twenty-three joints. Outer ramus of posterior antennae at least ⅔ as long as the inner. The succeeding four pairs of appendages as in *Calanus* and like forms. In the three anterior ones are found peculiarities (in the *Hete-*

rorhabdinae): stunting of the second and third inner marginal lobes of the maxilla through lengthening of outer ramus; preponderance of distal bristles of anterior maxilliped over the proximal. The four anterior pairs of feet with 3-jointed rami: but in *Temora* the number of joints is reduced through fusion. The fifth pair of feet is like the others (inner marginal bristle of second joint of outer ramus of special form, sword-shaped, awl- or thorn- like) or rudimentary, inner ramus 1-jointed or lacking, outer ramus 1- to 3-jointed.

♂ Abdomen with five segments, anal segment rarely shortened: genital orifice and grasping antenna on opposite sides of the body. Grasping antenna right or left, joints 19 to 21, and 22 to 23 fused. Both feet of fifth pair present, inner rami complete or reduced to absence; outer rami forming hooks or forceps. Slight sexual differences occasionally in form of last thoracic segment and swimming feet.

Sub-fam. Centropaginae.

Centropagina Giesbrecht, 1892, p. 59.

♀ Cephalothorax with six segments, abdomen with three; rostral filaments soft. Anterior antennae (24th and 25th joints fused), mandibles and maxilla as in *Calanus;* the length of the distal curved bristles of the anterior maxillipeds and the heavily bristled first basal of the posterior maxillipeds is characteristic. All five pairs of feet with 3-jointed rami.

♂ Grasping antenna on the right side; outer ramus of left fifth foot 2-jointed: the right foot with forceps.

1. Genus **Centropages** Kröyer.

Centropages Kröyer, 1849, p. 602.
Catopia Dana, 1848, p. 25; 1849, p. 280; 1852, p. 1172.
Hemicalanus Dana, 1852, p. 1103.
Ichthyophorba Lilljeborg, 1853, p. 184.
Diaptomus Lubbock, 1857, p. 403.
Ichthyophorba Claus, 1863, p. 198.
Centropages Brady, 1883, p. 81.
Centropages Giesbrecht, 1892, pp. 59, 303, 731; 1898, p. 53.
Centropages Wheeler, 1899, p. 172.
Centropages Thompson and Scott, 1903, p. 247, pl. 1, figs. 19-25.

♀ Head separate from thorax, fourth thoracic segment from fifth. Abdomen with three segments, genital segment asymmetrical. Anterior antennae 24-jointed; joints 24 and 25 fused. Outer ramus of posterior antennae 7-jointed and almost 1½ times as long as the inner ramus. The distal bristles of the anterior maxillipeds sickle-shaped, with spinous feathering, and much longer and thicker than the proximal bristles. First basal of the posterior maxillipeds with strongly protruding lobes, both the middle ones set with bristles, which have a spinous feathering; inner ramus well developed, 5-jointed. Rami of swimming feet usually 3-jointed, but the inner ramus is exceptionally 2-jointed. First basal with bristle on inner border in first to fourth feet, second basal thus equipped in the first pair. First basal of fifth pair without inner marginal bristle; inner marginal bristle of second joint of outer ramus thorn-like and fused with the joint (fig. 32*c*.)

♂ Sexual peculiarities in the form of the abdomen, right anterior antenna, and fifth pair of feet. The abdomen is composed of five segments; anal segment in most species very short; genital opening on the left. Right anterior antenna a grasping organ. Joints 19-21 and 22-23 fused, geniculation between the 18th and 19th. Inner marginal bristles lacking on outer ramus of left fifth foot, joints 2 and 3 fused. The outer ramus of the right foot 3-jointed, both distal joints metamorphosed into a forceps, one blade of which is the terminal joint, while the other is the thickened inner marginal bristle of the second joint.

1. **Centropages bradyi** Wheeler.

Centropages violaceus Brady, 1883, p. 83, pl. 37, figs. 1-14.
Centropages bradyi Wheeler, 1899, p. 174, fig. 12.

♀ Second joint of outer ramus of fifth foot with a stout smooth spine (fig. 32*c*). Sides of inflated genital segment without spines or knob-shaped projections. Furca symmetrical, with a peculiar short, truncated, peg-shaped projection (fig. 32*b*) between insertions of the two outer bristles. (Wheeler, 1899).

♂ Joint 17 of right anterior antenna with smooth anterior border, not serrate; joints 19 and 20 fused, separated from joint 21; joint 18 with accessory series of teeth on lower surface (Wheeler, 1899).

Coloration: Opaque, with a large purplish spot in middle of body.

Length: Female, thorax, 1.6 mm.; abdomen ?

Occurrence: June 10, 1904, one female.

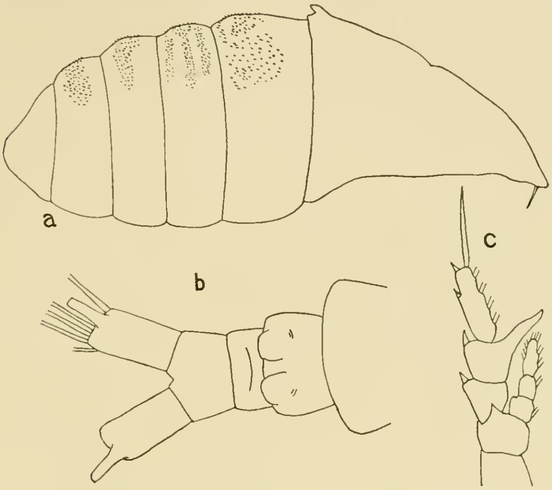

Fig. 32.—*Centropages bradyi.* (*a*) Female, thorax, lateral, ×45. (*b*) Abdomen, ventral, after Wheeler 1899. (*c*) Fifth foot ×83.

Wheeler, 1899, p. 174, does not mention the spine-like protuberance on the dorsal surface of the first segment of the cephalothorax in the female, but since the other characters as given by him (especially the furca) agree with the San Diego specimen, I have not made a new species of the latter. This agrees in possessing the dorsal spine, with *C. dorsispinatus* (Thompson, 1903, p. 247, pl. 1, figs. 19-25), but differs widely in other respects.

Sub-fam. Temorinae.

Temorina Giesbrecht, 1892, p. 60.

♀ Cephalothorax with five segments: fourth and fifth thoracic segments fused; rostral filaments soft, sometimes plumose. Anterior antennae 23- or 24-jointed; the second joint is either not divided, or, if it is divided into two parts, the proximal portion is fused with the first joint. Outer ramus of posterior antennae 7-jointed, and, with the following four appendages, is like those of the *Calanidae.* The first four pairs of feet usually with 3-jointed rami, in which, however, the two proximal joints may be fused; inner ramus absent in fifth pair, or small and 1-jointed; the outer ramus is 1- to 3-jointed.

♂ Grasping antenna usually the right; distally from the geniculation, the nineteenth and twenty-first and twenty-second and twenty-third joints are fused; sexual peculiarities often in the swimming feet as well as in the form of the body, anterior antennae and fifth pair of feet.

1. Genus **Pleuromamma** Giesbrecht.

Diaptomus Lubbock, 1856, p. 27.
Pleuromma Claus, 1863, p. 195.
Pleuromma Brady, 1883, p. 45.
Pleuromma Giesbrecht, 1892, pp. 61, 347, 757.
Pleuromma Dahl, 1893, p. 105.
Pleuromma Wheeler, 1899, p. 176.
Pleuromamma Giesbrecht, 1898, p. 108.

Easily recognizable by a dark-pigmented knob on the right or left side of the first thoracic segment (figs. 33*a*, 34*a*). Furca at most twice as long as broad. Rami of the first to fourth pairs of feet 3-jointed, first joint of outer ramus of third pair with a deep notch in the outer border; terminal bristle of outer ramus of third pair short and bent outward; first joint of inner ramus of second pair with hooks on inner border, on right and left foot in the female, usually on one side in male. Fifth pair in female rudimentary, 2- to 4-jointed, in male 5-jointed on each side, without forceps. Grasping antenna of male on right or left side. Abdomen of female with three segments; of male with five, sometimes asymmetrical.

1. **Pleuromamma abdominalis** Lubbock.

Diaptomus abdominale Lubbock, 1856, p. 28, pl. 10, figs. 1-8.
Pleuromma abdominale Claus, 1863, p. 197, pl. 5, figs. 1-6, 13, 14; pl. 6, fig. 1-10.
Pleuromma abdominale Brady, 1883, p. 46, pl. 11, figs. 1-13.
Pleuromma abdominale Giesbrecht, 1892, pp. 347, 357, pl. 5, fig. 8; pl. 32, figs. 3, 5, 13, 22, 25-30; pl. 33, figs. 43, 44, 48, 49, 52.
Pleuromamma abdominalis Giesbrecht, 1898, p. 109.

♀ Pigment knob on right or left side; proximal joint of first antenna with several smaller and two larger (one straight and one curved) teeth on anterior border. Fifth pair of feet 4-jointed, with three apical bristles (fig. 33*b*).

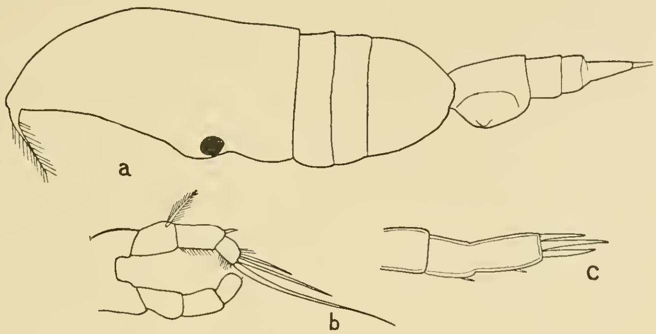

Fig. 33.—*Pleuromamma abdominalis* and *P. gracilis*. (*a*) *P.a.*, female, lateral, ×31. (*b*) *P.a.*, fifth foot ×45. (*c*) *P.g.*, fifth foot ×195.

♂ Pigment knob, genital opening and hooks on inner border of first joint of inner ramus of second foot, on left side. Proximal joint of anterior antennae with small teeth only, grasping antenna on right side. Abdomen symmetrical. End joint of left fifth foot broadened.

Coloration: Transparent, except for a small amount of red in the mouth region.

Length: Female, about 2.4-3 mm.; male, 3.3 mm.

Occurrence: A common species, both summer and winter, but males are very infrequently found; one male was taken June 2, 1904.

2. **Pleuromamma gracilis** Claus.

Pleuromma gracile Claus, 1863, p. 197, pl. 5, figs. 7-11.
Pleuromma abdominale (in part) Brady, 1883, p. 47, pl. 2, figs. 1-16; pl. 21, figs. 13, 14.
Pleuromma gracile Giesbrecht, 1892, pp. 347, 357, pl. 5, fig. 7; pl. 32, figs. 6, 18-20; pl. 33, fig. 41-47.
Pleuromamma gracilis Giesbrecht, 1898, p. 110.

♀ Pigment knob on right side; anterior border of anterior antennae with only small teeth; fifth pair of feet 2-jointed, three prongs at the end (fig. 33*c*).

♂ Pigment knob on right side; abdomen symmetrical; anterior antennae as in female as regards armature; grasping antenna on left side; first joint of inner ramus of second foot with hooks only on right side; third and fourth feet as in female.

Coloration: As in *P. abdominalis.*

Length: Both sexes, 1-2 mm.

Occurrence: More abundant than *P. abdominalis,* but males are rare.

Brady, 1883, p. 47, considers that *P. gracilis* Claus is an immature form of *P. abdominalis* Claus, but Giesbrecht, 1892, does not favor this view, and the San Diego specimens of *P. gracilis* present such differences when compared with *P. abdominalis* that there can be no doubt of the distinctness of the species. The forms represented by *P. gracilis* are without doubt mature, since females are often found with attached spermatophores.

3. **Pleuromamma xiphias** Giesbrecht.

Pleuromma xiphias Giesbrecht, 1889, p. 6; 1892, pp. 347, 367, pl. 32, fig. 14; pl. 33, figs. 42, 45, 50.

Pleuromamma xiphias Giesbrecht, 1898, p. 110.

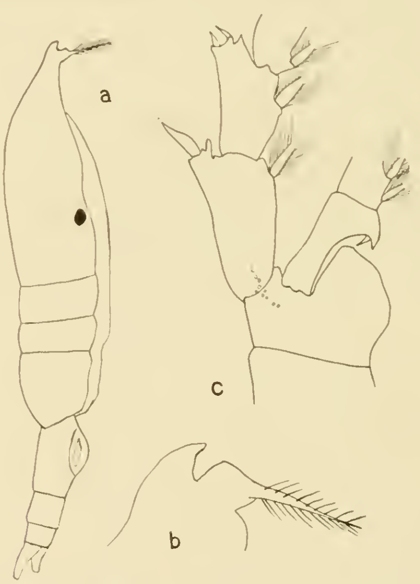

Fig. 34.—*Pleuromamma xiphias.* (*a*) Female, lateral, ×18. (*b*) Head of female, lateral, ×48. (*c*) Second basal, and proximal joints of rami of second foot, ×48.

Allied to *P. abdominalis*, but the front of the head anterior to the rostrum is prolonged into a prominent process (fig. 34*b*).

Coloration: As in the other species.

Length: Female, 4.1-4.5 mm.

Occurrence: San Diego, July 31, 1903, one female; June 23, 1904, one female; taken also December 23, 1903, on "Banks." The occurrence of the male is uncertain; large male animals have been taken with the characteristic shape of *xiphias*, but I cannot say definitely whether they belong to this species or not.

2. Genus **Metridia** Boeck.

Metridia Boeck, 1864, p. 13.
Paracalanus Brady and Robertson, 1878, p. 126.
Metridia Giesbrecht, 1892, pp. 61, 339, 749; 1897, p. 254; 1898, p. 105.
Metridia Dahl, 1894*a*, p. 10.
Metridia Wheeler, 1899, p. 175.
Metridia Wolfenden, 1904, p. 125.
(See also T. Scott, 1893, p. 42, pl. 3, figs. 8-20.)

Closely allied to *Pleuromamma*, but is without the lateral pigment knob. Terminal bristle of outer ramus of third pair of normal form; swimming feet of the male (especially the second pair) corresponding with those of the female. Furca 2 to 5 times as long as broad.

1. **Metridia lucens** Boeck.

Metridia lucens Boeck, 1864, p. 14.
Paracalanus hibernicus Brady and Robertson, 1873, p. 126, pl. 8, figs. 1-3.
Metridia armata Brady, 1878, p. 42.
Metridia hibernica Giesbrecht, 1892, pp. 340, 357, pl. 33, figs. 2, 12, 16, 22, 28, 36, 39.
Metridia lucens Dahl, 1894, p. 11.
Metridia lucens Giesbrecht, 1898, p. 106.

♀ Cephalothorax $1\frac{2}{3}$ times as long as the abdomen; lateral angles of fifth thoracic segment slightly pointed. Genital segment somewhat shorter than the two last abdominal segments together, the anal segment about $\frac{3}{4}$ as long as the preceding. Furca shorter than the last abdominal segment and twice as long as broad. The anterior antennae reach back hardly to posterior margin of the genital segment. Terminal bristle of end joint of outer ramus of fourth foot little over $\frac{1}{4}$ as long as the joint. Fifth foot 3-jointed and with three rather long bristles on end joint (fig. 35*c*).

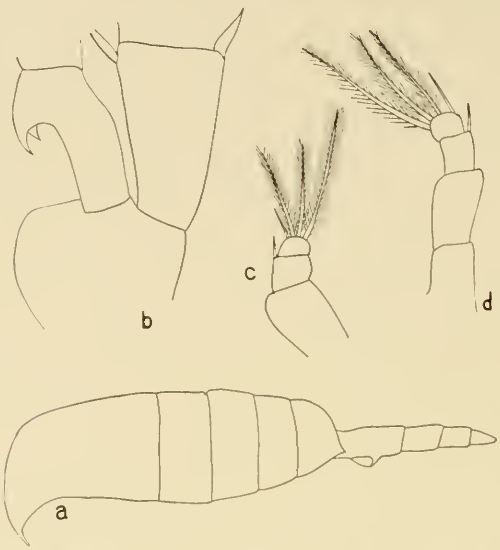

Fig. 35.—*Metridia lucens* and *M. boeckii.* (*a*) *M.l.*, female, lateral, ×20. (*b*) *M.l.*, second basal and first joint of inner ramus of second foot of female to show hooks, ×195. (*c*) *M.l.*, fifth foot of female ×195. (*d*) *M.b.*, fifth foot of female ×195.

♂ Grasping antenna on right side. Fifth foot: second joint of outer ramus of left foot without, first joint of outer ramus of right foot with a long, thorn-like bristle.

Length: Female, 3.2 mm.

Occurrence: Very common, summer and winter.

2. **Metridia boeckii** Giesbrecht.

Metridia boeckii Giesbrecht, 1889, p. 5; 1892, pp. 340, 346, pl. 33, figs. 8, 19, 31, 37; 1898, p. 107.

♀ Like *M. lucens*, but furca is as long as the fifth abdominal segment, and twice as long as broad. Anterior antennae reach a little beyond the posterior border of the thorax. Fifth foot with four joints (fig. 35*d*).

♂ Unknown.

Length: Female, 2.5 mm.

Occurrence: One or two in catches with *M. lucens*.

It should be noted that not a male specimen of *Metridia* has been taken in any catch, so far as I have examined them, and rather particular attention has been paid to this point.

Sub-fam. Lucicutiinae.

Leuckartiina Giesbrecht, 1892, p. 62.

♀ Cephalothorax with five segments, fourth and fifth thoracic segments fused, rostral filaments thin and usually soft; abdomen with four segments, symmetrical. The second joint of the anterior antenna is divided, and the twenty-fourth joint is separate from the twenty-fifth. Outer ramus of posterior antennae 8-jointed, the four following appendages like those in the *Calanidae*. The first four pairs of feet almost always with 3-jointed rami, the fifth pair like the preceding ones and that of *Centropages*, with 3-jointed outer ramus and 2- to 3-jointed inner ramus.

♂ (Known only in *Lucicutia.*) Grasping antenna the left; distal to the geniculation the nineteenth to twenty-first, and twenty-second and twenty-third joints are fused; fifth pair of feet without forceps, basals 2-jointed, the right with 2-, the left with 3-jointed rami; no other sexual differences except in form of body.

1. Genus **Lucicutia** Giesbrecht.

Leuckartia Claus, 1863, p. 182.
Leuckartia (in part) Brady, 1883, p. 50.
Leuckartia Giesbrecht, 1892, pp. 62, 358; 1895, p. 258.
Lucicutia Giesbrecht, 1898, p. 110.
Lucicutia Steuer, 1904, p. 596.
Lucicutia Wolfenden, 1904, p. 121.

Head broad; furca symmetrical. First lobe on outer border of maxilla with five bristles.

♀ Five segments in cephalothorax, abdomen with four, symmetrical. Rostral filaments slender, situated on a papilla. Posterior antennae like those of *Centropages*, but with eight joints in outer ramus. Blade of mandible weakly built, outer ramus bent rather far proximally. Outer border lobes of maxilla with only five bristles; inner border lobes well developed, the proximal one, however, with weak masticatory bristles. Inner ramus 2-jointed, articulated with basal; outer ramus large, oval. Distal bristles of maxillipeds little longer than the proximal; bristles of outer border of posterior maxilliped slender, without hairs. Outer rami of the five pairs of feet 3-jointed; inner ramus of first pair 2-jointed (second and third joints fused), of second to fifth pairs 3-jointed; first basal with bristle on inner margin in second to fourth pairs, second basal in first pair with inner marginal bristle, and sometimes with a tube-like process. The bristle on the inner margin of the second joint of the outer ramus of the fifth pair has the form of a curved awl (fig. 36*b*).

♂ Sexual peculiarities in the form of the abdomen, posterior antennae and fifth pairs of feet. Abdomen with five segments, genital opening on right side. The left antenna is a grasping organ, geniculating between joints 18 and 19; joints 19 to 21, 22 and 23 fused. Fifth pair of feet with 2-jointed basals; rami of left foot 2-jointed, of right 3-jointed. The distal joint of the outer ramus of the right foot is hooked and may be moved toward the proximal joints.

1. **Lucicutia flavicornis** Claus.

Leuckartia flavicornis Claus, 1863, p. 183, pl. 32, fig. 17.
Leuckartia flavicornis Giesbrecht, 1892, p. 358, pl. 5, fig. 4; pl. 19, figs. 2, 3, 15, 17, 21, 23, 29, 38; pl. 38, fig. 38, 40.
Lucicutia flavicornis Giesbrecht, 1898, p. 111.

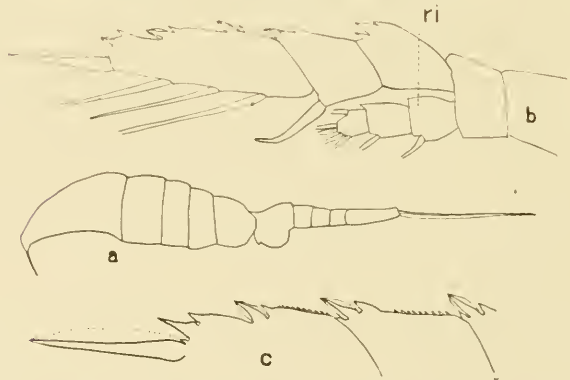

Fig. 36.—*Lucicutia flavicornis.* (*a*) Female, lateral, ×18. (*b*) Fifth foot, female, ×83. *Ri.*, inner ramus. (*c*) Outer margin of outer ramus of third foot ×140.

♀ Anal segment shorter than the preceding; second terminal bristle of furca thick, twice as long as abdomen. The anterior antennae reach beyond middle of the furca, joint 19 as long as tenth to twelfth, inclusive. Second basal of maxilla with four bristles. Inner ramus of first pair of feet 3-jointed, with eight bristles; inner ramus of fifth pair reaches almost to the distal border of the second joint of the outer ramus: first joint of outer ramus much shorter than the third, which is twice as long as the terminal bristle.

♂ Terminal portion of grasping antenna (joints 19-25) somewhat longer than joints 14-18. Inner ramus of right foot of fifth pair straight, with five bristles, which are at the end of the terminal joint.

Coloration: Transparent, with light yellowish pigment in various locations. The San Diego specimens showed this to a very small extent.

Length: Female, 1.6 mm.; male a little less.

Occurrence: June 8, 1904, one male, one female; June 10, 1904, one male (?).

Sub-fam. Heterorhabdinae.

Heterochaetina Giesbrecht, 1892, p. 63.

Cephalothorax with five segments; fourth fused with fifth thoracic segment; rostral filaments slender, sometimes plumose; last thoracic segment in some cases with pointed lateral angles. Abdomen with three or four segments, not always symmetrical. Second joint of anterior antennae divided, the two terminal joints usually distinct. Second joint of outer ramus of posterior antennae divided into two, so that there are as a result eight joints in the ramus (which, however, may be reduced by fusions). Blade of mandible with few teeth, inner ramus small, sometimes lacking. Inner ramus and both distal lobes of inner margin of maxilla small, occasionally absent; outer ramus always present, and usually much lengthened. Anterior maxilliped elongate, lobes small, the proximal ones usually rudimentary; bristles of distal lobes, and usually those of the inner ramus, almost always long, thick and hooked. The four anterior pairs of feet with 3-jointed rami, fifth pair like the others, rami almost without exception 3-jointed.

♂ Sexual differences in form of body, anterior antennae, fifth pair of feet, seldom in structure of mouth parts. Grasping antenna usually the left; first and second joints fused, as well as the nineteenth to twenty-first, twenty-second and twenty-third (or twenty-second to twenty-fifth): fifth pair of feet with 3-jointed outer and 1- to 3-jointed inner ramus; forceps incomplete or absent.

1. Genus **Heterorhabdus** Giesbrecht.

Heterochaeta Claus, 1863, p. 180.
Heterochaeta Brady, 1883, p. 48.
Heterochaeta Giesbrecht, 1892, pp. 64, 372, 745; 1895, p. 259.
Heterochaeta, Aurivillius, 1899, p. 38, figs. 4, 5.
Heterorhabdus Giesbrecht, 1898, p. 113.
Heterorhabdus Wolfenden, 1904, p. 124.

♀ Cephalothorax with five segments, rostral filaments soft, situated on a papilla. Abdomen with four segments, left half of furca not articulating with anal segment, larger than the right and with much longer bristles. Rami of posterior antennae about equal in length, outer ramus with eight bristles. Anterior maxilliped straight, terminal portion and proximal lobes with their bristles strongly suppressed, while the distal lobes are provided with strong hooked bristles. Posterior maxillipeds distinguished by shortness of the bristles on the inner ramus and by the length and thickness of one bristle on the inner margin of the first basal joint. All the feet have 3-jointed rami; inner marginal bristle of the first basal in pairs one to four, and of the distal basal joint in the first pair, well-developed and plumose. Terminal joint of outer ramus of third pair usually different in form from that joint in the other pairs, being broad and oval (fig. 38*d*). The inner marginal bristle of the second joint of the outer ramus of the fifth pair is thickened and sword-shaped (fig. 38*e*).

♂ Sexual peculiarities in form of posterior portion of body, left anterior antenna and fifth pair of feet. Abdomen with five segments, genital opening on right side. Grasping antenna slender. Fifth pair of feet with 3-jointed rami; terminal joints of both outer rami hooked; processes on the distal basal joint.

KEY TO SPECIES.

Abdomen 4-segmented, fifth foot symmetrical.................. ♀
Abdomen 5-segmented, fifth foot asymmetrical................ ♂
·1. Third joint of outer ramus of third foot of same form as in second and fourth pairs (fig. 40*a*)..................**H. longicornis**

1. This joint in third pair broad and oval, terminal bristle shortened (fig. 38*d*) 2
2. First basal of posterior maxilliped with a very long, heavy bristle in the middle of the inner border; rostral papilla with a point (fig. 37*a*) .... **H. spinifrons**
2. As above, but rostral papilla without point (figs. 38*b*, *c*) 3
3.♀ Inner marginal bristle of second joint of inner ramus of fifth foot much shorter and more slender than those of the third joint; first joint of outer ramus with thorn-like inner marginal bristle. ♂ Fifth foot (fig. 39) .... **H. clausi**
3.♀ Inner marginal of second joint of inner ramus of fifth foot but little shorter than those of third joint; first joint of outer ramus without inner marginal bristles............... **H. papilliger**

1. Heterorhabdus spinifrons Claus.

Heterochaeta spinifrons Claus, 1863, p. 182, pl. 32, figs. 8-9, 14, 16.
Heterochaeta spinifrons Giesbrecht, 1892, pp. 372, 382, pl. 10, figs. 1, 3, 11, 16, 19, 31; pl. 39, figs. 42, 43, 51, 52, 54.
Heterorhabdus spinifrons Giesbrecht, 1898, p. 114.

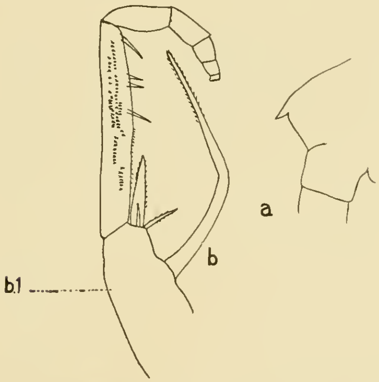

Fig. 37.—*Heterorhabdus spinifrons.* Female. (*a*) Head, lateral, ×83. (*b*) Posterior maxilliped ×167. *B*.1, first basal.

The papilla on front of head ends in a sharp point; anterior antennae reach beyond the end of the furca by the last four or five joints. The fourth lobe of the anterior maxilliped has two long, thick bristles, and a small, slender one which is hardly ¼ as long as the other two; the fifth lobe has two bristles, one of which is longer and thicker than the other. A spine-like bristle at the end of the inner margin of the first basal of the posterior maxilliped is ¼ the length of the long bristle in the middle of the margin (fig. 37*b*). Hooks at the end of both outer rami of the fifth foot of the male relatively longer than in *H. papilliger,* the left over twice as long as the first and second joints of the outer ramus.

Coloration; Transparent and colorless.

Length: Female, 3.4 mm.

Occurrence: June 23, 1904, one female.

2. **Heterorhabdus papilliger** Claus.

Heterochaeta papilligera Claus, 1863, p. 182, pl. 3, figs. 10-13, 15.
Heterochaeta papilligera Giesbrecht, 1892, pp. 372, 382, pl. 20, figs. 4, 7, 10, 15, 17, 23, 35, 36; pl. 39, figs. 40, 53.
Heterorhabdus papilliger Giesbrecht, 1898, p. 114.

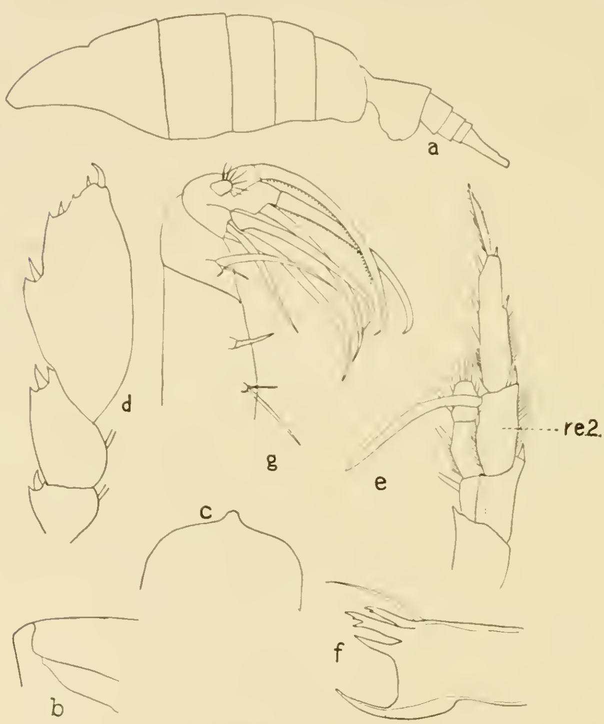

Fig. 58.—*Heterorhabdus papilliger.* (*a*) Female, lateral, ×31. (*b*) Head, female, lateral, ×83. (*c*) Head, female, dorsal, ×83. (*d*) Outer ramus of third foot of male ×83. (*e*) Fifth foot of female ×140. *Re.2*, second joint of outer ramus. (*f*) Right mandibular blade of male ×83. (*g*) Anterior maxilliped, female, ×83.

Papilla on front of head elongated but not ending in a point (figs. 38*b*, *c*). Anterior antennae when at the sides of the body reach about to the end of the furca. Fourth lobe of the anterior maxillipeds (fig. 38*g*) with two long, thick bristles and a shorter, thinner one, which is over half as long as the others; fifth lobe with two bristles of about equal length and thickness. On the end of the inner border of the first basal of the posterior maxilliped is a spine-like bristle, which is hardly one-eighth as long as the bristle in the middle of the margin, and the latter one is almost twice as long as the second basal (cf. fig. 37*b*). Hooks at the end of both outer rami of the fifth foot in the male relatively shorter than in *spinifrons*; the left little longer than the first and second joints of the outer ramus together.

Coloration: As in *spinifrons.*

Length: Female, 2.2 mm.; males slightly smaller.

Occurrence: A few specimens of both sexes were taken during May and June, 1904.

3. **Heterorhabdus clausi** Giesbrecht.

Heterochaeta clausii Giesbrecht, 1889, p. 2; 1892, pp. 372, 382, pl. 20, fig. 2, 28, 37, 38.
Heterorhabdus clausi Giesbrecht, 1898, p. 115.

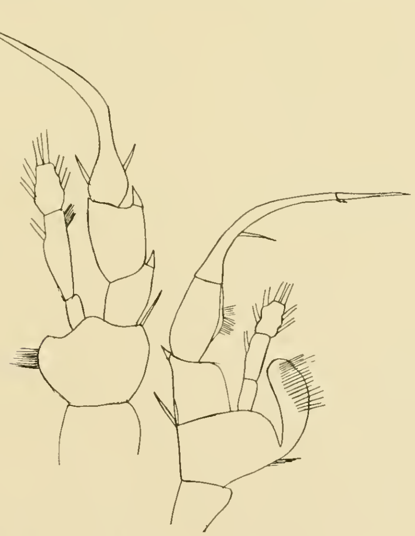

Fig. 39.—*Heterorhabdus clausi.* Fifth foot, male, ×83.

Like *papilliger*, but the anterior antennae reach somewhat beyond the end of the furca. Inner ramus of anterior maxillipeds with longer bristles; inner marginal bristle of first and second joints of inner ramus of fifth foot in the female short and slender, that of the first joint of the outer ramus thick and hooked; second basal of the right fifth foot in the male with a long lamellar process, the second joint of the outer ramus with a shorter projection on the inner border, third relatively longer, especially on the left side.

Length: Male, 2-2.5 mm.

Occurrence: San Diego, July 22, 1903, one male; June 23, 1904, one male.

4. **Heterorhabdus longicornis** Giesbrecht.

Heterochaeta longicornis Giesbrecht, 1889, p. 2; 1892, pp. 373, 383, pl. 20, figs. 14, 21, 25, 26; pl. 39, fig. 44.
Heterorhabdus longicornis Giesbrecht, 1898, p. 116.
Heterorhabdus zetesios Wolfenden, 1902, p. 367.
Heterorhabdus longicornis (male) Wolfenden, 1904, p. 124, pl. 9, fig. 34.

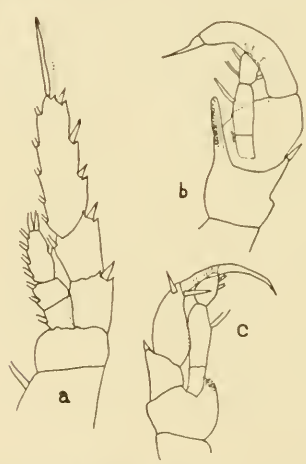

Fig. 40.—*Heterorhabdus longicornis*. Male. (*a*) Third foot ×140. (*b*) Right fifth foot ×140. (*c*) Left fifth foot ×140.

♀ Anterior antennae reach beyond the end of the furca for the last eight or nine joints; inner ramus of maxilla with five bristles, first and second inner marginal lobes relatively long; anterior maxillipeds with a greater number of bristles, but with less strongly developed hooked bristles than in the other species; inner ramus clearly with three joints, and with seven long bristles; bristles of first basal of the posterior maxillipeds and third joint of outer ramus of third swimming foot of usual form. Inner marginal bristle of second joint of outer ramus of fifth pair more slender, and inner marginals of first and second joints thicker than in the other species, distal border of second joint of outer ramus of ordinary form.

♂ Like female in structure of maxillipeds and terminal joint of outer ramus of third and fourth swimming feet. Fifth foot (figs. 40*b*, *c*): right with stiff upright process on second basal (inner margin), covered with stiff spines, second joint of outer ramus with a projection having four teeth at end.

Length: Male, 3 mm.

Occurrence: San Diego, June 23, 1904, one male.

2. Genus **Augaptilus.**

Hemicalanus (in part) Claus, 1863, p. 176.
Augaptilus Giesbrecht, 1889, p. 3; 1892, pp. 65, 400, 724; 1898, p. 120.
(See also T. Scott, 1893, p. 36, pl. 2, figs. 25-37; Steuer, 1904, p. 597.)

♀ Cephalothorax composed of five segments; rostral filaments short and sometimes feathered. Abdomen with 3 segments, genital segment usually not wholly symmetrical. Anterior antennae 25-jointed, outer ramus of posterior antennae rarely longer than the inner ramus. Mandibular blade with two teeth (mandible sometimes uniramous and with a stylet-like blade). Inner ramus of maxilla lacking; both maxillipeds with reduced proximal lobes and peculiarly equipped bristles (cf. fig. 41*b*). Feet with spines on outer border of outer rami reduced in part, the third bristle on the inner border of the last joint of the outer ramus of the fifth foot not elongated, the inner marginal bristle of the middle joint awl-shaped or lacking; both rami 3-, rarely 2-jointed.

♂ Sexual differences in the form of the abdomen, anterior antennae and fifth feet. Abdomen with 5 segments, genital opening right or left. The right or left anterior antenna may be the grasping organ. Rami of both feet of fifth pair 3-jointed (fig. 41*c, d*).

1 **Augaptilus longicaudatus** Claus.

Hemicalanus longicaudatus Claus, 1863, p. 179, pl. 29, fig. 3.
Augaptilus longicaudatus Giesbrecht, 1892, p. 414, pl. 27, fig. 31; pl. 28, figs. 11, 19, 23, 31, 35, 38; pl. 2, fig. 22; pl. 39, figs. 37, 48; 1898, p. 123.
Augaptilus longicaudatus Scott, 1894, p. 34, pl. 1, figs. 24-26; pl. 2, fig. 5.

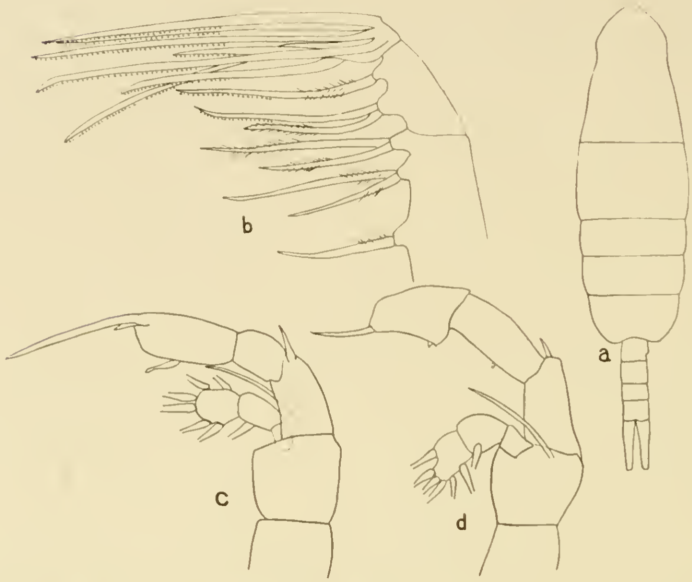

Fig. 41.—*Augaptilus longicaudatus.* Male. (*a*) Dorsal ×18. (*b*) Anterior maxilliped ×83. (*c*) Right fifth foot ×83. (*d*) Left fifth foot ×83.

♀ Genital segment not entirely symmetrical, twice as long as both the following segments together; furca as long as the anal segment, and about 5 times as long as broad. Anterior antennae longer than trunk by about the last 6 joints. Inner ramus of posterior antennae ⅓ longer than the outer ramus; first and second joints of outer ramus not fused; mandible uniramous. Anterior maxilliped: First and second lobes lacking, third with 1 bristle, fourth and fifth with 2, sixth with 1. First basal of posterior maxilliped with 0, 0, 1, 2 bristles. Length of first and second basals and inner ramus as 7:6:5. Outer ramus of fifth foot 2-jointed.

♂ Grasping antenna on left. Fifth foot, fig. 41*c*, *d*.

Coloration: Transparent, without pigment.

Length: Male, 3.39 mm.

Occurrence: June 10, 1904, 1 male.

3. Genus **Arietellus** Giesbrecht.

Arietellus Giesbrecht, 1892, pp. 66, 415.
Rhincalanus (part) T. Scott, 1893, p. 31.
Arietellus Giesbrecht, 1898, p. 124.

Last two thoracic segments fused, elongated into a strong spine on each side (fig. 42*a*), front with wedge-shaped process, rostral filaments slender. Abdomen of female with 4 segments, symmetrical; furca, and appendages with long, richly plumose bristles. Anterior antennae of female and the right one of male at most 20-jointed, joints 1 and 2, 21-25 fused; grasping antenna on the left, 19-jointed, terminal portion 2-jointed. Inner ramus of posterior antenna straight, longer than outer; mandible uniramous, inner ramus lacking; inner ramus and third inner marginal lobe of maxilla lacking, outer ramus long and characteristic. Anterior and posterior maxillipeds as in *Augaptilus* except in appendages of bristles (fig. 42*c*). Rami of first to fourth feet 3-jointed; fifth foot of female (fig. 42*b*) 3-jointed, basals 2-, outer ramus 1-jointed, inner ramus rudimentary. Fifth foot of male without forceps, basals 2-, outer ramus 3-jointed, inner ramus 1-jointed.

1. **Arietellus setosus** Giesbrecht.

Arietellus setosus Giesbrecht, 1892, p. 415, pl. 29, figs. 1, 3-7, 9-13; pl. 39, figs. 34-36; 1897, p. 254; 1898, p. 124.

With the characters of the genus.

Coloration: Terminal expansions of plumose furcal bristles red, the remaining portion black. Body orange red, bristles on posterior antennae and mouth parts, deep red.

Length: 5.5 mm.

Occurrence: One female was taken at San Diego, Dec. 22, 1903.

Fig. 42.—*Arietellus setosus.* Female. (*a*) Dorsal ×9. (*b*) Fifth foot ×83. (*c*) Distal portion of one of the bristles of the anterior maxilliped ×140.

4. Genus **Phyllopus** Brady.

Phyllopus Brady, 1883, p. 78.
Phyllopus Giesbrecht, 1892, pp. 66, 419; 1898, p. 124.
Phyllopus Wolfenden, 1904, p. 124.

♀ Last thoracic segment not entirely symmetrical; abdomen with 4 segments, genital segment asymmetrical. Anterior antennae with 24 joints. Inner ramus of posterior antennae about half as long as the outer ramus of 8 joints. Blade of mandible strong, with four teeth. Anterior maxillipeds elongated, posterior with short, broad first basal. First to fourth pairs of feet with 3-jointed rami, second basal with inner marginal bristle in first pair and with outer marginal in first and fourth. Fifth pair with basal of two joints and 3-jointed outer ramus. Inner ramus lacking, inner marginal bristle of middle joint of outer ramus thick and long; terminal joint shortened, its distal margin toothed (fig. 43*b*).

♂ Like female except in structure of anterior antennae and fifth feet. Abdomen with 5 segments. Left anterior antenna 20-jointed, geniculating between joints 17 and 18. Fifth feet each with 2 basals, and 3-jointed outer rami, the right foot has a rudimentary inner ramus, broad and without spines. Second basal of each foot with a long, slender plumose bristle.

1. **Phyllopus bidentatus** Brady.

Phyllopus bidentatus Brady, 1883, p. 78, pl. 5, figs. 7-16.
Phyllopus bidentatus Giesbrecht, 1892, p. 419, pl. 18, figs. 25-33; pl. 38, fig. 35; 1898, p. 124.
Phyllopus bidentatus ♂ Wolfenden, 1904, p. 124, pl. 9, fig. 16.

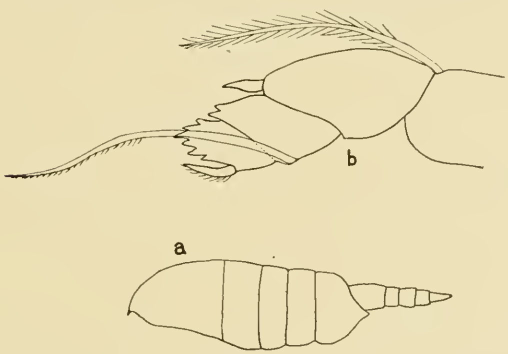

Fig. 43.—*Phyllopus bidentatus*. Female. (*a*) Lateral ×18. (*b*) Fifth foot ×195.

With the generic characters. Both Giesbrecht (1892) and Wolfenden (1904) state that the "bidentate" lateral portion of the last thoracic segment does not exist as in Brady's description. The San Diego specimen agrees with the description of the two former authors. The male of the species is described by Wolfenden as cited, and the above description is taken from him.

Coloration: Transparent, without pigment.

Length: Female, 2.2 mm.
Occurrence: San Diego, May 31, 1904, one female.

Fam. CANDACIIDAE.

Candacidae Giesbrecht, 1892, p. 67.
Candaciidae Giesbrecht, 1898, p. 126.

♀ Cephalothorax with 5 segments, rostrum absent, abdomen with 3 segments. In posterior antennae the second basal and first joint of inner ramus is fused, outer ramus slender, end joints shortened. Blade of mandible with few teeth. Second lobe of inner margin of maxilla very long, third and fourth absent. Anterior maxilliped without lobes, bristles on distal portions sickle-shaped and hooked. Posterior maxilliped as in *Calanus* but small and weak. Inner ramus of anterior pairs of feet 2-jointed; fifth pair rudimentary.

♂ Genital orifice on left: grasping antenna the left, seventeenth and eighteenth and nineteenth and twentieth joints fused; fifth foot without inner ramus, the left 4-jointed, the right 3-jointed ending in a forceps or bristle.

1. Genus **Candacia** Dana.

Candacia Dana, 1846, p. 184.
Ifionyx Kröyer, 1848-49, p. 601.
Candace Dana, 1849, p. 279; 1852, p. 1109.
Candace Lubbock, 1856, p. 29.
Candace Claus, 1863, p. 189.
Candace Streets, 1877, p. 139.
Candace Brady, 1883, p. 66
Candace Thompson, 1888*b*, p. 148.
Candace Giesbrecht, 1892, pp. 67, 423, 729.
Candace Wheeler, 1899, p. 177.
Candacia Giesbrecht, 1898, p. 126.

♀ Fourth and fifth thoracic segments fused: front of head rectangular, lateral angles of last thoracic segment pointed; abdomen with 3 segments, genital segment often asymmetrical. Anterior antennae 23- or 24-jointed, proximal segments thickened, anterior border toothed. Rami of posterior antennae short, outer ramus slender, second joint elongated, terminal ones very short. Basal of mandible large, rami short, blade with 2 teeth. Anterior maxilliped elongate, without lobes, distal bristles strong, sickle-shaped; posterior maxilliped small and weak, second basal and inner ramus suppressed. First to fourth pairs of feet with 3-jointed outer rami, inner rami relatively small, 2-jointed; first basal with inner marginal bristle in second and third pairs. Outer border of outer ramus toothed, fifth pair stunted, 3-jointed on each side.

♂ Last thoracic segment more often asymmetrical, the point on the right side noticeable for form, size, and color. Abdomen with 5 segments, genital segment often asymmetrical with outgrowths on the right side. Right anterior antenna a grasping organ. Fifth foot on right side 3-jointed, on left side 4-jointed; the right foot terminates in a forceps or bristle.

KEY TO SPECIES.

1. Terminal bristle of outer ramus of third foot with outward bent point, at least as long as the distance between the distal spines of the outer border of the joint (fig. 44*c*) 2
1. This bristle much shorter than the designated portion of the outer border (fig. 47*d*) ....
2. Genital segment of female longer than broad ....**C. pectinata**
2. Genital segment of female broader than long, male not known.. .... **C. bipinnata**
3. The thick proximal portion of the anterior antennae is 7-jointed (fig. 45*b*) 4
3. This portion 6-jointed 5
4. Terminal joint of fifth foot of female without bristles on inner border; joint of grasping antenna proximal to geniculation with deep teeth on anterior border. Fifth foot of male (fig. 46*c*) .... **C. curta**
4. Terminal joint of fifth foot of female with three bristles, apical teeth slender and sharp. Teeth on grasping antenna fine; genital segment with flat outgrowth on right side; (fig. 47*b*).. .... **C. aethiopica**

1. Candacia pectinata Brady.

Candace pectinata Brady, 1878, p. 49; 1883, p. 67, pl. 30, figs. 1-13.
Candace pectinata Giesbrecht, 1892, pp. 424, 439, pl. 4, fig. 3; pl. 21, figs. 2, 12; pl. 22, figs. 9, 17, 18, 31, 43-46; pl. 39, figs. 1, 21, 22, 24, 25.
Candacia pectinata Giesbrecht, 1898, p. 128.
Candace pectinata Wheeler, 1899, p. 177, fig. 15.

Genital and following segment in female asymmetrical, the latter protruding posteriorly; last thoracic segment in the male asymmetrical. Anterior antennae with 23 joints, pectinate part of joints of grasping antenna deeply toothed, the segments on either side of the articulation suppressed. Proximal hooked bristles of second basal of anterior maxilliped as thick and almost as long as the distal ones. Terminal joint of fifth foot of female long and claw-like (fig. 44*b*), without inner marginal bristle; right fifth foot of male with forceps.

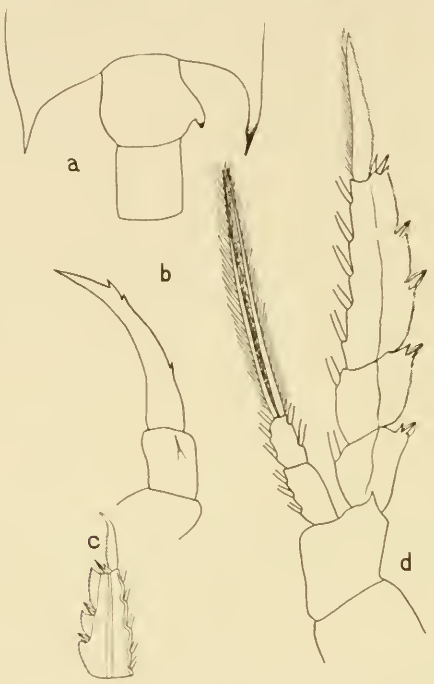

Fig. 44.—*Candacia pectinata.* (*a*) Last thoracic segment and first and second segments of abdomen, male, ×45. (*b*) Fifth foot of female ×83. (*c*) Third joint of outer ramus of third foot of male ×49. (*d*) Fourth foot of female ×83.

Coloration: Rather transparent, lateral prolongations of last thoracic segments, genital orifice, rami and bristles of feet and mouth parts, joints 18 and 19 of grasping antenna, usually a blackish brown.

Length: Females average 2 mm., males 1.9 mm.

Occurrence: Rather common; both sexes are taken in summer and winter.

2. **Candacia bipinnata** Giesbrecht.

Candace bipinnata Giesbrecht, 1889, p. 5; 1892, pp. 424, 439; pl. 22, fig. 20; pl. 39, figs. 27, 29.
Candacia bipinnata Giesbrecht, 1898, p. 129.

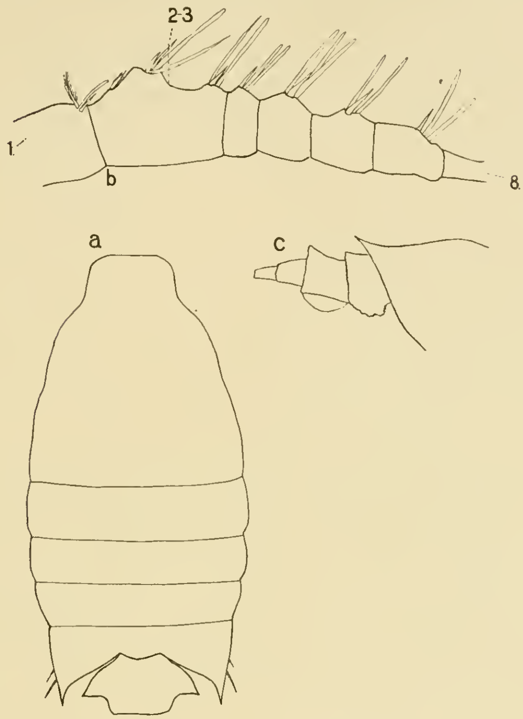

Fig. 45.—*Candacia bipinnata.* (*a*) Cephalothorax and genital segment of female, dorsal, ×31. (*b*) First eight joints of anterior antennae of female ×83. (*c*) Last thoracic segment and abdomen of female ×20.

♀ Like *C. pectinata*, but genital segment (fig. 45*a*) is broad and has a wing-like expansion on each side. ♂ Unknown.

Coloration: Much as in *C. pectinata.*

Length: Female, 2.6 mm.

Occurrence: Taken usually with *C. pectinata,* but in fewer numbers.

3. **Candacia curta** Dana.

Candace curta Dana, 1849, p. 279; 1852, p. 1116; 1855, pl. 78, figs. 6 *a-d*.
Candace curta Giesbrecht, 1892, pp. 424, 439, pl. 21, fig. 15; pl. 22, figs. 12, 24; pl. 39, figs. 8-10, 12.
Candacia curta Giesbrecht, 1898, p. 129.

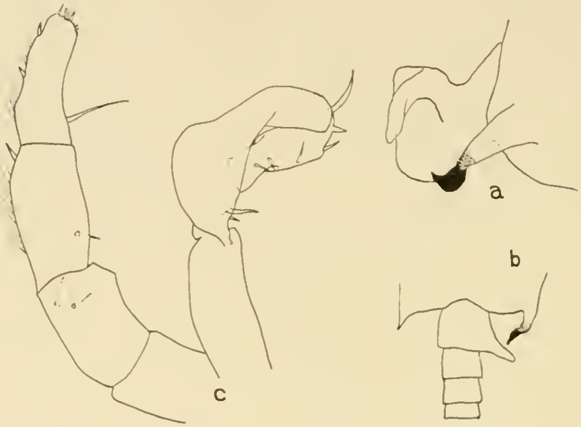

Fig. 46.—*Candacia curta*. Male. (*a*) Last thoracic segment, and genital segment, lateral, ×83. (*b*) Same, dorsal, ×31. (*c*) Fifth foot ×83. Right foot at right of figure.

Allied to *C. pectinata*, but right side of genital segment in female has a ventral projection: fifth foot of female with two heavy teeth on the end, and one on the inner border. Proximal joint of inner ramus of first foot with but two inner marginal bristles.

Coloration: As in preceding species, with very slight variations.

Length: Male, 1.5 mm. Giesbrecht gives 2.4-2.65 mm.

Occurrence: San Diego, Jan. 4, 1904, one male.

4. **Candacia aethiopica** Dana.

Candace ethiopica Dana, 1848, p. 23.
Candace melanopus Claus, 1863, p. 191, pl. 33.
Candace ethiopica Giesbrecht, 1892, pp. 424, 439, pl. 4, fig. 13, pl. 21, figs. 1, 9; pl. 22, figs. 1, 6, 13, 14, 32, 40-42; pl. 39, figs. 7, 11, 13.
Candacia aethiopica Giesbrecht, 1898, p. 128.

Genital segment of female slightly asymmetrical, with a process on the left side; last thoracic segment of male asymmetrical. Anterior antennae 23-jointed, denticulation of the geniculating joints of grasping antenna fine, joints proximal and distal to the geniculation long and slender. Proximal hooked bristle of the second basal of the anterior maxilliped as thick and almost as long as the distal (fig. 47*h*). Terminal joint of fifth foot of female with one tooth on the outer margin, 3 apical teeth, and 3 bristles on the inner border; right fifth foot of male with a forceps (fig. 47*g*).

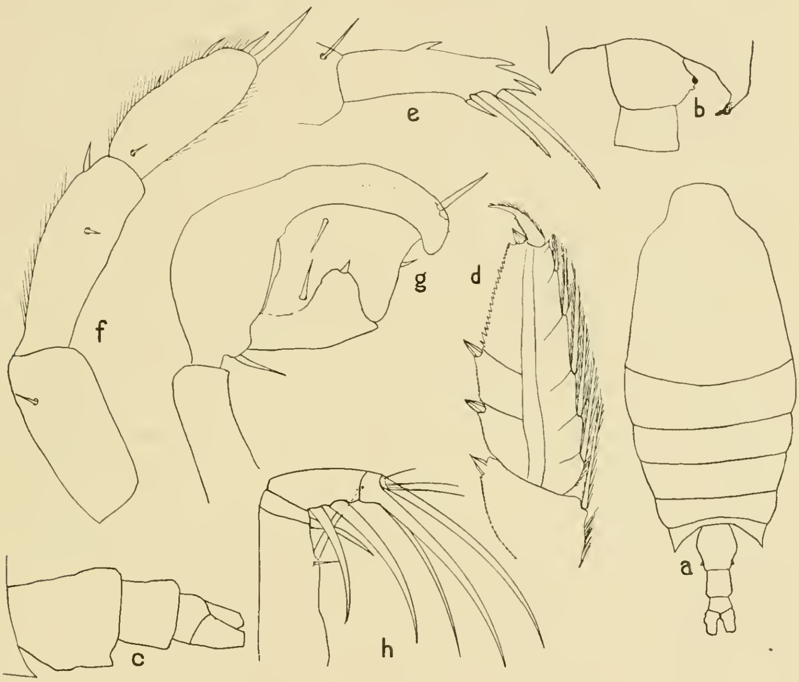

Fig. 47.—*Candacia aethiopica.* (*a*) Female, dorsal, ×165. (*b*) Last thoracic segment, and genital segment of male, dorsal, ×60. (*c*) Abdomen of female, lateral, ×37. (*d*) Second and third joints of outer ramus of third foot, female, ×60. (*e*) Fifth foot of female ×130. (*f*) Left fifth foot of male ×130. (*g*) Forceps of right fifth foot of male ×130. (*h*) Anterior maxilliped of female ×130.

Coloration: Dorsal surface of cephalothorax, excepting anterior portion of head and the last thoracic segment, black brown, distinguishing the species at once. Appendages colored about as in the other forms.

Length: Female 2.9 mm, male 2-2.5 mm.

Occurrence: Several males and females were taken October 20, 1904.

Fam. PONTELLIDAE.

Pontellidae Giesbrecht, 1892, p. 68; 1898, p. 131.

♀ Head and thorax distinct, fourth thoracic segment usually fused with fifth. Rostrum forked, usually ending in two very strong prongs; rarely absent. Eyes large, sometimes with one or two pairs of cuticular lenses and one unpaired lens. Anterior antennae 16- to 24-jointed, the two terminal joints always fused. Second basal and first joint of inner ramus fused, terminal joints of outer ramus shortened. Mandible on the whole as in the *Centropagidae*. First basal of maxilla large, second basal and rami relatively small. Anterior maxillipeds as in the *Centropagidae*, long, hooked bristles on distal portion and commonly on the proximal. First basal of posterior maxillipeds large with long bristles on lobed inner border, second basal and inner ramus relatively small. Inner ramus of four anterior pairs of feet or second to fourth, 2-jointed; fifth pair rudimentary, outer ramus 1-jointed (rarely 2-jointed), inner ramus 1-jointed or lacking.

♂ Distinct from female in form of abdomen, anterior antennae and fifth pair of feet, at times also in form of eyes, rostrum and last thoracic segment. Genital orifice on left side, grasping antenna on right, middle joints much or slightly broadened; joints 19 and 21 and 22 to 25 fused. Fifth pair of feet rarely with rudiment of inner ramus; forceps of right foot incomplete or very powerful.

Sub-fam. PONTELLINAE.

Pontellina Giesbrecht, 1892, p. 68.

♀ Cephalothorax with five or six segments; last thoracic segment ends in one (seldom two) sharp points on each side and is at times asymmetrical. Rostrum ends in two strong chitinous prongs or in two filaments. One pair of cuticular lenses is occasionally found on the dorsal side, seldom two pairs, ventral eye strongly protruding (fig. 48*c*). Abdomen with from one to three segments, never symmetrical. Anterior antennae 16- to 24-jointed, at least two terminal joints fused, usually also a number of proximal joints. Posterior antennae with reduced number of terminal joints in outer ramus which is often more slender and thinner than the inner ramus. Mandible as a whole as in *Centropages,* blade with at least five teeth. Maxilla with relatively large proximal basal, second inner marginal lobe large, second basal, rami and first outer marginal lobe accordingly relatively smaller. Anterior maxilliped as in *Centropages,* with very strong hooked bristles; posterior maxilliped short, first basal with indented or folded inner margin, set with long, strong bristles; inner ramus 3- to 5-jointed, bristles short. Outer ramus of four anterior feet 3-jointed, inner ramus of second to fourth pairs or of all 2-jointed. Basal of fifth pair 2-jointed, inner and outer rami usually 1-jointed; outer ramus seldom 2-jointed.

♂ Sexual peculiarities in form of body, more often in eyes, anterior antennae and fifth foot. Last thoracic segment as a rule asymmetrical, right posterior angle more strongly developed; abdomen with 5 segments, in cases with asymmetrical processes on right side. Right anterior antenna with broadened middle joints; beyond the geniculation either the nineteenth and twenty-first joints only are fused (besides the twenty-fourth and twenty-fifth) or also the twenty-second and twenty-third; fifth foot without inner ramus (perhaps a rudiment on left foot), four jointed on each side, the right foot with forceps.

1. Genus **Labidocera** Lubbock.

Pontella (part) Dana, 1846, p. 184; 1848, p. 26; 1849, p. 280.
Pontellina (in part) Dana, 1852, p. 1135.
Labidocera (sub-genus) Lubbock, 1853*a*, p. 25; 1853*b*, p. 202.
Pontella Claus, 1863, p. 207; 1893, p. 233.
Pontella Brady, 1878, p. 73; 1883, p. 87.
Pontella Thompson, 1887, p. 34.
Labidocera Giesbrecht, 1889, p. 7; 1892, pp. 70, 444, 746; 1897, p. 254; 1898, p. 132.
Labidocera T. Scott, 1893, p. 82.
Labidocera Wheeler, 1899, p. 178.

Head usually without hooks on side; one pair of dorsal eye lenses, larger in the male than in the female; rostral hooks strongly chitinized. Cephalothorax of 5 segments, ending in points laterally, more strongly developed on right side in the male Abdomen of female with 2 or 3 segments, of male with 5, sometimes asymmetrical in the female. Anterior antennae of female 23-jointed; terminal section of grasping antenna (the right) of male 4-jointed. Mandibular blade with 5-7 hooked, pointed teeth. Second basal of maxilla bent toward outside, about twice as long as the second lobe of the inner margin; anterior maxilliped stunted and provided with strong hooked bristles especially on the distal half; posterior maxilliped with 4-jointed inner ramus. Inner ramus of swimming feet 2-jointed, outer ramus 3-jointed; fifth foot of female on each side with 2-jointed basal portion, rami 1-jointed, though the inner ramus may be rudimentary. Fifth foot of male 4-jointed on each side, right without inner ramus, left at times with rudi mentary inner ramus. The two terminal joints of the right foot form a powerful forceps.

1. **Labidocera trispinosa** n.sp.

♀ Cephalothorax symmetrical, evenly rounded in front; crest, and hooks on side of head absent; rostrum bifid, very long; last thoracic segment produced on each side into sharp points (*cf.* fig. 48*a*. left side). Abdomen with 3 segments, genital longer than the last two, asymmetrical, with a prominent blunt wing-like process on the right side (fig. 48*d*); middle abdominal segment with a knob-like projection on the left in front. Furca symmetrical, about 3 times as long as broad. Anterior antennae extending back to the posterior border of fourth thoracic segment. Fifth pair of feet symmetrical (fig. 48*g*), outer ramus ending in two teeth, the inner one twice as long as the outer; inner ramus about one-half as long as the outer, articulating with basal; outer ramus longer than the first and second basals together.

♂ Eye lenses larger, and more nearly contiguous (fig. 48*a*). Last thoracic segment on right side with a long slender spine, curving dorsally, (fig. 48*b*), a shorter straight dorsal spine, and a very short spine directed toward median line. On the left side the thorax is about as in the female. Abdomen with five segments, genital segment in some cases slightly asymmetrical; orifice on right side; middle segment as long as the first two, and longer than the last two. Anterior antennae reaching to base of furca; joints 16 and 17 about of equal length; teeth on joint 18 directed toward distal end of antenna, those on the next joint larger and straight (fig. 48*h*). Fifth foot, fig. 48*e, f*.

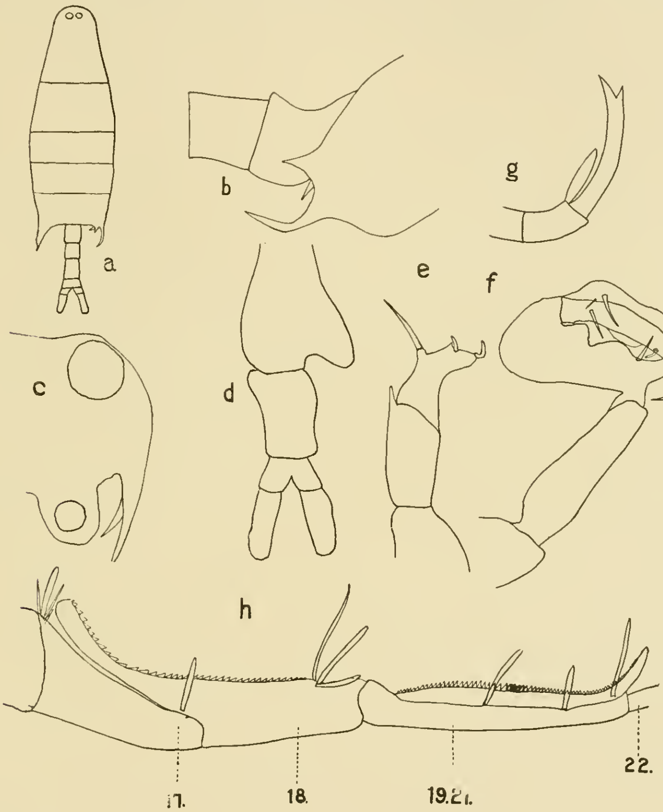

Fig. 48.—*Labidocera trispinosa, n. sp.* (*a*) Male, dorsal, ×18. (*b*) Lateral portion of last thoracic segment from right side ×60. (*c*) Head of male, lateral, ×60. (*d*) Abdomen of female, dorsal, ×60. (*e*) Left fifth foot of male. (*f*) Right fifth foot of male. (*g*) Fifth foot of female. (*h*) Joints 17, 18, 19 to 21, 22, of grasping antenna of male, ×160.

This species is distinct from any of the seventeen described species of *Labidocera* in the form of the last thoracic segment of the male, and the genital segment of the female. It approaches *L. lubbocki* Giesbrecht and *L. brunescens* Giesbrecht, more closely than any others, but differs distinctly from them in the above-named features as well as in the structure of the fifth feet of the sexes, etc.

Coloration: Rather transparent, intestinal contents light green, thorax and abdomen yellowish with green tinge in places.

Length: Female, 1.6 mm. Male, 1.7-2.2 mm.

Occurrence: May 24, 1904, one female. June 16, 1904, four males, five females.

Sub-fam. PARAPONTELLINAE.

Parapontellina Giesbrecht, 1892, p. 73.

Cephalothorax usually with five, seldom with six segments, rostral filaments slender or lacking, last thoracic segment with rounded or pointed sides. Eyes without dorsal chitin lenses.

♀ Abdomen usually with three, seldom two segments, at times asymmetrical. Anterior antennae 17- to 19-jointed; several proximal joints fused in addition to the terminal points. Second basal of mandible elongate, usually cylindrical, blade narrow with from five to seven teeth. Maxilla elongate, lobes slightly protruding and not articulating; rami more often stunted; the entire second basal may be absent. Distal hooked bristles of anterior maxillipeds long and strong, seldom so on proximal portion of the appendage. Posterior maxilliped as in the *Pontellinae* but inner ramus is only 1- or 2-jointed. Outer ramus of anterior four pairs of feet 3-jointed, inner ramus of second to fourth or of all 2-jointed. Fifth pair stunted, basal 1- or 2-jointed, outer ramus 1-jointed usually claw-like and without inner ramus; not always symmetrical.

♂ Sexual peculiarities in form of body, anterior antennae and fifth foot. Last thoracic segment and abdomen at times asymmetrical as in many *Pontellinae;* abdomen with five segments. The right grasping antenna simulated in some respects in the left; the right antenna with but little broadened middle joints and differences in the segmentation of the joints in the proximal portion; joints nineteen and twenty-one and twenty-two and twenty-five fused. Right fifth foot 3- to 4-jointed, forceps not complete, the left 3-jointed, seldom with rudiment of inner ramus.

1. Genus **Acartia** Dana.

Acartia Dana, 1846, p. 183; 1852, p. 118.
Dias Brady, 1883, p. 72.
Dias Lilljeborg, 1853.
Dias Claus, 1863, p. 191.
Dias Brady, 1883, p. 72.
Acartia Thompson, 1888*a*, p. 149; 1888*b*, p. 141.
Acartia Giesbrecht, 1892, pp. 75, 506, 721; 1898, p. 150.
Acartia Dahl, 1894*c*, p. 13.
Acartia Wheeler, 1899, p. 182.

Fifth thoracic segment and abdomen of male symmetrical; latter with shortened anal segment. Antennae of female with seventeen segments, of the same diameter throughout the length; grasping antenna of male with very slightly thickened middle joints. Outer ramus of posterior antenna much shorter than the inner; second joint of inner elongated, first joint with nine bristles on the inner border. Outer ramus of mandible articulates in the middle of the margin of the second basal. First outer marginal lobe of maxilla with long bristles, outer ramus rudimentary, its place supplied by two bristles. Proximal lobes of anterior maxillipeds well developed, with long bristles; posterior maxilliped with four joints. Inner ramus of first pair of feet with two joints, fifth pair of female without inner ramus, with long outer terminal bristle on second basal.

♀ Cephalothorax with five segments, last two fused. Posterior antenna very slender, second basal joint fused with proximal joint of inner ramus, mandible with weak blade, which has seven teeth. Posterior maxilliped without outer marginal bristles, and with three inner marginals on third joint. Outer ramus of first to fourth pairs of feet 3-jointed, first basal without bristles, second with rather long outer marginal bristle in fourth pair. The very much stunted fifth pair (fig. 49*d*) consists on each side of two or three joints; the end joint (outer ramus) is a thick stylet-shaped bristle, and on the outer border of the second basal is a slender feathered bristle.

♂ Sexual differences in form of body, anterior antennae and fifth pair of feet. Abdomen with five segments, genital orifice on left side; the fourth segment and furca shortened. The right anterior antenna is a grasping organ and joints 19-21 and 22-25 are fused. The fifth pair of feet (fig. 49*c*) consists of a common middle part and a right foot of four joints, a left of three, each uniramous. The right especially has the form of a claw, which, because of a process on the joint preceding the terminal, becomes an incomplete forceps.

1. **Acartia tonsa** Dana.

Acartia tonsa Dana, 1848, p. 26.
Acartia tonsa Giesbrecht, 1892, pp. 508, 522; pl. 30, figs. 7, 24, 34; pl. 43, figs. 6, 10; 1898, p. 154.

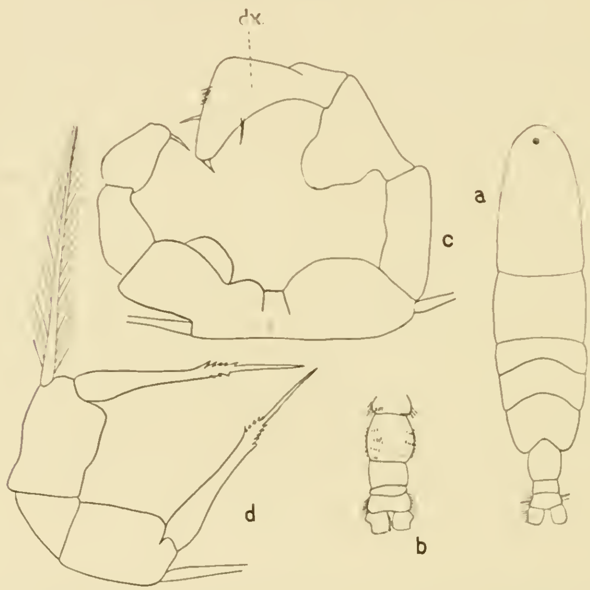

Fig. 49.—*Acartia tonsa.* (*a*) Female, dorsal, ×45. (*b*) Abdomen of male, dorsal, ×55. (*c*) Fifth foot of male ×138. *Dx.*, right foot. (*d*) Fifth foot of female ×138.

Rostral filaments present, last thoracic segment rounded laterally; abdomen of male (fig. 49*b*) with spines on the second segment: anal segment with lateral hairs. Anterior antennae of female without thorns, not reaching to the posterior border of the genital segment. Middle joint of fifth foot of female about as broad as long (fig. 49*d*); terminal portion of foot as long as the rest of the appendage, straight, toothed posterior to middle; plumose bristle as long as terminal claw. Second joint of right fifth foot of male (fig. 49*c*) without process on inner margin; process of third and fourth joints broader than in *A. clausi*.

Coloration: Very transparent, without pigment.

Length: Female, 1.2-1.5 mm. Male, 1-1.1 mm.

Occurrence: Enormous quantities may be obtained in Glorietta Bight, San Diego Bay, especially at night; the species occurs rather infrequently outside.

II Sub-order.—PODOPLEA.

Body divided into an anterior and posterior portion but the line of separation falls in front of the last thoracic segment (fig. 50*a*); the posterior portion of the body has as the first segment the fifth thoracic segment, which bears almost without exception a rudimentary pair of feet (figs. 50*a*, 57*b*); these are never of service to the male in pairing. The spermatophores are placed directly upon the genital orifice of the female, without the use of a pair of appendages. The genital organs of the male are usually paired, their orifices always symmetrically placed. The female carries the eggs until the young are set free.

KEY TO THE GENERA OF THE PODOPLEA.

(The genera marked with an asterisk have been found in the San Diego region.)

1. Inner rami of third and fourth feet 3-jointed, or lacking in fourth pair 2
1. Inner rami of third and fourth feet 1-jointed.......... Mormonilla
2. Inner ramus of first foot 1-jointed 3
2. Inner ramus of first foot 2-jointed (fig. 53*c*).......... 14
3. Head with two large chitinous lenses (figs. 62, 57*b*).......... 4
3. Head without chitinous lenses 7
4. Inner ramus of fourth foot 2- or 3-jointed (fig. 59*b*).......... 5
4. Inner ramus of fourth foot 1-jointed or replaced by bristles (fig. 63*b*) 6
5. Abdomen with four or five segments which are broadened laterally (figs. 57*a*, 59*a*).......... *Sapphirina

5. Abdomen with two segments, not broadened................**Corina**
6. Eye lenses separated by at least their diameter; the last two thoracic segments without lateral sharp prolongations.....**Copilia**♀
6. Eye lenses placed close together, last two segments of the anterior portion of the body prolonged into lateral pointed processes (figs. 61*a*, 62*b*)...........................***Corycaeus**
7. Entire body much flattened, furca very long and stylet-like..**Copilia**♂
7. Body of various shapes but more rounded; if at times depressed, never leaf-like 8
8. Outer ramus of first foot 1-jointed, postero-lateral angles of fourth segment of body prolonged into processes (fig. 54*a*).... .... ***Clytemnestra**
8. Outer ramus of first foot 2- to 3-jointed........................ 9
9. Outer ramus of posterior antenna 1-jointed; furca very short, each ramus with a very long bristle twice as long as the body at least; rami of furca and the two bristles fused in the median line; remaining furcal bristles stunted................**Aegisthus**
9. Outer ramus of posterior antenna 3-jointed; furca short, rami separate (fig. 52*c*), each with a long bristle, at least as long as the body, and at least twice as long as the other bristles (fig. 52*a*)...................................... ***Microsetella**
9. Outer ramus of posterior antenna lacking; furca longer than broad, rami separate 10
10. Anterior and posterior maxillipeds alike in structure, both with long, spinous bristles ....***Oithona**
10. Posterior maxilliped with few or no short bristles and a terminal hook (Oncaeidae) (figs. 55*b*, 56*b*) 11
11. Fifth pair of feet 1-jointed, with two lancet-shaped appendages at the end which have dentate borders; body elongate..**Lubbockia**
11. Fifth pair 1- or 2-jointed or knob-like, with naked or plumose bristles; body more robust 12
12. Anterior antennae with very long and thick aesthetasks on the terminal joints; fifth feet 2-jointed ....**Ratania**
12. Anterior antennae with numerous penicillate aesthetasks on the proximal joints; fifth foot a protuberance.............**Pachysoma**
12. Anterior antennae with few and very delicate aesthetasks; fifth foot reduced to a small rod or knob, or at times to one bristle 13
13. Terminal hooked bristles on the posterior antenna of medium length; inner ramus of rear feet at least as long as the outer, terminal joint in fourth pair at least 1½ times as long as the first and second joints together ....***Oncaea**
13. Hooked bristles on the much elongated terminal joint of posterior antennae very long; inner ramus of rear feet shorter than outer, its terminal joint in the fourth pair no longer than each of the proximal joints ....**Conaea**
14. Front of head with two great chitinous lenses..............**Miracia**
14. Head without lenses 15
15. Forehead conical, rounded in front; body very narrow; outer ramus of posterior antennae lacking .... **Setella**

15. Forehead pointed (fig. 53*a*); body broad; outer ramus of posterior antenna 1-jointed.................................. 17
16. Furca with separate rami (about twice as long as broad) and bristles much shorter than body (fig. 53*a*)..............*Euterpe
16. Rami of the fuca very short and with the two unusually long bristles fused in the median line......................Aegisthus

Fam. CYCLOPIDAE.

1. Genus **Oithona** Baird.

Oithona Baird, 1843.
Scribella Dana, 1847, p. 279; 1848, p. 19.
Oithona Dana, 1852, p. 1097.
Oithona Claus, 1863, p. 104.
Oithona Brady, 1883, p. 97.
Oithona Giesbrecht, 1892, pp. 77, 537, 753; 1896, p. 324.
Oithona Wheeler, 1899, p. 186.

♀ Anterior and posterior parts of body composed of five segments, first and second abdominal segments fused (fig. 50*a*). Genital opening lateral. Anterior antennae rather obscurely jointed, bristles long; posterior antennae 3-jointed, outer ramus absent. Inner ramus of mandible small, 1-jointed, outer ramus 4-jointed; blade dentate. Rami of maxilla 1-jointed, inner ramus small. Maxillipeds slender, bristles strong, spinous; inner ramus of posterior maxilliped 2-jointed. Rami of swimming feet 3-jointed. Fifth pair very rudimentary, being reduced to two bristles on each side.

♂ Front of head blunt (fig. 51*a*); first and second abdominal segments not fused (fig. 50*b*, 51*a*), bristles of furca short. Anterior antenna are grasping organs, geniculating at two places. Swimming feet somewhat irregular in number and arrangement of bristles.

1. **Oithona plumifera** Baird.

Oithona plumifera Baird, 1843.
Oithona plumifera Dana, 1852, p. 1099, pl. 76, figs. 4*a-e*.
Scribella scriba Dana, 1849, p. 279.
Oithona spinirostris Claus, 1863, p. 105.
Oithona plumifera Giesbrecht, 1891, p. 475; 1892, pp. 537, 548; pl. 4, fig. 10; pl. 34, figs. 12, 13, 22, 25, 27-29, 32, 33, 44-47; pl. 44, figs. 1, 7, 12-15.
Oithona plumifera Wheeler, 1899, p. 186, fig. 22.

♀ Front ending in a somewhat ventrally directed, pointed beak, but visible in dorsal view. Furca shorter than anal segment, about three times as long as broad, outer marginal bristle about three times as long as the furca. Anterior antennae extend to the posterior border of the fourth abdominal segment. Second basal of mandible with two hooked bristles; inner ramus of maxilla with a minute bristle. Outer ramus of first pair of feet (fig. 50*d*) with one outer marginal bristle on the first joint, one on the second and two on the third; outer ramus of the second and third pairs, with one on the first joint, none on the second and two on the third; of the fourth pair with none

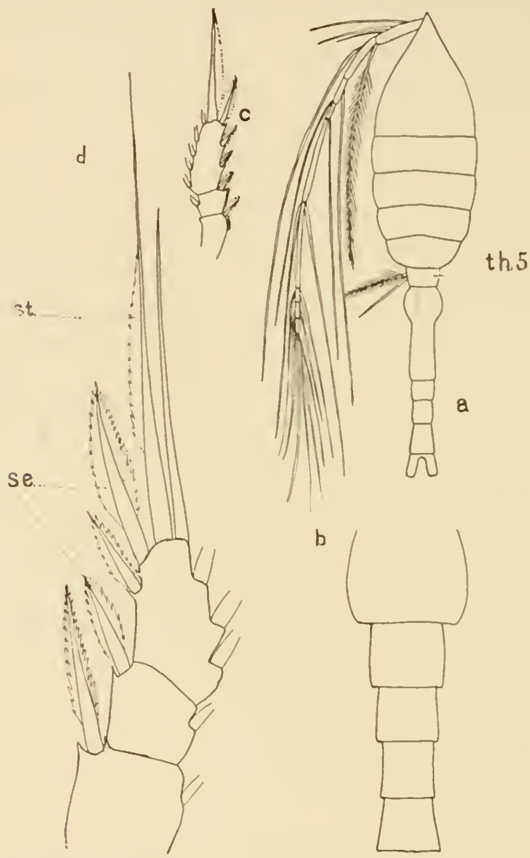

Fig. 50.—*Oithona plumifera.* (*a*) Female, dorsal, ×40. *Th.5,* fifth thoracic segment. (*b*) Abdomen of male ×140. (*c*) Outer ramus of third foot of male ×83. (*d*) Outer ramus of first foot of female ×265. *Se.,* outer marginal bristles. *St.,* terminal bristle.

on the first and second joints, two on the third; proximal bristle of outer margin of third joint of third and fourth pairs reduced.

♂ Genital segment broad (fig. 50*b*). Proximal joint of distal portion of anterior antennae with a half crescentic process on the inner margin. Third joint of outer ramus of first and fourth pairs of feet with two outer marginal bristles, the second and third with three (fig. 50*c*).

Coloration: Giesbrecht shows red pigment in body, and especially in long bristles of anterior antennae, furca, feet and mouth parts, while other animals may be colorless. All specimens I have seen are colorless.

Length: Female, 1-1.4 mm.; male, 0.75-1 mm.

Occurrence: Not as abundant as *O. nana*, but some specimens occur in all catches where the ordinary Podoplea are numerous, summer and winter.

2. **Oithona nana** Giesbrecht.

Oithona nana Giesbrecht, 1892, p. 549, pl. 4, fig. 8; pl. 34, figs. 10, 11, 20, 24, 26, 34, 35, 42; pl. 44, figs. 2, 4.

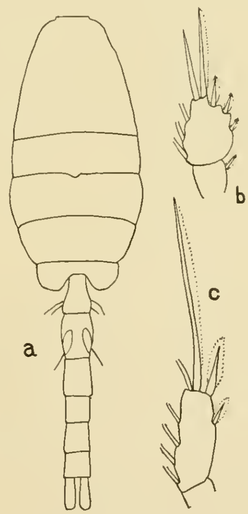

Fig. 51.—*Oithona nana.* (*a*) Male, dorsal, ×83. (*b*) Third joint of outer ramus of first foot of female ×83. (*c*) Third joint of outer ramus of fourth foot of male ×83.

♀ Front blunt: furca as long as the anal segment, hardly twice as long as broad, outer marginal bristle about as long as the furca. Anterior antennae reach about to the posterior margin of the third thoracic segment. Second basal of mandible with one hooked bristle. Inner ramus of maxilla with four bristles. First, second and third (fig. 51*b*), joints of outer ramus of first to third feet respectively, with one, one, three outer marginal bristles, of the fourth with one, one, two.

♂ Division line between the first and second thoracic segments with a sharp median projection; genital segment narrower than in *O. plumifera.* Proximal joint of the distal portion of the anterior antennae without the round process. Third joint of outer ramus of first to third feet with three outer marginal bristles, of the fourth with two (fig. 51*c*).

Coloration: Transparent, without pigment.

Length: Female, 0.7-0.8 mm.; male, 0.5-0.6.

Occurrence: Rather abundant in hauls taken from inside of the kelp beds at Point Loma. Both sexes found. The tow in which Oithona occurs most plentifully contains scarcely any other genera than *Oncaea*, *Euterpe* and *Corycaeus*.

Fam. HARPACTICIDAE.

1. Genus **Microsetella** Brady and Robertson.

Microsetella Brady and Robertson, 1873, p. 130, pl. 9, figs. 11-16,
Harpacticus Dana, 1847, p. 152.
Canthocamptus Dana, 1852, p. 1187.
Ectinosoma Brady, 1883, p. 99.
Ectinosoma Möbius, 1887, p. 116.
Microsetella Giesbrecht, 1892, pp. 78, 549, 750.

♀ Body cylindrical, smaller in front and behind, anterior portion with four segments, posterior with five; furca short, bristles very long. Anterior antennae 5-jointed, posterior 3-jointed, outer ramus 3-jointed and slender. Rami of first to fourth feet 3-jointed, inner ramus longer than outer; fifth pair rudimentary and leaf-like (fig. 51*b*).

♂ Posterior portion of body with five segments, anterior antennae rather strong grasping organs; feet much smaller.

1. **Microsetella rosea** Dana.

Harpacticus roseus Dana, 1847, p. 153.
Canthocamptus roseus Dana, 1852, p. 1189; 1855, pl. 83, figs. 1-10.
Microsetella rosea Giesbrecht, 1892, pp. 550, 554, pl. 44, figs. 32, 35, 37, 38, 41, 43, 48, 49.

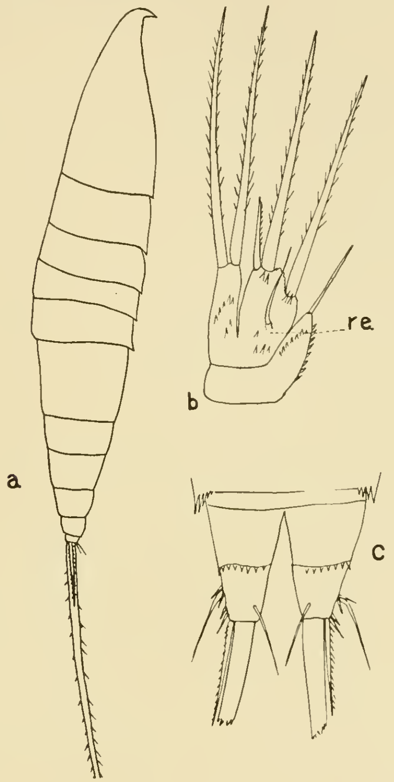

Fig. 52.—*Microsetella rosea.* Female. (*a*) Lateral ×83. (*b*) Fifth foot ×195. *Re.*, outer ramus. (*c*) Furca, ventral, ×195.

♀ Longest bristle of furca almost twice as long as the body, third terminal bristle less than half as long as the abdomen. Innermost bristle of fifth foot not much shorter than the others.

♂ Unknown.

Coloration: Rather transparent, region of mouth red, and also long furcal bristles; digestive tract rosy red.

Length: Female, 0.84—0.9 mm.

Occurrence: June 10, 1904, five females; catch taken near La Jolla.

2. Genus **Euterpe** Claus.

Harpacticus Dana, 1847, p. 152; 1852, p. 1189.
Euterpe Claus, 1863, p. 109.
Euterpe Giesbrecht, 1892, pp. 78, 555.

♀ Anterior portion of body with four segments, posterior with five; front of head pointed (*cf.* fig. 53*a*). Anterior antennae 7-jointed, posterior 3-jointed, outer ramus 1-jointed. Rami of swimming feet 2-jointed in the first pair, 3-jointed in second to fourth pairs; fifth pair rudimentary (fig. 53*d*).

♂ First and second abdominal segments not fused (fig. 53*a*): anterior antennae (fig. 53*c*) are powerful grasping organs, fourth and fifth joints fused and much thickened, geniculating with the hooked terminal joint which is composed of the fused sixth and seventh joints. Rami, especially the inner, of the first pair of feet of peculiar form; fifth pair shorter and with fewer bristles than in the female.

1. **Euterpe acutifrons** Dana.

Harpacticus acutifrons Dana, 1847, p. 153; 1852, p. 1192; 1855, pl. 83, fig. 11*a*, *b*.
Euterpe gracilis Claus, 1863, p. 109, pl. 14, figs. 1-13.
Euterpe acutifrons Giesbrecht, 1892, p. 555, pl. 44, figs. 16-31.

The only species of the genus.

Coloration: Transparent, almost without pigment, but digestive canal is often yellowish or green.

Length: Male, .73 mm.; females slightly smaller.

Occurrence: Abundant in catches with *Oithona*, *Oncaea* and *Corycaeus*.

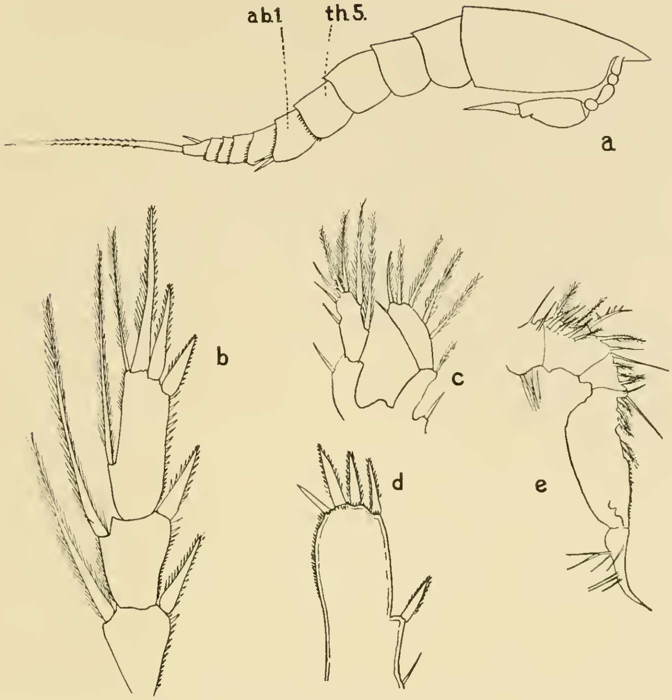

Fig. 53.—*Euterpe acutifrons.* (*a*) Male, lateral, ×175. *Ab.*1, first abdominal segment. *Th.*5, fifth thoracic segment. (*b*) Outer ramus of fourth foot of female ×140. (*c*) First foot of male ×265. (*d*) Fifth foot of female ×410. (*e*) Anterior antenna of male ×195.

3. Genus **Clytemnestra** Dana.

Clytemnestra Dana, 1847, p. 154; 1852, p. 1193.
Clytemnestra Lubbock, 1860, p. 180.
Goniopsyllus Brady, 1883, p. 107.
Clytemnestra Giesbrecht, 1892, pp. 79, 565, 733.
Clytemnestra Wheeler, 1899, p. 188.

♀ Anterior part of body composed of four segments, posterior part of five; furca short. Anterior antennae 7- to 8-jointed, bristles short, posterior antennae 3-jointed, outer ramus supplied by one or two bristles. Posterior maxilliped 2-jointed, slender and elongated, with short hooks at the end. Rami of swimming feet long and narrow, inner ramus the longer, 3-jointed in all pairs; outer ramus 3-jointed except in first pair, where it is 1-jointed; fifth pair rudimentary, 2-jointed.

♂ Posterior portion of body with six segments, furcal bristles sometimes lengthened. The anterior antennae are grasping organs, geniculating between the last two joints; posterior maxillipeds longer, with thicker second joint and longer terminal hook.

1. **Clytemnestra rostrata** Brady.

Clytemnestra tenuis Lubbock, 1860, p. 160, pl. 29, figs. 6-7.
Goniopsyllus rostratus Brady, 1883, p. 107, pl. 42, figs. 9-16.
Clytemnestra rostrata Giesbrecht, 1892, pp. 566, 572, pl. 45, figs. 19, 20, 22, 25, 26, 31, 33.
Clytemnestra rostrata Wheeler, 1899, p. 189, fig. 26.

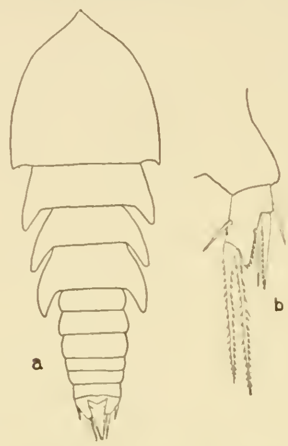

Fig. 54.—*Clytemnestra rostrata.* Female. (*a*) Dorsal, ×45. (*b*) Furca, dorsal, ×265.

Furca at most as long as broad, bristles not plumose, equal in length in both sexes. Anterior antennae in each sex seven-jointed, last joint in female five times as long as the preceding one; lancet-shaped bristle lacking in the male. Outer ramus of posterior antenna replaced by one bristle; second basal of first foot without bristle on outer margin, outer ramus with three bristles; outer ramus of second foot with one outer marginal bristle on first and second joints, two on the third; second joint of inner ramus of third foot longer than the terminal joint. Fifth foot as long as the outer ramus of the fourth, with five bristles on the terminal joint, which are as long in the female as in the male.

Coloration: Reddish, due to the presenee of rose, brown or greenish oil globules in the transparent body.

Length: Female, 1.28 mm.

Oecurrenee: Rather uncommon; one female was taken June 14, 1904, at San Diego. Oecurs also in the winter.

Fam. ONCAEIDAE.

Oncaeidae Giesbrecht, 1892, p. 81.

Paired eyes with cuticular lenses and pigment bodies not developed.

♀ Form of body in general like the *Cyclopidae*. Each portion of the furca has six bristles. Anterior antennae 4- to 6-jointed; posterior antennae 3- or 4-jointed; mandibles reduced to blade, without specific form. Maxillae are bristle-bearing platelets, usually separated into two lobes. Anterior maxilliped 2-jointed. Posterior maxilliped 4-, seldom 3-jointed, terminal hook strong. First to fourth pairs of feet with 3-jointed rami; inner ramus of fourth foot longer or but little shorter than the outer.

♂ Sexual peculiarities in form of abdomen and posterior maxillipeds, fewer joints usually in anterior antennae, rarely in posterior antennae and mouth parts.

1. Genus **Oncaea** Philippi.

Oncaea Philippi, 1843, p. 62.
Antaria Dana, 1852, p. 1227.
Antaria Claus, 1863, p. 158.
Antaria Brady, 1883, p. 119.
Oncaea Lubbock, 1860, p. 183.
Oncaca Giesbrecht, 1892, pp. 81, 590, 755.

Shape of body as in *Oithona*. Terminal joints of inner rami of swimming feet long and narrow, that of the fourth pair at least one and one-half times as long as the first and second together; fifth foot rod or knob-shaped.

♀ Both portions of body with five segments (figs. 55*a*, 56*a*). Anterior antennae 6-jointed, posterior 3-jointed, hooked bristles of medium length (*cf.* fig. 56*c*). Posterior maxillipeds 4-jointed, rows of spines on inner border of second basal. Outer marginal bristles of outer rami of first and second feet as follows:

One on the first and second, three on the third joint; of the third and fourth feet, one on the first and second, two on the third joint.

♂ Abdomen with five segments, genital segment large, lips of the orifice with spines at the sides. Posterior maxilliped with more muscular second basal, and more strongly curved terminal hook than in the female. In the anterior antennae the three short terminal joints are fused into one piece.

1. **Oncaea conifera** Giesbrecht.

Antaria mediterranea Claus, 1863, p. 159, pl. 30, figs. 1-7.
Oncaea conifera Giesbrecht, 1892, pp. 591, 603, pl. 2, fig. 10; pl. 47, figs. 4, 16, 21, 28, 34, 38, 42, 55, 56.

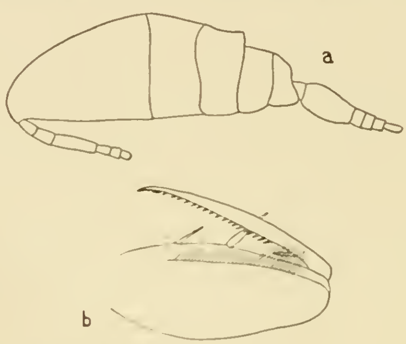

Fig. 55.—*Oncaea conifera.* Female. (*a*) Lateral ×45. (*b*) Posterior maxilliped ×265.

♀ Median portion of second thoracic segment protruding from the dorsal surface of the body (fig. 55*a*), genital segment almost one and one-half times as long as the rest of the abdomen, the following segments broader than long. Furca as long as the fifth abdominal segment, between two and two and one-half times as long as broad, its branches strongly directed away from each other. Hook at end of posterior maxilliped set with thick spines, distal bristles of second basal heavier and longer than the proximal (fig. 55*b*). Processes at end of third joint of inner ramus of swimming feet very large, present even in the fourth pair, the adjacent lancet-like bristle shortened. Fifth pair of feet elongated, with thickened terminal bristle.

♂ Lips of genital orifice long, furca short and broad.

Coloration: Often distinctly green-yellow tint to body, which is not very transparent.

Length: Female, 1.2 mm.; male, about 0.8 mm.

Occurrence: A few were taken June 14, 1904, and in some cases the sexes were pairing.

2. **Oncaea minuta** Giesbrecht.

Oncaea minuta Giesbrecht, 1892, p. 603, pl. 47, figs. 3, 6, 26, 46, 59.
Oncaea minuta (male) Aurivillius, 1899, p. 29, figs. 1-3.

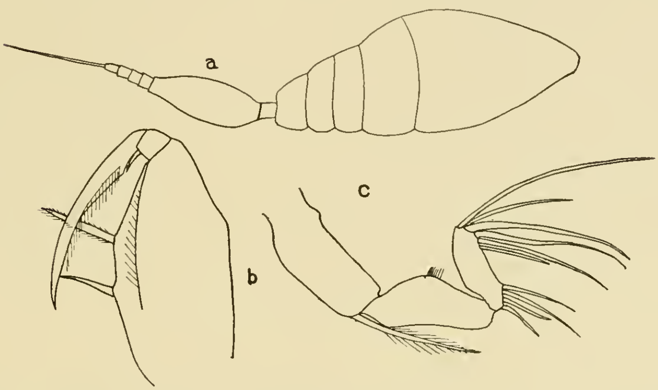

Fig. 56.—*Oncaea minuta.* Female. (*a*) Lateral ×140. (*b*) Posterior maxilliped ×265. (*c*) Posterior antenna ×265.

♀ Genital segment longer than the rest of the abdomen, the following segments broader than long; furca shorter than the fifth abdominal segment, less than twice as long as broad, innermost terminal bristle shorter than the outermost. Posterior antennae retrograded; terminal hook of posterior maxillipeds, and the distal bristles of the second basal provided with spines. Outer ramus of swimming feet narrow, end joint of inner ramus even in the fourth with terminal processes and smooth proximal outer marginal bristle.

♂ Unknown (?)

Coloration: Reddish throughout body; eggs red.

Length: Female, 0.46-0.5 mm.

Occurence: Rather uncommon; a few come during the summer.

Fam. Corycaeidae.

Corycaeidae Giesbrecht, 1892, p. 83.

Paired eyes highly developed in both sexes or in females, with large cuticular lenses and pigment bodies.

♀ The broad front and the two chitin lenses, sometimes contiguous and sometimes separated, are characteristic of the body form (fig. 57*b*; 62.). Anterior portion of the body may be conical (*Corycaeus* fig. 62) or cubical (*Copilia*) or oval and depressed (*Sapphirina* fig. 58*a*, *b*; 59*a*, *Corina*). The number of segments may be 10 (*Sapphirina*), 8 (*Corina*, *Copilia*) or 7 to 4 (*Corycaeus*); each part of the furca with only four or five bristles. Anterior antennae 3- to 6-jointed, posterior antennae (fig. 58*c*) with at least a heavy terminal hook; mandibles reduced to blade; maxillae oval or elongate platelets, with 3 to 5 bristles; anterior maxillipeds as in the *Oncaeidae*, posterior 3-jointed, terminal hook strong. Rami of swimming feet 3-jointed, except in the case of the inner ramus of the fourth pair, which shows all transitions from the 3-jointed ramus to a rudiment consisting of a single bristle.

♂ Sexual peculiarities in form of body and posterior maxillipeds, also in the other appendages and more striking than in the *Oncaeidae*.

1. Genus **Sapphirina** J. V. Thompson.

Sapphirina J. V. Thompson, 1829.
Sapphirina Templeton, 1836.
Sapphirina Dana, 1848, p. 41; 1849, p. 281; 1852, p. 1234.
Sapphirina Claus, 1863, p. 149.
Sapphirina Haeckel, 1864, p. 102.
Sapphirina Brady, 1883, p. 121.
Sapphirina Giesbrecht, 1892, pp. 84, 618, 761.
Sapphirina Wheeler, 1899, p. 190.

Body depressed; anterior and posterior portions of body with 5 segments in the female, middle abdominal segments broadened. Furca leaf-like, with five bristles. Rami of feet broad, in first, second, and third pairs about equal in length; inner ramus of fourth pair with 3 joints, of varying relative size; fifth pair of feet with two bristles. Male with leaf-like broadened segments in trunk, iridescent; no general sexual peculiarities in mouth parts and swimming feet.

♀ Eye lenses contiguous or close together. Genital orifice placed far at the side of the segment. Anterior antennae 3- to 5-jointed, posterior antennae (fig. 58*c*) with a short hooked bristle on the terminal joint and slender bristles elsewhere. The terminal joint of the anterior maxillipeds is drawn out into a long spine; hook at end of posterior maxillipeds short and thick. Outer rami of swimming feet with broad-edged, lancet-shaped outer marginal bristles; in the first to third pairs the first, second, and third joints have respectively one, one, three bristles; in the fourth pair, one, one, two (three). The first, second and third joints of the inner ramus of the first foot have respectively one, one, six bristles; of the second foot one, two, six; of the third one, two, five, and of the fourth one, two, two, (one).

♂ Abdomen with five segments; genital valves broad but short, with several bristles; hooks at end of posterior maxillipeds elongated, and articulating with the second basal by means of an intervening joint (fig. 60*a*).

1. **Sapphirina iris** Dana.

Sapphirina iris Dana, 1849, p. 41; 1852, p. 1239; 1855, pl. 87, figs. 1 *a-d*.
Sapphirina salpae Claus, 1863, p. 152.
Sapphirina gemma Brady, 1883, p. 127; pl. 48, fig. 6-8.
Sapphirina salpae Giesbrecht, 1892, pp. 618, 641; pl. 2, fig. 9; pl. 52, figs. 1, 2, 18, 19, 27, 45, 51; pl. 53, figs. 7, 23, 24, 60; pl. 54, figs. 9, 13, 15, 16, 19, 57.
Sapphirina iris, Giesbrecht, 1895, p. 261.

♀ Furca more than 2⅓ times as long as broad, inner border more convex than outer, a small point at end of inner margin (fig. 57*c*); the dorsal bristle is placed farther back than those on the outer border. Anterior antennae 5-jointed, 6/7 as long as the posterior; second joint 1⅓ times as long as the three terminal joints. Inner ramus of posterior antennae about ⅘ the length of the second basal, end hook half as long as the second joint of the inner ramus. Inner ramus of fourth foot little shorter than the outer, third joint of latter with 3 outer marginal bristles. Third joint of inner ramus not much shorter than the other two together, with two bristles on the end.

♂ Body about 2½ times as long as its greatest width (fig. 57*a*). Eye lenses ventral, overhung by the margin of the front of the head. Furca, anterior antennae, fourth pair of feet like same parts in the female, posterior antennae, mandible, maxilla,

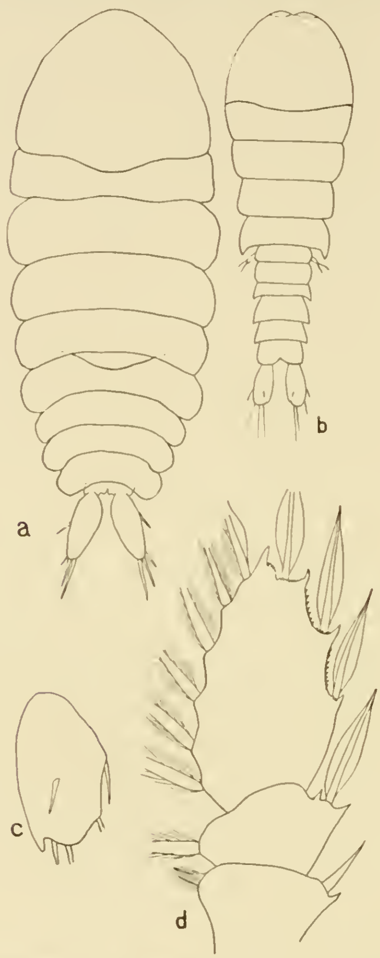

Fig. 57.—*Sapphirina iris.* (*a*) Male, dorsal, ×9. (*b*) Female, dorsal, ×9. (*c*) One ramus of furca of female, dorsal, ×83. (*d*) Outer ramus of fourth foot of male ×140.

anterior maxillipeds somewhat different; terminal joint of inner ramus of second pair with 3 lancet-like bristles.

Coloration: Egg cases red; body rather transparent and strikingly iridescent in the male.

Length: Female, 5-7 mm.: male, 7-8 mm.

Occurrence: Both sexes are rather common, in winter and summer collections.

2. **Sapphirina angusta** Dana.

Sapphirina angusta Dana, 1849, p. 41; 1852, p. 1240; 1855, pl. 87, figs. 3*a*, *b*.

Sapphirina danae Lubbock, 1856, p. 33, pl. 12, figs. 9-11.

Sapphirina clausii Haeckel, 1864, p. 104, pl. 2, figs. 21-25.

Sapphirina angusta Giesbrecht, 1892, pp. 619, 641; pl. 52, figs. 5, 6, 53, 58, 66; pl. 53, figs. 6, 17, 29, 30; pl. 54, figs. 2, 8, 17, 20, 60, 61.

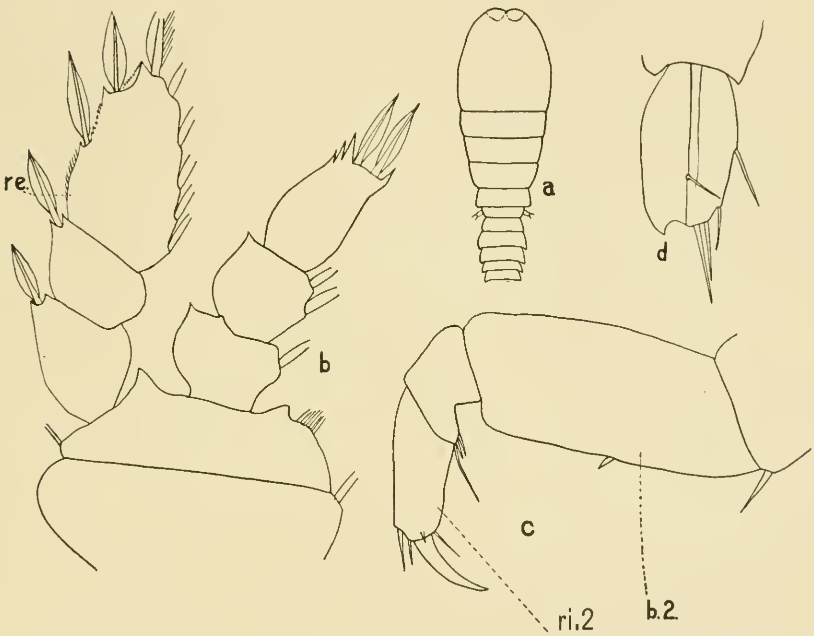

Fig. 58.—*Sapphirina angusta.* (*a*) Female, dorsal, furca not shown, ×14. (*b*) Fourth foot of female ×160. *Re.*, outer ramus. (*c*) Posterior antenna, female, ×160. *B.*2, second basal joint. *Ri.*2, second joint of inner ramus. (*d*) Furca of male, dorsal, ×60.

♀ Head longer than broad; furca almost twice as long as broad, with a broad tooth at end of inner border (fig. 58*d*), dorsal bristle placed farther back than the outer marginal bristles. Anterior antennae 5-jointed, 5/6 as long as the posterior, second joint 5/4 as long as the 3 terminal joints together. Inner ramus of posterior antennae 5/7 as long as the second basal joint terminal hook $\frac{2}{3}$ as long as the second joint of the inner ramus (fig. 58*c*). Inner ramus of fourth foot little shorter than the outer; terminal joint of inner ramus about $\frac{3}{4}$ the length of the first and second joints together, with two bristles on the end (fig. 58*b*).

♂ Length of trunk $2\frac{1}{4}$ as much as its greatest diameter. Eye lenses as in *iris*. Furca, fourth pair of feet, anterior antennae as in the female, the other appendages somewhat different; terminal joint of inner ramus of second foot with 3 lancet bristles and elongated teeth.

Coloration: Egg cases blue, otherwise as *S. iris*; the males are brilliantly iridescent.

Length: Female, 2.5-5 mm; male, 3-5 mm.

Occurrence: Both sexes occur frequently in summer and winter.

3. **Sapphirina scarlata** Giesbrecht.

Sapphirina scarlata Giesbrecht, 1892, p. 642; pl. 52, figs. 42, 60, 61; pl. 53, figs. 12, 39; pl. 54, figs. 25, 31, 72.

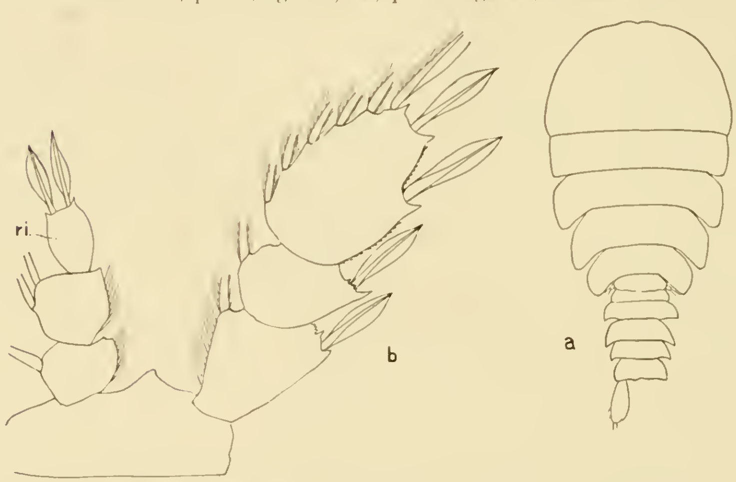

Fig. 59.—*Sapphirina scarlata*. Female. (*a*) Dorsal, ×18. (*b*) Fourth foot, ×140. *Ri.*, inner ramus.

♀ Head broad, furca hardly twice as long as wide; inner marginal bristle placed a little farther forward than the outer marginal. Anterior antennae 5-jointed, not half as long as the posterior, second joint $1\frac{1}{4}$ times as long as the terminal joint.

Inner ramus of posterior antennae longer than the second basal; terminal hook half as long as second joint of inner ramus. Inner ramus of fourth foot half as long as the outer (fig. 59*b*), terminal joint of inner ramus as long as first or second joints, with two bristles at the end.

♂ Length of trunk not quite twice its greatest breadth, eye lenses set back almost on the margin of the front. Furca, antennae and anterior mouth parts as in the female; terminal joint of outer ramus of second foot with two lancet bristles, the three thick, awl-shaped teeth elongated.

Coloration: Transparent, with bright red spots on the thorax and abdomen.

Length: Female, 3.3 mm.

Occurrence: One adult female was taken; immature specimens have come in at other times.

4. **Sapphirina lomae** n.sp.

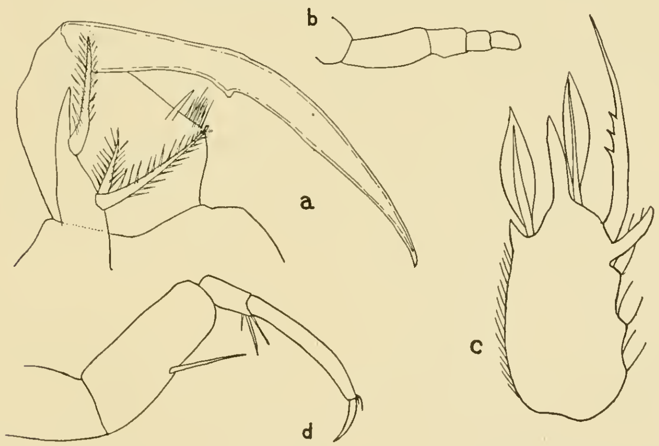

Fig. 60.—*Sapphirina lomae, n. sp.* Male. (*a*) Posterior maxilliped ×83. (*b*) Anterior antenna, bristles omitted, ×83. (*c*) Third joint of inner ramus of second foot ×195. (*d*) Posterior antenna ×83.

Resembling *S. nigromaculata* in general; anterior antennae (fig. 60*b*) nearly half as long (7/16) as posterior and 5-jointed; second joint shorter than the three terminal joints together. Inner ramus of posterior antennae (fig. 60*d*) nearly half again as long as the second basal, terminal hook not 1/5 as long as the second joint of the inner ramus. Inner ramus of fourth foot not ½ as long as the outer ramus, third joint of former with two terminal bristles; third joint of inner ramus of second foot (fig. 60*c*) with 2 lancet bristles, the third notched on one side; projections on margin of joint much elongated.

S. lomae differs from *S. nigromaculata* most in the relative lengths of the joints of the posterior antennae and in the form of the toothed bristles on the terminal joint of the inner ramus of the second foot. Two males were taken on May 31, 1904, but are so badly mutilated that it is impossible to make a drawing of the entire animal.

Length: 3.2 mm.

Occurrence: San Diego, May 31, 1904, 2 males.

NOTE.—The species of *Sapphirina* are separated into two general groups, according as the inner ramus of the fourth foot is very small and narrow (fig. 59*b*), compared with the outer ramus, or at least ⅔ as long as the outer. *S. iris* and *S. angusta* belong in the latter group, and *S. scarlata* and *S. lomae* in the former. *S. iris* is distinct from any other species in having 3 bristles on the outer margin of the third joint of the outer ramus of the fourth foot; *S. angusta* may be recognized by the shape of the furcal rami.

2. Genus **Corycaeus** Dana.

Corycaeus Dana, 1848, p. 35; 1849, p. 280; 1852, p. 1203.
Corycaeus Lubbock, 1856, p. 32; 1857, p. 409; 1860, p. 182.
Corycaeus Claus, 1863, p. 154.
Corycaeus Giesbrecht, 1891, p. 480; 1892, pp. 85, 659, 735.
Corycaeus Dahl, 1894*b*, p. 67.
Corycaeus Wheeler, 1899, p. 191.

♀ Eye lenses close together, in some cases contiguous; fifth thoracic segment very short. Anterior antennae 6-jointed, bristles not plumose; second basal of posterior antennae large, first basal very short, each provided with a long, heavy bristle, inner ramus with a thick, strongly curved hooked bristle. Terminal joint of anterior maxilliped ends in a strong hook; second basal of posterior maxilliped with one bristle on the inner margin, terminal hook more slender than in *Sapphirina*. Outer ramus of swimming feet longer than inner rami; outer marginal bristles of outer ramus in first and second pairs are lanceolate and dentate, and are more or less suppressed in the third and fourth pairs.

♂ Lips of genital orifice long, with one bristle; the posterior antenna and maxilliped show distinct differences, especially in the elongation of the terminal hook.

The genus may be readily recognized by the cylindrical shape of the body, with the eye lenses at the anterior end.

1. **Corycaeus venustus** Dana.

Corycaeus venustus Dana, 1849, p. 280; 1852, p. 1222, pl. 86, fig. 4*a*.

Corycaeus limbatus Brady, 1883, p. 114, pl. 49, figs. 18-22.

Corycaeus venustus Giesbrecht, 1892, pp. 659, 674, pl. 51, figs. 32, 33, 34, 47.

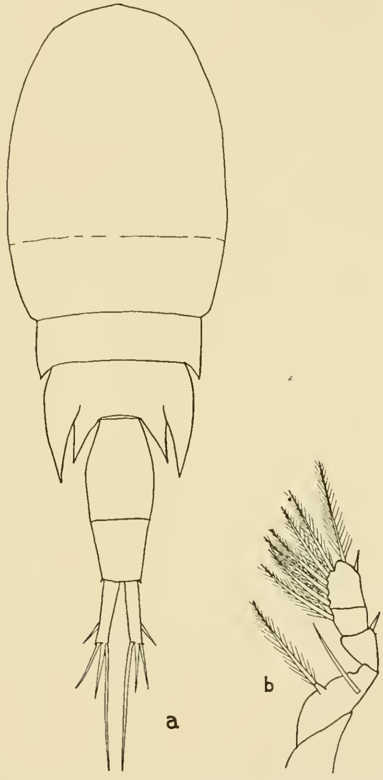

Fig. 61.—*Corycaeus venustus.* (*a*) Female, dorsal, ×83. (*b*) Fourth foot, female, ×140.

♀ Cephalothorax with 4 segments, abdomen with 2, ventral keel rounded, furca almost 5 times as long as broad (Genital segment: anal segment: furca:: 3:2:2).

♂ Genital segment about 3/4 as long as the anal segment and furca together.

Coloration: Varying amounts of red or yellow red pigment in mouth region, posterior thoracic segments, and genital segment; eye red.

Length: Female, 0.8-1 mm.; male, not over 0.8 mm.

Occurrence: A few were taken June 16, 1904.

2. **Corycaeus carinatus** Giesbrecht.

Corycaeus carinatus Giesbrecht, 1892, pp. 661, 675; pl. 51, figs. 20, 26.

Corycaeus carinatus Wheeler, 1899, p. 192, fig. 30.

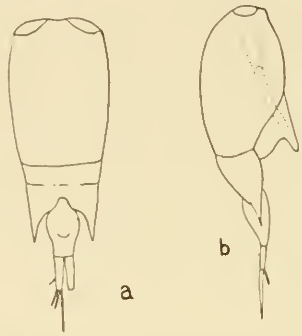

Fig. 62.—*Corycaeus carinatus.* (*a*) Female, dorsal, ×40. (*b*) Female, lateral, ×40.

♀ Cephalothorax with 2 segments, abdomen with 1; ventral keel beak-like and pointing back; the abdomen tapers toward the posterior end, furca half as long as the rest of the abdomen, about 4 times as long as broad.

♂ Unknown.

Coloration: Red or yellowish red pigment in region of mouth, extensions of thoracic segments, and in the genital segment; eye red.

Length: 0.86 mm. to 0.92 mm.

Occurrence: A few specimens taken at San Diego, Dec. 30, 1903, and Jan. 4, 1904.

Cambridge, Mass.,
January 4, 1905.

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1903. Copepoda Calanoida, chiefly abyssal from the Faroë Channel and other parts of the North Atlantic. Jour. Linn. Soc. London, Zool., Vol. 29, pp. 133-141. (List of species, notes on distribution.)

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Steuer, Adolf.

1904. Copepoden der Valdivia-Expedition. Zool. Anz., Bd. 27, pp. 593-598, 4 figs. (*Valdiviella* new genus; new species in *Lucicutia* and *Augaptilus.*)

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1900. Report on two collections of tropical and more northerly plankton. Trans. Liv. Biol. Soc., Vol. 14, pp. 262-294, 1 pl., 3 figs. (Two tables, and notes on distribution.)

1903. Report on the Copepoda obtained by Mr. George Murray during the cruise of the "Oceana" in 1898. Ann. Mag. Nat. Hist. (7), Vol. 12, pp. 1-36, pls. 1-7. (Four new species in *Euchaeta, Scolecithrix, Xanthocalanus, Isochaeta.*)

Thompson, I. C. and Andrew Scott.

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1899. The free-swimming Copepods of the Woods Hole region. Bull. U. S. F. C., Vol. 19, pp. 157-192, 30 figs. (30 species; 4 new in *Labidocera, Centropages, Pontella, Corynura.*)

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1903. Occupation of a table at the zoological station, Naples. Report of the Committee. Appendix D, on the Copepod subfamily Aetidiinae, with a proposed revision of the classification. Report 72nd Meet. Brit. Assoc. Adv. Sci., Belfast, pp. 263-267. (3 new species in *Pseudaetideus* = new genus for *Chiridius armatus, Aetideus, Gaidius.*)

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V

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BY

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ERRATA.

Page 240, line 21, for Pl. II read Pl. XI.

Page 250, line 11, for Cellariidæ read Cellulariidæ.

Page 274, last line, first word, for possesed read possessed.

Page 285, line 5 from bottom of page, read 84 for 93.

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BY

ALICE ROBERTSON.

The bryozoa of the west coast of North America constitute a fauna practically unknown to science. From time to time during the last half century some scattering work has been done, the earliest being by Trask ('57), who described and figured a number of species from San Francisco Bay. Later Gabb and Horn ('62), in connection with their work on the Geological Survey of California, identified a number of species of bryozoa, both recent and fossil; and Hincks ('82 and '84) reported on a large collection from Queen Charlotte Islands. Still later, the present writer ('00) reported on the bryozoa of the Harriman Alaska Expedition, having previously published on the Entoprocts of San Francisco Bay ('99). Besides the work of these investigators, mention should be made of that of Conrad ('55) and of Fewkes ('89), both of whom added to our knowledge of the bryozoa of this coast.

The following pages constitute the first of a contemplated series of papers on the bryozoa of the Pacific coast of North America, and include about half of the sub-order *Chilostomata*, comprising, in the main, those Chilostomes which grow as free, flexible colonies. The inclusion of the adherent genera *Aetea* and *Eucratea* is somewhat arbitrary since they are more or less incrusting. In reality the forms treated comprise the first seven families of the *Chilostomata* as given by Hincks, and these with the exception of the two genera mentioned above are erect, flexible and non-incrusting. Even these two genera send off erect free branches, and are thus partially non-incrusting. The bryozoa here identified comprise only a small part of the material on hand, the greater portion of which was collected at San Pedro and San Diego in 1901, 1902, and 1903 on dredging expeditions conducted by the Zoological Department of the University of California; another portion was dredged in Puget Sound during the summers of 1903 and 1904 by the Department of Zoology of the University of Washington, and kindly placed at my disposal by Professor Trevor Kincaid.

In the endeavor to make this work as useful as possible to the general student as well as to the expert, original figures are given of all the species mentioned. These include a habit sketch which is a photograph wherever possible, and one or more other figures giving details and variations. It is thought best even though a species is cosmopolitan in its range, and even though it has already been sufficiently well represented for diagnostic purposes, to refigure it here; and this for two reasons: first, bryozoan literature, consisting as it does, except in two or three instances, of detached papers scattered through scientific journals is not readily accessible to the general student. Second, the number of cosmopolitan species, or of species easily identified, is surprisingly small, while the number new to science is correspondingly large; hence as far as illustration at least is concerned, it is desired to make this work as complete as possible for the forms found on the Pacific Coast. The diagnoses are somewhat lengthy descriptions, with references to figures wherever clearness seemed to demand it. Further, in order to assist in the identification of species, simple keys have been devised for the families, and where more than one genus or species occur under a family, separate keys are given for each. The keys for species cover only those treated in this paper and are intended only for the bryozoa of this coast. Since Hincks' ('80) monograph upon the British Polyzoa is the most complete and exhaustive of any recent work, and its method is generally followed by other workers, it is here adopted as the basis of classification, although his conclusions are not always accepted. Free use is made of the diagnostic definitions given by that author, especially for families and genera, supplementing and amending where necessary for greater accuracy, or in order to include forms peculiar to the region. Synonymy is based upon that of Hincks, further supplemented by Miss Jelly's invaluable Synonymic Catalogue ('89). No attempt has been made at revision of the classification. It were useless to undertake such a task except after careful study and comparison of all large collections.

It is needless here to enter into an exhaustive discussion of the bryozoa as a class. Such can be found in any of the more recent treatises on zoology, and the reader desirous of obtaining a full, clear, and delightfully written article on the group, is referred especially to that by Dr. Sidney F. Harmer ('96). For the sake of clearness and convenient reference, however, a few definitions of terms used in this paper are given herewith.

Bryozoa and *Polyzoa* are synonymous terms. These are colonial animals, and the technical term used to designate the colony as a whole is *zoarium.* An illustration of a bryozoan colony or zoarium may be found in any of the habit sketches, especially the photographs (Pl. XVI). The units of which a zoarium is composed consist of the *zoœcia* and their contained *polypides.* A zoœcium is a chamber or sac, in which the polypide, consisting of a digestive canal and a circlet of tentacles, is lodged. It may be calcareous and opaque, or semi-calcareous or chitinous and transparent. The contents of a zoœcium whose walls are transparent are easily made out. Below is given a figure of a zoœcium of *Beania mirabilis* with its contained *polypide* in a state of retraction folded within it. The zoœcium (*zœ.*) is seen to be a sac or bag whose front or ventral face is bordered with a number of spinous processes, some erect (*e. sp.*), others curved (*c. sp.*). Within the zoœcium is the polypide (*pd.*) consisting of a bent tube, the intestinal canal, having a circlet of tentacles (*tent.*) around one extremity. Various regions of the tubular portion have specific names. In the middle of the membranous floor from which the tentacles arise is the mouth (*m.*). This opens into a short tube known

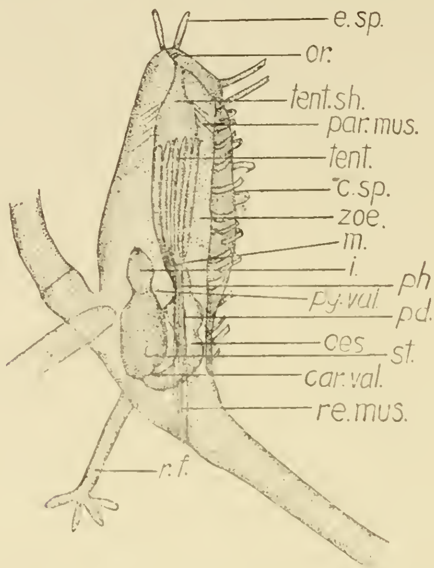

Fig. 1.—*Beania mirabilis.* A zoœcium and its inclosed polypide shown in profile view. *c. sp.* crossed spines; *car. val.* cardiac valve; *e. sp.* erect spine; *i.* intestine; *m.* mouth; *œs.* œsophagus; *or.* orifice; *par. mus.* parietal muscle fibres; *pd.* polypide; *ph.* pharynx; *py. val.* pyloric valve; *r. f.* root fibre; *re. mus.* retractor muscle; *st.* stomach; *tent.* tentacles; *tent. sh.* tentacle-sheath; *zœ.* zoœcium.

as the pharynx (*ph.*) which is really a portion of the œsophagus (*œs.*); this in turn opens by a narrow valve, the cardiac valve (*car. val.*) into a stomach (*st.*). The stomach is a bag of a yellow or brown color due to the gland cells in its walls; it opens into the intestine (*i.*), by the so-called pyloric valve (*py. val.*). Visible above the tentacles when the polypide is retracted is a delicate membrane, the tentacle-sheath (*tent. sh.*). Near the distal end where the tentacle-sheath approaches the orifice (*or.*), a few muscle fibres may be seen on each side of the sheath extending to the walls of the zoœcium. These are part of the parieto-vaginal muscles which assist in retracting the tentacular sheath (*par. mus.*). Likewise, extending from the base of the tentacles to the basal wall of the zoœcium another band of retractor muscles is visible whose contraction draws the polypide within the zoœcium (*re. mus.*). Fig. 2 represents a zoœcium of

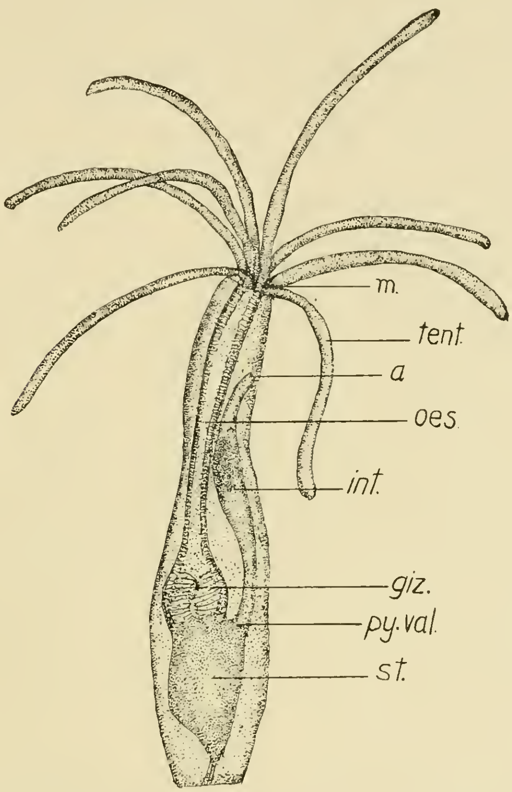

Fig. 2.—*Bowerbankia imbricata.* A zoœcium and inclosed polypide. *a.* anus; *giz.* gizzard; *int.* intestine; *m.* mouth; *œs.* œsophagus; *py. val.* pyloric valve; *st.* stomach; *tent.* tentacle.

Bowerbankia imbricata, in which the polypide is expanded. Here the œsophagus (*œs.*) is stretched out to its fullest extent, the mouth (*m.*) being at the upper margin, and the tentacles outside the zoœcium. This polypide possesses a region between the œsophagus and stomach known as the gizzard lined with large cells (*giz.*). The intestine (*int.*) is much elongated, the anus (*a.*) reaching almost to the summit of the body wall. The tentacles are commonly arranged in the form of a bell, but have the power of independent motion as shown in this figure drawn from a living specimen. Many zoaria grow erect and free, and if calcareous, their branches frequently possess flexible *joints* at definite points along the length (Pl. V, fig. 14, *j.*). The zoœcia included between these joints form an *internode*, the number of zoœcia in an internode being rather definite for any given species. In *Menipea ternata e.g.*, there are, as a rule, three zoœcia in an internode (fig. 14). From the lower zoœcia small fibres are given off known as *rootlets*, because they serve to anchor the colony (fig. 14, *r.*). Zoœcia, especially if calcareous, often possess appendages of various kinds which serve as diagnostic marks. There are also certain well marked regions to which special names are applied:

Aperture—the chitinous front wall of the zoœcium. This may occupy a part of the front wall only as in Pl. IV, fig. 2, *ap.;* or almost the whole of it as in Pl. X, fig. 50, *ap.*).

Area—the calcareous wall inclosing the whole or part of the aperture. (Pl. XV, fig. 88, *a.*).

Avicularium—an appendage of the zoœcium more or less resembling a bird's head. This may be sessile as in Pl. V, fig. 14, *av.*, or pedunculated as in Pl. II, fig. 60, *av.*

Epistome—a ciliated lobe which overhangs the mouth, and is present only in the Phylactolæmata or fresh-water bryozoa.

Internode—the zoœcia included between the flexible joints of a branch or stem (Pl. V, fig. 14).

Introvert—the thin cuticle at the anterior end of the polypide which may be retracted into the interior of the zoœcium.

Joint, or *articulation*—a non-calcified portion of the wall of the zoœcium permitting more or less flexibility in the stem or branch (Pl. V, fig. 14, *j.*).

Lophophore—the membranous floor or rim surrounding the mouth of the polypide from which the tentacles spring.

Oœcia or *Ovicell*—synonymous terms for the chamber above the zoœcium in which the embryo develops (Pl. V, fig. 14, *œ.*).

Operculum—the chitinous lip by which the orifice of the zoœcium is closed (Pl. IV, fig. 2, and Pl. XIV, fig. 86, *op.*). When the aperture is entirely membranous, the operculum is inconspicuous. (Pl. X, fig. 50).

Orifice—the opening at the summit of the aperture through which the polypide emerges. (Text fig. 1, *or.*).

Scutum—a modified spine overhanging the aperture (fig. 14, *sc.*), often being large and flabellate (Pl. VI, fig. 19, *sc.*).

Stolon—a creeping tubular stem from which the individuals of a colony grow. It is not found in the *Chilostomata,* but is characteristic of many of the *Ctenostomata.*

Spine—a jointed or unjointed process found on the margin of the aperture (fig. 1 of the text, *sp.*).

Tentacle-sheath—the delicate membrane of the introvert which incloses the tentacles when the polypide is retracted. (Text fig. 1, *tent sh.*)

Vibraculum—a chitinous seta of varying length, depending on the species, extending from a chamber on the dorsal side of the zoœcium (Pl. IX, figs. 41, 45, *v.*).

Vibracular chamber—a chamber on the dorsal side of the zoœcium in some of the *Cellulariidæ*, resembling an avicularium, from which extend a hairlike process called the vibraculum, and the rootlet (Pl. IX, figs. 42, 46, *v. ch.* and *v.*).

For purposes of orientation, it must be explained that the *front* or *ventral* side of a zoœcium is that on which the aperture with its operculum occurs; the side opposite is the *dorsal.* The top of a zoœcium, and the ends of the growing tips of branches or colony are referred to as the *distal* or *anterior* end of zoœcium, or extremity of branch or colony; the lower part or end nearest the root or point of origin, as the *proximal* or *posterior* extremity.

Thirty-four species and one subspecies belonging to thirteen genera are here recognized. Of the genera, *Stirparia* has as yet been reported only from Australia; *Synnotum* only from the Adriatic; and *Corynoporella* only from Greenland. Of the whole list, thirteen species and one subspecies are new, while twenty species and one subspecies are restricted to the Pacific Coast. The ovicells of *Aetea anguina* are here described and figured for the first time, as are the avicularia and ovicells of *Stirparia*, and the ovicells of *Corynoporella*.

LIST OF SPECIES TREATED.

Aetea anguina Linnæus.
Aetea truncata Landsborough.
Eucratea chelata Linnæus.
Gemellaria loricata Linnæus.
Menipea ternata Ellis and Solander.
Menipea gracilis Busk.
Menipea occidentalis Trask.
Menipea occidentalis catilinensis subsp. nov.
Menipea erecta Robertson.
Menipea pribilofi sp. nov.
Scrupocellaria californica Trask.
Scrupocellaria varians Hincks.
Scrupocellaria diegensis sp. nov.
Caberea ellisi Fleming.
Bugula neritina Linnæus.
Bugula murrayana Johnston.
Bugula californica sp. nov.
Bugula pacifica Robertson.
Bugula flabellata Thompson.
Bugula pugeti sp. nov.
Bugula curvirostrata sp. nov.
Bugula longirostrata sp. nov.
Bugula laxa sp. nov.
Beania mirabilis Johnston.
Beania longispinosa sp. nov.
Stirparia ciliata sp. nov.
Stirparia occidentalis sp. nov.
Stirparia californica sp. nov.
Corynoporella spinosa sp. nov.
Synnotum aviculare Pieper.
Cellaria borealis Busk.
Cellaria mandibulata Hincks.
Cellaria diffusa sp. nov.
Flustra lichenoides Robertson.
Flustra membranacea-truncata Smitt.

PHYLUM MOLLUSCOIDA Milne-Edwards.

Class BRYOZOA Ehrenberg.

Sub-Class Ectoprocta Nitsche.

Colonial bryozoa with anal orifice outside the lophophore; a well developed introvert, and a spacious cœlome.

Order GYMNOLÆMATA Allman.

Polypide destitute of an epistome; lophophore circular.

Sub-Order I. CHILOSTOMATA Busk.

Gymnolæmata with calcareous or chitinous zoœcia whose orifice is closed by a movable chitinous lip or "operculum"; ova usually matured in globular oœcia situated above the orifice of some of the zoœcia; vibracula or avicularia, or both, frequently present.

Of the fifteen or more families included by Hincks in the *Chilostomata*, all but the first seven, viz., the *Membraniporidæ*, *Microporidæ*, *Cribrilinidæ*, *Microporellidæ*, *Porinidæ*, *Myriozoidæ*, *Escharidæ*, are omitted here. These are incrusting, or if erect, are for the most part non-flexible in habit of growth. Below is given a key to the first seven families of the Chilostomes which are, for the most part, erect and flexible in habit of growth.

KEY TO THE FIRST SEVEN FAMILIES OF THE CHILOSTOMATA.

1. Colony creeping 2
1. Colony erect 3
2. Colony sending up erect branches from a point just below the aperture .... **Eucratiidæ**
2. Colony not sending up erect branches .... **Aeteidæ**
3. Colony articulated 4
3. Colony not articulated 5
4. Zoœcia multiserial, arranged round an imaginary axis.......... **Cellariidæ**
4. Zoœcia biserial .... **Cellulariidæ**
5. Zoœcia arranged back to back 6
5. Zoœcia not back to back 7
6. Zoœcia with avicularia .... **Notamiidæ**
6. Zoœcia without avicularia .... **Eucratiidæ**
7. Zoœcia biserial, avicularia pedunculated .... **Bicellariidæ**
7. Zoœcia multiserial, avicularia sessile .... **Flustridæ**

Aeteidae Hincks.

Zoarium composed of creeping branches more or less adherent to the substratum, often growing in free tufts adherent only part of their length. *Zoœcia* uniserial, arising from each other in a tubular prolongation of greater or less length. *Aperture* terminal, orifice at its summit.

The definitions of family *Aeteidæ*, of genus *Aetea*, and of species *Aetea anguina* are here much changed from those given by Hincks, whose diagnoses are based upon the erroneous notion which that observer entertained concerning the true nature of the Aetean zoœcium. The adherent portion of the zoœcium he regarded as a stolon which together with the circle of setæ in which the tentacle-sheath terminates (Smitt, '67) seemed, he thought, to relate *Aetea* to the Ctenostomes, and to place it in the position of a form transitional between these and the Chilostomes. Whatever may be the relationship between these suborders, *Aetea* cannot be said to reveal it, since as will be shown in the discussion under the species *A. anguina*, the adherent "stolonic portion" so-called, is not a stolon, but an important part of the zoœcium.

Aetea Lamouroux.

Aetea Lamouroux, 1812.
Anguinaria, Johnston, 1847.
Aetea, Hincks, 1880.
Aetea, Jullien, 1888.

Zoarium adherent to the substratum. Each *zoœcium* partially adherent, partially erect, the erect portion carrying at its distal extremity the membranous *aperture* with its *operculum*.

KEY TO THE SPECIES OF AETEA.

1. Tubular portion of zoœcium ringed, upper third spatulate, bent........ .... **A. anguina**
1. Tubular portion of zoœcium not ringed, upper extremity not bent, but erect and truncate .... **A. truncata**

1. **Aetea anguina** (Linnæus) Lamouroux.

Pl. IV. Figs. 1, 2, 3, and 4.

Sertularia anguina Linn., 1758, ed. 10, p. 816.
Cellularia anguina, Pallas, 1766, p. 78.
Corallina anguiformis Ellis, 1767, Ger. ed., p. 50, Pl. XXII, figs. c, C. D.
Cellularia anguina, Ellis, 1767, p. 434, Pl. 19, fig. 10.
Cellaria anguina, Ell. and Solander, 1786, p. 26.
Aetea anguina, Lamouroux, 1812, Vol. III, p. 184.
Anguinaria spatulata, Johnston, 1847, ed. II, p. 290, Pl. L, figs. 7, 8.
Aetea anguina, Busk, 1852, pt. I, Pl. XV, fig. 1.
Aetea anguina forma spatulata, Smitt, 1867, p. 280, Pl. XVI, figs. 2, 4.
Aetea anguina, Hincks, 1880, p. 4, Pl. I, figs. 4, 5.

Zoarium composed of creeping branches consisting of a single series of zoœcia growing irregularly over a stem, frond, or other substratum (Pl. IV, figs. 1, 2). *Branches* arising at right angles to the zoœcia from each side of the creeping portion. *Zoœcia* composed of a creeping posterior portion (fig. 2, *ad.*), and an anterior, erect, tubular portion (*tu.*). The posterior creeping portion of the zoœcium narrow and tubular where it arises from the neighboring zoœcium (*ad.*) gradually widening anteriorly or toward the growing point (*gr.*), then turning upward almost at a right angle and becoming erect (*tu.*), the remainder creeping on to give rise to a new zoœcium. The erect portion is tubular, the lower two-thirds being minutely ringed, the upper one-third being somewhat inflated, and in many cases bent forward thus forming the so-called snake's head (*s. h.*). At the base of the tubular portion and anterior to it, a septum (*sep.*) separates the zoœcium from the one next following. The membranous aperture (*mem. ap.*) is situated on the ventral side of the widened upper third of the erect tube and at its upper edge is the movable lip or operculum (*op.*). The dorsal surface of the widened upper end of the tube is minutely granulated. The *polypide* is simple in structure, very minute, and when retracted is drawn downward into the horizontal, adherent portion of the zoœcium (fig. 3, *pd.*). The tentacle-sheath terminates above in a circle of setæ which are everted during the expansion of the polypide. *Oœcia* globular, membranous, situated at the upper extremity on the ventral side of the zoœcium just below the operculum (fig. 4, *œ.*).

As Smitt ('67), Waters ('79), and Jullien ('88) have already shown, there has been much misconception in regard to the zoœcium of *Aetea*. Busk ('49) considered the erect, tubular portion alone to be the zoœcium, and in this error was followed by Hincks ('80) who regards the erect tube as the zoœcium, the horizontal portion as a stolon, which he compares with the stolon of the Ctenostomes. Jullien, apparently unaware of the observations of Smitt or Waters on this point, criticizes the statement of Hincks as to the stolonic nature of the adherent portion. This he considers the true zoœcium, since into it he finds the polypide withdraws itself on retraction and on its walls the retractor muscle fibers are inserted; while the upright tubular portion he regards a peristome. Smitt and Waters had previously shown, however, that the polypide inhabits the creeping portion, and that this is in no sense a stolon. Later, Waters ('96) has shown that in the species known as *Aetea anguina* forma *recta*, the ovary is situated in the creeping part, thus affording conclusive proof of the zoœcial character of this so-called "stolon."

In the colonies of this species found on the California coast (figs. 1, 2), the creeping and erect portions are continuous. The polypide when expanded occupies the upright tube, but on retraction retreats into the creeping portion almost completely, only the tips of the tentacles and the long, delicate sheath with its muscles remaining in the tube (fig. 3). In this figure, part of the upright tube is represented as broken and the polypide is not in a state of complete contraction, but the insertion of the retractor muscles on the wall of the creeping part (*mus.*), and the presence of the ovary (*ov.*) on the adnate ventral wall are shown. From the evidence presented it seems to be established that the zoœcium of *Aetea* consists of *both* the creeping and the erect portions and not merely of either one of these.

In our specimens of *Aetea* the oœcia are abundant. As shown in fig. 4, each consists of a membranous bag situated on the *ventral* side of the zoœcium below the operculum but exterior to the aperture, and contains an ovum in the early cleavage stage (*o.*). In all cases in which the oœcium is present the tubular part of the zoœcium is distinctly curved, as shown in fig. 4, as if affording protection to the delicate oœcium and its contents. This is the first instance, so far as known, of the delineation of the oœcium of *Aetea anguina;* Waters has figured the oœcium of the so-called variety *recta* in which it is on the dorsal side of the erect portion. The difference of location of the oœcia in these two forms is probably sufficient to separate them into distinct species.

There is a possibility that the species found here is an undescribed one peculiar to this coast, but the oœcium of *Aetea anguina* not having been hitherto known, and no other distinctions being apparent between our form and that found in foreign localities, this identification must stand for the present. The distribution of *Aetea anguina* is world wide, and this fact adds to the probability that we have here the older well known form.

This species is abundant at San Pedro and San Diego, growing over kelp, hydroid stems, shells, and other bryozoa.

2. **Aetea truncata** (Landsborough) Busk.

Pl. IV, figs. 5, 6.

Anguinaria truncata Landsborough, 1852, p. 228, Pl. XVI, figs. 57, 57*.
Salpigia Hassallii Coppin, 1848, p. 273, Pl. X, fig. 3.
Aetea truncata, Busk, 1852, p. 31.
Aetea truncata, Smitt, 1865, Pl. II, figs. 5-14; Pl. III, figs. 1-8.
Aetea truncata, Smitt, 1867, 279 and 295, Pl. XVI, fig. 1.
Aetea truncata, Hincks, 1880, p. 8, Pl. I, figs. 8-11; Pl. II, fig. 3.

Zoarium growing irregularly over the substratum. *Zoœcia* rather widely separated, the posterior creeping portion frequently lengthening into a long slender fiber (Pl. IV, fig. 5 *ad.*): the tubular erect portion varying in length (*tu.*), the membranous *aperture* (*ap.*) occupying on an average a little more than one-third of its length; slightly wider at the top than at the point of union with the adherent portion; truncate, granular, no part of the zoœcium annulated as is the erect portion of the zoœcium of the preceding species. *Oœcia* not known.

No colonies of the branching form described by Hincks occur in our material, the simple form of *Aetea truncata* alone prevailing. The creeping portion of the zoœcium is rather closely adherent to the substratum so that it is not easily removed. The polypide resembles that of *Aetea anguina*, being of simple structure and when retracted is drawn almost completely into the creeping part.

This species was obtained in considerable quantity at La Jolla growing over the older stems of a kelp hold-fast.

Eucratiidae Hincks.

Zoarium forming slender, branching, phytoid tufts. *Zoœcia* uniserial, or in two series placed back to back; expanding from the base upwards, with a terminal or subterminal and usually oblique aperture. Neither avicularian nor vibracular appendages known. *Oœcia* globose.

KEY TO GENERA AND SPECIES.

1. Colony creeping .... *Eucratea chelata*
1. Colony erect .... *Gemellaria loricata*

Eucratea Lamouroux.

Cellularia (part) Pallas, 1766.
Cellaria (part), Ellis and Solander, 1786.
Eucratea Lamouroux, 1812.
Catenaria (part), d'Orbigny, 1850.
Eucratea, Johnston, 1847.
Scruparia, Busk, 1852.
Eucratea, Hincks, 1880.

Zoarium composed of creeping adherent branches and of erect free shoots. Both creeping and erect branches composed of zoœcia arranged uniserially, the erect branches arising from the ventral wall of the zoœcia. *Zoœcia* prolonged into a tube of greater or less length. *Aperture* large.

3. **Eucratea chelata** (Linnæus) Lamouroux.

Pl. V, figs. 7, 8, 9.

Sertularia chelata Linn., 1758, ed. 10, p. 816.
Cellularia chelata, Pallas, 1766, p. 77.
Bull's Horn Coralline Ellis, 1767, p. 42, Pl. XXII, figs. b, B.
Cellaria chelata, Ellis and Solander, 1786, p. 25.
Eucratea chelata, Johnston, 1847, ed. II, p. 288, fig. 64.
Catenaria chelata, d'Orbigny, 1850, Vol. V, p. 43.
Scruparia chelata, Busk, 1852, pt. I, p. 29, Pl. XVII, fig. 2.
Eucratea chelata, Smitt, 1867, pp. 281 and 301, Pl. XVI, figs. 7-9.
Eucratea chelata, Hincks, 1880, p. 11, Pl. III, figs. 9, 10.

Zoarium composed of creeping branches consisting of a single series of zoœcia growing irregularly over the substratum and adherent to it, and of erect branches (Pl. V, figs. 7 and 8). Creeping *branches* (*cr. br.*) arising from the sides of the adherent zoœcia; the erect, free branches (*e. br.*), from a point on the zoœcial wall just below the aperture. *Zoœcia* narrowed posteriorly into a tube, widening gradually anteriorly; the polypide even in contraction remaining in the anterior portion of the zoœcium. *Aperture* (*ap.*) oval, surrounded by a thin, raised, unarmed margin; *operculum* at its summit (*op.*). *Oœcia* mitriform, somewhat pointed above, with a keel down the center, borne on an imperfectly developed zoœcium arising just below the aperture (fig. 9, *a.*). Tentacle-sheath terminating above in a circle of setæ which are everted during expansion of the polypide.

The presence of setæ both in *Eucratea* and *Aetea* is given only on the authority of others. Few of our specimens of *Eucratea* possessed oœcia, and none perfect ones. Figure 9 is taken from Hincks.

Although not abundant at any one point, *Eucratea chelata* has been found at several localities on the coast of southern California.

Gemellaria Savigny.

Gemellaria Savigny, 1811.
Notamia Farre, 1837.
Gemellaria, Hincks, 1880.

Zoarium erect, branching dichotomous, each branch given off from the sides of the zoœcia close to their upper extremity.

Zoœcia joined back to back, each pair arising from the anterior extremity of the preceding pair. *Aperture* large, sloping slightly upward. *Oœcia?*

4. **Gemellaria loricata** (Linnæus) Savigny.

Pl. V, figs. 10, 11.

Sertularia loricata Linn., 1758, ed. 10, p. 815.
Cellularia loricata. Pallas, 1766, p. 64.
Coat of Mail Coralline Ellis, 1767, p. 40, Pl. XXI, figs. b, B.
Cellaria loricata, Ell. & Sol., 1786, p. 24.
Notamia loriculata, Farre, 1837, p. 413, Pl. XXVII, figs. 6-9.
Gemellaria loriculata, Savigny, 1811, Egypt. Polyp.
Gemellaria loriculata, Van Beneden, 1844, p. 33, Pl. V, figs. 1-7.
Gemellaria loricata, Johnston, 1847, ed. II, p. 293, Pl. XLVII, figs. 12, 13.
Gemellaria loriculata, d'Orbigny, 1850, p. 46.
Gemellaria loricata, Busk, 1852, pt. I, p. 34, Pl. XLV, figs. 5, 6.
Gemellaria loricata, Smitt, 1867, pp. 286 and 324, Pl. XVII, fig. 54.
Gemellaria loricata. Hincks, 1880, p. 18, Pl. III, figs. 1-4.

Zoarium forming densely bushy masses, 50 or 75 mm. in height, made up of numerous long, straight branches; branching dichotomous (Pl. V, fig. 10). *Zoœcia* narrowed below, widening above; *aperture* (fig. 11, *ap.*) oval, occupying about half the front, sloping somewhat toward the top, with a thin, raised, unarmed margin; *operculum* (*op.*) semicircular, at the anterior edge of the aperture. Colony attached by numerous rootlets. Main stem of colony thicker below.

This species is found only on the northern shores. It is abundant at Orca, Prince Williams Sound, where it was taken from shore rocks at low tide; at Juneau, it was dredged at 20 fathoms. Hincks reports it from Queen Charlotte Islands.

Cellulariidae Busk.

Escharidæ (part) Johnston, 1847.
Cabercadæ Busk, 1852.
Cellulariadæ Busk, 1852.
Cellulariæ Smitt, 1867.
Cellulariidæ, Hincks, 1880.

Zoarium erect, branching dichotomous. *Zoœcia* in two or more series, closely united in the same plane; avicularia and vibracula, or avicularia only, almost universally present, sessile.

This is a well marked group all of whose members have a strong family resemblance. The walls of the zoœcia are strongly calcified, being generally variously adorned with spines and sessile avicularia, and many with waving vibracula. In all the embryos mature in globose, hood-like oœcia. This family is well represented in our fauna, there being at least six species of *Menipea*, four of which are new; and three of *Scrupocellaria*, all of which are peculiar to this region. *Caberea* is represented by but one species, the northern *C. ellisi*.

KEY TO THE GENERA OF CELLARIIDÆ.

1. Zoœcia three or more in an internode without vibracula........**Menipea**
1. Zoœcia many in an internode, vibracula present 2
2. Vibracular chamber not covering dorsal surface of zoœcium .... **Scrupocellaria**
2. Vibracular chamber directed obliquely and covering the dorsal surface of the zoœcium ....**Caberea**

Menipea Lamouroux.

Pl. V, fig. 16.

Menipea Lamouroux, 1816.
Cellularia, Johnston, 1847.
Cellarina, Van Beneden, 1849.
Emma, Busk, 1852.
Menipea, Busk, 1852.
Cellularia, Smitt, 1867.
Menipea, Hincks, 1880.

Zoœcia oblong, widest above, attenuated below, often elongated downward; lateral *avicularia* generally present, sometimes wanting; frontal avicularia generally present on the zoœcium at the bifurcation of a branch. No vibracula. *Oœcia* present; large, globose. *Root fibers* characteristically located, being found in two positions: first, on the front, or on the lateral wall of a zoœcium just below or to one side of the aperture (fig. 16, *r. d.* and *r.*); second, in a definite dorso-lateral chamber situated just above the lateral avicularium (*r. ch.* and *u. r.*). In certain members of this genus, different functions are performed by these differently located fibers. Those found to one side, or below the aperture invariably turn downward and serve to anchor the colony (*r.*); those arising in the dorso-lateral chambers may assist in anchoring the colony when they occur on zoœcia in the lower part of the colony; usually, however, they turn upward, and twining about the other portions of the colony, function as tendrils (*u. r.*).

Waters ('96) calls attention to the diagnostic importance of the root fibres, their position being fairly constant so that it may be used as a specific character. Of the Menipeas of this region, *M. ternata* and *M. gracilis* have root chambers in identical positions and root fibers performing identical functions. The other three species differ from these two and from each other in the number and shape of the root chambers and in the function of the root fibers arising from them.

KEY TO THE SPECIES OF MENIPEA.

1. Zoœcia commonly three in an internode 2
1. Zoœcia many in an internode .... **M. erecta**
2. Spines two or three 3
2. Spine more than two or three 5
3. Scutum half way down on the margin of the aperture 4
3. Scutum two-thirds of the way down on the margin of the aperture...... 6
4. Scutum small, spine-like .... **M. ternata**
4. Scutum large, flabellate .... **M. gracilis**
5. Scutum simple 6
5. Scutum divided 7
6. Scutum half way down on the margin of the aperture...... **M. pribilofi**
6. Scutum two-thirds of the way down on the margin of the aperture...... .... **M. occidentalis**
7. Scutum two-thirds of the way down on the margin of the aperture...... .... **M. occidentalis** subspecies **catalinensis**

5. **Menipea ternata** (Ellis and Solander) Busk.

Pl. V, figs. 12, 13, 14, 15, 16; Pl. VI, fig. 17.

Cellaria ternata Ell. and Sol., 1786, p. 30.
Cellularia ternata, Johnston, 1847, p. 335, Pl. LIX, figs. 1, 2.
Cellarina gracilis, Van Beneden, 1849, p. 67, Pl. X, figs. 1, 2.
Menipea ternata, Busk, 1852, pt. I, p. 21, Pl. XX, figs. 3-5.
Cellularia ternata, Smitt, 1867, p. 282, Pl. XVI, figs. 10-26.
Menipea ternata, Hincks, 1880, p. 26, Pl. VI, figs. 1-4.

Zoarium consisting of loosely spreading, straggling branches, or sometimes of rather large dense masses, frequently 30 to 35 mm. high and from 60 to 80 mm. broad (Pl. V, figs. 12, 13). Branching dichotomous. *Internodes* consisting of three zoœcia, as a rule, although there are many instances of five or seven zoœcia to an internode. The longer internodes are generally terminal and bear the ovicells. *Joints* light colored, arising in distinct tubes (fig. 14, *j.*). *Zoœcia* elongated, narrowed below; *aperture* oval (*ap.*), occupying less than half the front, with two or three spines, one on the inner margin just above the operculum, and one or two on the upper, outer margin; zoœcium at bifurcation of branch having sometimes one, sometimes two rather long spines at its summit. Towards extremity of branches the spines increase in length, often very considerably. *Scutum* varying in shape from a mere spine to a somewhat broad flabellate process (*sc.*). *Lateral avicularia* (*av.*) large, and prominent, generally developed on all the zoœcia of an internode except the one at the bifurcation of a branch; sometimes, however, missing. Frontal avicularia (*fr. av.*) on the zoœcium at bifurcation only; small, raised, with mandible directed forward, often obliquely to right or left. *Oœcia* smooth, somewhat globose, reaching not quite to the lower margin of the next upper zoœcium (*oc.*). From a flat disk in front or to one side of the aperture of many of the lower zoœcia in a colony, root fibers (*r.*) extend downward, assisting in anchoring the colony to the substratum; from zoœcia higher in the colony other upward extending fibres arise in a dorso-lateral chamber (*r. ch.*) which is slightly raised and which projects from the zoœcial wall.

M. ternata is widely distributed, being found on Channel Rocks, and San Juan Island in Puget Sound; and at Dillons Beach, Lime Point, Mendocino, and Lands End on the coast of California. It is also reported by Hincks from Queen Charlotte Islands.

In the species from these different localities considerable variation occurs. As a rule, the colonies from California grow in more compact masses, and the triads of zoœcia forming the internodes are shorter than are those of the Puget Sound species. Thus the length of an internode in the Puget Sound species varies between 1,100 and 1,500 μ, and that of the species found farther south, slightly less. In the main points, however, the *Menipeas* from these various localities strongly resemble each other and in no points more constantly than in the position and form of the chambers from which the root and climbing fibres spring.

6. **Menipea gracilis** Busk.

Pl. VI, figs. 18, 19, 20, 21.

Menipea gracilis Busk, 1881.
Menipea ternata, forma *gracilis*, Smitt, 1867.

Zoarium forming a loose, tangled mass due to the great number of tendril-like fibres which twine around neighboring branches. (Pl. VI, fig. 18.) Branching dichotomous; *internodes* consisting of three zoœcia, except terminal internodes and those possessing ovicells, which may have five, seven, or nine zoœcia; internodes of three zoœcia only, often very long, ranging from 1,600 to 1,900 μ in length. *Zoœcia* enlongated, *aperture* large. (fig. 19). Zoœcia with two or three spines, depending upon the presence or absence of the lateral avicularia. If the latter are absent there will usually be two spines on the outer margin; if present, then but one (*sp.*). There is always a spine on the inner margin of the aperture just above the scutum. Zoœcium at bifurcation possesses one or two spines, more often one, at its summit. *Scutum* (*sc.*) large, flabellate, projecting outward and arching over the aperture in well developed specimens, projecting beyond the outer edge of the zoœcium. *Lateral avicularia* frequently absent, when present often minute. *Frontal avicularia* (*fr. av.*) occur on the zoœcium at the bifurcation of the branch, but these too, are frequently absent; on oœcial internodes, however, they are often found on each zoœcium, situated a little to one side of the aperture and so close to the oœcium as to seem perched upon its upper margin (fig. 20, *av.*). *Oœcia* (*oc.*) high, rounded, with striations radiating from a thin place at the base of the oœcial wall. *Rootlets* originating at two places. Those which anchor the colony springing, as a rule, from a disk to one side and below the aperture (fig. 19, *r. d.*); the others, more tendril-like, and for the most part extending upward, arising from a definite chamber just above the lateral avicularium, the chamber projecting somewhat and being not quite circular especially as seen from the dorsal side (fig. 21, *r. ch.*).

This species is abundant at Orca, Prince Williams Sound; reported by Hincks from Cumshewa Harbor, Queen Charlotte Island.

7. **Menipea occidentalis** Trask.

Pl. VI, figs. 22, 23, 24, 25.

Menipea occidentalis Trask, 1857, p. 113, Pl. 4, fig. 4.
Menipea compacta Hincks, 1882, vol. 10, p. 461.
Menipea compacta Hincks, 1884, vol. 13, p. 208, Pl. IX, fig. 8.

Zoarium forming bushy tufts from 15 to 50 mm. in height, attached by a large number of root fibres. Root fibres not developed throughout the colony, this species being in no sense a climber. *Branching* extremely regular and characteristic (fig. 22), each tuft or frond consisting of a main rib or primary branch (*pr. br.*) from which secondary branches arise alternately (*sec. br.*), these again giving off tertiary branches (*ter. br.*). *Internodes* consisting of three zoœcia (fig. 23). *Joints* (*j.*) yellow or brown arising from definite chambers on each side of the most anterior zoœcium of an internode. *Zoœcia* elongated, narrowed below; *aperture* (*ap.*) occupying about half the front, surrounded by six jointed spines, sometimes by five or seven; two arising on the margin of the upper half of the aperture opposite each other and meeting across it (*c. sp.*); two other longer ones extending from the upper margin of the aperture (*u. sp.*), and between these two and the two crossed spines, two other opposite flaring spines (*fl. sp.*); on the terminal zoœcia these flaring spines often grow very long so that each zoœcium is then bordered anteriorly with a bristling array of four long spines. *Scutum* (*sc.*) sometimes a mere spine, sometimes broader than a spine, arising on the lower half of the inner margin of the aperture. *Avicularia* large, lateral, sessile, found typically on all the zoœcia except the one at the bifurcation of a branch. *Frontal avicularia* wanting. *Oœcia* usually developed on the tertiary branches, large, globose, covering the zoœcial wall below the apertures of the zoœcia just above (fig. 24, *oe.*), their front walls perforated by a small number of pores. *Rootlets* of one sort only, extending downward, serving to anchor the colony; arising in root chambers just above the lateral avicularia (fig. 25, *r. ch.*); the root chambers situated on the lower zoœcia only, and never appearing unless a root fibre is developed; rounded, projecting dorsally and laterally, the root fibre springing from the lower side and extending downward keeping close to the branch and running parallel with the other root fibres of the branch, thus forming a sort of cable or rope for the attachment of the colony.

This species was first described by Dr. John Trask ('57), but his description was apparently unknown to Hincks ('82), who redescribed it under the name of *M. compacta*. It is perhaps the most abundant species of bryozoa on the shores of San Francisco Bay and Golden Gate Straits. It grows between tide marks on rocks and sea weed forming bushy tufts of a white, yellowish or dirty grey color, depending on its age. It is quite easily recognized by its excessive spininess. It is found from Queen Charlotte Islands to San Diego, but is most abundant above Point Concepcion. South of that point it is noticeably scarce on the shore and in dredgings, and the colonies are small and delicate.

8. **Menipea occidentalis catalinensis.** Subsp. nov.

Pl. VII, figs. 26, 27.

South of Point Concepcion, notably at Santa Catalina and San Pedro, *M. occidentalis* shows considerable variation. The internodes more often consist of five or seven zoœcia, and the scutum which in the type form is a mere spine, or at most is slightly flabellate, in the subspecies *catalinensis* is decidedly fan-shaped, the edge being divided and extended into five, six, or more spinous processes, making it so large as to cover the lower half of the aperture (fig. 26, *sc.*). One or both of the spines that meet over the upper part of the aperture may be bifid (*c. sp.*). The bifid spines and the large and much divided scutum are very noticeable features and constitute the chief differences between the subspecies *catalinensis*, and the typical *M. occidentalis.* While these variations from the type occur rather constantly in specimens from the south, affecting as they do such variable appendages as spines and scuta, they are not considered of sufficient importance to establish a new species. The drawing (fig. 26) gives the impression, unfortunately, that the individual zoœcia of the subspecies *catalinensis* are larger than those of the type *M. occidentalis*, but it was unintentionally made on a larger scale of magnification than was that of figure 23.

9. **Menipea erecta** Robertson.

Pl. VII, figs. 28, 29, 30, 31.

Menipea erecta Robertson, 1900, p. 317, Pl. XIX, figs. 1, 2.
Scrupocellaria scabra, Robertson, 1900, p. 318, Pl. XIX, figs. 3, 4.

Zoarium composed of numerous stiff, dichotomously divided branches from 20 to 25 mm. in length (fig. 28). *Internodes* consisting of three, five, or seven zoœcia, the number increasing toward the extremities of the branches; articulations extending through the zoœcia just below the aperture, sometimes including its lower border (fig. 29, *art.*). *Zoœcia* biserial, alternate, narrowed below; *aperture* oblong, occupying more than half the front; margin raised, crenulate, with one or two blunt spines at the upper outer angle; *scutum* (*sc.*) a flattened spine, sometimes growing broad and bifid. *Lateral avicularia* frequently wanting (fig. 30), sometimes feebly developed (fig. 31), and again rather large (fig. 29). When avicularia are present there is usually but one spine at the upper, outer angle, although this is not the invariable rule. *Frontal avicularia* (*fr. av.*) generally present on each zoœcium, though sometimes lacking; when present, they are situated to one side of the aperture, at the base of the scutum of the adjacent zoœcium. *Oœcia* large, globose, more or less striated. *Root fibres* mainly upon the lower zoœcia, springing directly from the zoœcial wall and extending downward (fig. 30, *r.*).

Examination of material from several localities, especially of that from Puget Sound, leads me to unite the species formerly identified as *Scrupocellaria scabra* Van Beneden with *Menipea erecta* Robertson ('00).

This species is obtained from three localities, Kadiak and Sitka, Alaska, and San Juan Island, Puget Sound. The range of variation is considerable, but is not greater than frequently occurs in a species found in localities so remote, and consists mainly in the presence or absence of spines or avicularia. The specimens from Sitka, for example (fig. 30), show irregular development of frontal avicularia with entire absence of lateral avicularia. The colonies from Kadiak (fig. 29) show frequent absence of lateral avicularia and their replacement with spines; while a few zoœcia from San Juan specimens (fig. 31) show an entire absence of spines and considerable variation in the size of the lateral avicularia.

10. **Menipea pribilofi** sp. nov.

Pl. VII, figs. 32, 33; Pl. VIII, fig. 34.

Zoarium forming a compact mass 25–50 mm. high, attached by a large number of root fibres; the upward tendril-like fibres being very slightly developed (Pl. VII, fig. 32.). Branching dichotomous, main branches long, possessing a number of shorter inward curving secondary branches. *Internodes* consisting of three zoœcia except the oœcial internodes which generally consist of five; separated by dark colored chitinous joints. *Zoœcia* relatively short and stout, broad at the top, attenuated below, *aperture* occupying less than half the front surface, with three spines on its upper margin; the bifurcating zoœcium may have but two spines, but it is frequently found bristling with three or four. *Scutum* (Pl. VIII, fig. 34, *sc.*) simple, often a mere spinous process; when better developed, it broadens at the free extremity. Spines and scuta distinctly jointed. *Lateral avicularia* generally present, large (*lat. av.*). *Frontal avicularia* (*fr. av.*) few, when present found only on the zoœcium at the bifurcation of a branch, large, raised, beak set obliquely, sometimes transversely to the length of the zoœcium. *Oœcia* globose, smooth (Pl. VII, fig. 33, *oc.*). *Rootlets* in two positions. Those lower in the colony develop on the front surface of the lower zoœcia, below and to one side of the aperture. These rootlets invariably proceed straight downwards (Pl. VIII, fig. 34, *r.*). Often on a zoœcium in the same internode, and on zoœcia at higher levels, just above the lateral avicularia, other rootlets curving upward, develop from a circular chamber slightly raised above the zoœcial wall (*u. r.*). These upward growing fibres are of much less frequent occurrence than in *M. ternata* and *M. gracilis*, and the chambers from which they proceed are of much simpler construction. On the upper half of the colony neither fibres nor chambers are found.

In the habit of growth, greater compactness, greater development of spines, and scarcity of tendril-like fibres, this species resembles *M. occidentalis* rather than *M. ternata*.

Menipea pribilofi is known only from the shores of Alaska, and the islands of Bering Sea, having been obtained in considerable quantity from St. Paul Island, Pribilof Islands; and in small quantity from Homer, Unalaska, and Yakutat, Alaska.

Scrupocellaria Van Beneden.

Cellularia Pallas, 1766.
Cellaria, Ell. and Sol., 1786.
Scrupocellaria Van Beneden, 1844.
Cellularia, Johnston, 1847.
Canda, Busk, 1852.
Scrupocellaria, Hincks, 1880.

Zoarium jointed. *Zoœcia* numerous in each internode, rhomboid; *aperture* with or without scutum; a sessile *avicularium* at the upper, outer, lateral angle; a *vibraculum* at the lower outer angle, and generally a sessible *avicularium* on the front surface of each zoœcium.

KEY TO THE SPECIES OF SCRUPOCELLARIA.

1. Vibracular chamber on every zoœcium 2
1. Vibracular chamber not on every zoœcium 3
2. Vibraculum slightly longer than a zoœcium .... **S. varians**
2. Vibraculum as long as three zoœcia .... **S. diegensis**
3. Vibraculum not as long as a zoœcium .... **S. californica**

11. **Scrupocellaria californica** Trask.

Pl. VIII, figs. 35, 36, 36*a*, 37.

Scrupocellaria californica Trask, 1857, p. 114, Pl. 4, fig. 2.
Scrupocellaria brevisetis (?) Hincks, 1882, p. 462.

Zoarium growing in large compact tufts, somewhat coarse in appearance. (Pl. VIII, fig. 36a.) *Branching* dichotomous, *internodes* consisting of five, seven, or nine zoœcia. *Zoœcia* slightly attenuated below, *aperture* occupying more than half the front (fig. 36). Two, often three spines on the upper, outer margin and one on the inner just above the scutum. Zoœcium at the bifurcation (*zœ. bi.*) of a branch with one short spine at its apex; two spines below on one side and one spine on the other just above the scutum. *Scutum* (*sc.*) often spine-like, sometimes broadened below, and always curved with a downward slope. *Lateral avicularia* generally present, when absent, an extra spine may develop in that place, making the third on the outer edge of the margin (*sp.*). Avicularia vary in size, but unlike those of the following species, the fluctuation in size lies in the greater or less relative proportion of the muscular part (*lat. av.*). *Frontal avicularia* (*fr. av.*) present on each zoœcium just below the aperture. *Vibracular cell* frequently lacking, and not visible from the front surface except on the zoœcium at the bifurcation of a branch (*v. c.*). *Vibracula,* when present, found only on the zoœcia of the lower part of the colony where root fibres are given off (*r.*). This is usually true except of the zoœcium at the bifurcation of a branch where vibracular cells are generally present irrespective of the formation of a root fibre. *Vibraculum* shorter than a zoœcium; vibracular chamber much like a lateral avicularium in form (fig. 35, *v. ch.*). The groove, lying in the part corresponding to the lower mandible of an avicularium, extending transversely across the dorsal surface of a zoœcium (*gr.*), the short stout vibraculum much like the elongated upper mandible of an avicularium. *Oœcia* sparingly developed, found only on internodes at the extremity of the branches, three or four in an internode, smooth (fig. 37, *oe.*). Rootlets abundant on the lower internodes of a colony where vibracular cells abound with their short vibracula (fig. 36, *r.*).

This species first figured and described by Trask ('57) from San Francisco Bay is probably the *S. brevisetis*, Hincks ('82) from Queen Charlotte Islands, of which only a short description without figure is given. Trask found neither vibracula nor vibracular chambers, but they are abundant, as I have observed, on the lower part of the colony, while almost entirely lacking on the upper portion.

S. californica is distributed at various points along the coast of California; it grows luxuriantly at Dillons Beach and at many places on San Francisco Bay, and occurs in small quantity below Point Concepcion.

12. **Scrupocellaria varians** Hincks.

Pl. VIII, figs. 38, 39; Pl. XVI, fig. 95.

Scrupocellaria varians Hincks, 1882, p. 461, Pl. XIX, figs. 1-1*c*.

Zoarium forming bushy tufts 12–25 mm. in height. (Pl. XVI, fig. 95.) *Branching* dichotomous, internodes consisting of a variable number of zoœcia, those in the lower part of the colony containing usually five or seven zoœcia, those at a higher level, nine or eleven. *Joints* yellow. *Zoœcia* biserial, alternate, slightly narrower below; aperture oval, occupying more than half the front; *scutum* sometimes a mere spine, sometimes bifid or trifid, usually inclined downward (Pl. VIII, fig. 38); two *spines* on the upper margin, one of them just above the scutum, the other opposite. Both lateral and frontal avicularia developed on each zoœcium. *Lateral avicularia* of different proportions, the greater number being much elongated, extending upward and outward, with a long, thin, pointed, curved beak (*c. av.*); *frontal avicularia* just below or slightly to one side of the aperture; sessile, raised, with mandible directed transversely. *Vibracular chamber* triangular, the apex visible from the front (fig. 39, *v. ch.*); *vibraculum* (*v.*) longer than a zoœcium, and the groove into which it falls, extending transversely across the zoœcium (*gr.*). *Oœcia* (fig. 38, *oc.*), smooth, developed on each zoœcium of the terminal internodes. Rootlets springing from the base of the vibracular chamber (fig. 39, *r.*).

Perhaps the most striking feature of this species is the peculiar size and prominence of many of the lateral avicularia. This is brought about by the great extension of the beak and is not due to increase of the muscular portion (*mus.*) ; thus, in fig. 39 (*c. av.*) the mandible (*man.*) is seen to be longer than the muscular part, and to be more than half as long as the whole appendage. In the shape of its vibracular chamber and in the unusually large size of its lateral avicularia, this species resembles *S. californica*, but as has been said, the increase of size of the avicularia in the two cases is due to increase of different parts of the organ. In other respects, *S. varians* and *S. californica* are very unlike, *e.g.*, in habit, in shape of scuta, and more especially in abundance of the vibracular chambers and length of the vibracula.

Although this species has been obtained in small quantities on the California coast as far south as San Pedro and La Jolla, it is characteristically a more northern form. It was first described by Hincks from Queen Charlotte Islands, and it is abundant in Puget Sound, both on Channel Rocks, and at San Juan. Material obtained in the south was dredged at 32 fathoms, while in Puget Sound this species is a shore form.

13. **Scrupocellaria diegensis,** sp. nov.

Pl. IX, figs. 41, 42, 43, 44; Pl. XVI, fig. 96.

Zoarium forming a coarse bushy mass often 50 mm. in height (Pl. XVI, fig. 96). Branching dichotomous, internodes consisting of a variable number of zoœcia, nine, thirteen, seventeen or more, especially in the terminal internodes. *Joints* somewhat inconspicuous, often occurring as high on the zoœcium as the lower margin of the aperture. *Zoœcia* biserial, the two rows inclined at an angle so that the internode is keeled, and in cross section is triangular; rather short and broad, slightly narrowed below (Pl. IX, fig. 41) ; *aperture* oval, with a wide margin, and occupying more than half the front surface. *Scutum* (*sc.*) in older zoœcia large, covering more than half the aperture, thickened on the inner surface and raised on a peduncle. *Spines* three, four, or five, the one immediately above the scutum, and frequently the one opposite, bifid (*bi. sp.*). In well developed zoœcia there are three spines on the outer margin, the lower of these frequently bifid, the second often quite long, and the third, or uppermost one shorter and sometimes missing; two spines on the inner margin, the lower generally bifid, the upper frequently lacking or broken. *Lateral avicularia* of moderate size, usually found on each zoœcium. A series of sessile, frontal avicularia (*fr. av.*) extends between the zoœcia, each avicularium situated usually at the base of the spine on the inner margin nearest the scutum. These frequently stand out prominently, the beak opening upward, so that the zoœcia frequently have the appearance of being flanked on each side by an avicularium, the one on the inner side being slightly smaller than that on the outer. The zoœcium at the bifurcation of a branch usually bears a raised avicularium of extraordinary size, with elongated beak directed obliquely, sometimes to the right, sometimes to the left (*bi. av.*). *Vibracular chamber* dorsal, large, its length equalling half that of the zoœcium on which it is placed (fig. 42, *v. ch.*); vibraculum long, two and a half times as long as the individual zoœcia (fig. 41, *v.*). The *rootlet* arises from near the base of the vibracular chamber, toward the outer side (figs. 42 and 43, *r.*) The rootlets are developed only on the lower zoœcia of a colony; in the upper zoœcia the place of the rootlet is marked by a pore (fig. 42, *p.*) *Oœcia* numerous, large, reaching to the margin of the aperture of the zoœcium next above, and sometimes covering it (fig. 41, *oe.*); somewhat flattened and marked by numerous pores.

This species grows in large bunches, and being very calcareous, and having many long vibracula, spines and other appendages which catch and hold debris, it is remarkably coarse and dirty in appearance and rough to the touch. It strongly resembles *Caberea*, and the vibracular cells while not as large as those of that genus, yet show affinities to them in size, and in the length and slope of the groove. This species likewise shows certain resemblances to *S. cervicornis*, Busk ('52), but its habit is very different and it does not possess the peculiar scutum for which the latter is named.

S. diegensis is extremely abundant at San Diego on the rocks at Ballast Point, on floats at Coronado, and wherever it can get a foothold. It seems to be almost the most abundant bryozoan of the region; also found at many points in the vicinity of San Pedro. Less abundant northward, being found only in small quantities in San Francisco Bay and not obtained north of this locality.

Caberea Lamouroux.

Caberea Lamouroux, 1816.
Flustra, (part), Johnston, 1847.
Cellularia (part), Johnston, 1847.
Caberea, Busk, 1852.
Canda, d'Orbigny, 1850.
Caberea, Smitt, 1867.
Caberea, Hincks, 1880.

Zoarium not articulated. *Zoœcia* in two or more series, subquadrangular, or ovate, with a very large aperture. Sessile, *frontal avicularia* on the side and front of zoœcia; *lateral avicularia* minute. *Vibracular cells* very large, placed in two rows, stretching obliquely downwards across the back of the zoœcia, which they almost cover, to the median line, notched above and traversed through a great portion of their length by a shallow groove. *Vibracula* usually toothed on one side.

This genus is easily distinguished from others of this family by the peculiar shape and size of the vibracular cell as shown in fig. 46. It is not common in our collections, being represented by only a small part of a colony of one species.

14. **Caberea ellisi** Fleming.

Pl. VIII, fig. 40; Pl. IX, figs. 45, 46.

Flustra ellisii Fleming, Mem. Wern. Soc. ii, p. 251, Pl. 17, figs. 1-3.
Flustra setacea Johnston, 1847, ed. II, p. 346.
Cellularia hookeri, Busk, 1852, pt. I, p. 37, Pl. XXXVIII, fig. 2.
Caberea ellisii, Smitt, 1867, pp. 287 and 327, Pl. XVII, figs. 55, 56.
Caberea ellisii, Hincks, 1880, p. 59, Pl. VIII, figs. 6-8.

Zoarium fan-shaped, dichotomously branched; *branches* thick, widening upward (Pl. VIII, fig. 40). *Zoœcia* in two or four rows, short, subquadrangular (Pl. IX, fig. 45); *aperture* elliptical, occupying nearly the whole of the front, with a broad minutely granular margin, sloping outwards; marginal zoœcia with two stout spines above on the outer side, and one on the inner; intermediate zoœcia with one spine on each side. *Lateral avicu-*

laria (*lat. av.*) small and inconspicuous, placed a little below the top of the zoœcium, with a rounded mandible; *frontal avicularia* (*fr. av.*) raised, two below the aperture, placed one on each side, or sometimes only one; mandible rounded, directed downwards. *Vibracula* very long, serrate (*v.*). *Oœcia* flattened, frequently with a depressed, smooth, semicircular space in front from which fine striae radiate to the margin. *Rootlets* arise from the side of the vibracular chamber, the two on opposite sides uniting in the median dorsal line with each other and with those below, forming a thick keel-like cable along the dorsal surface of the branches (fig. 46, *r.*). At the base of the colony the threads become free and attach themselves independently to particles of sand or to whatever forms the substratum.

A small quantity of *C. ellisi* was dredged in 20 fathoms at Juneau. It is reported also from Queen Charlotte Islands.

Bicellariidae Busk.

Bicellariadæ Busk, 1852.
Bicellarieæ Smitt, 1867.
Bicellariidæ, Hincks, 1880.

Zoarium erect, with or without articulated stem or peduncle, or composed of a number of zoœcia connected by tubular processes. *Zoœcia* rather loosely united in one, two, or more series, or disjunct, boat-shaped or sub-tubular; *aperture* occupying a large proportion of the front. *Avicularia*, when present, capitate, pedunculated, and articulated. *Oœcia* either pedunculated or sessile.

The diagnosis of the family *Bicellariida* as given by Hincks is here revised in order to include the genus *Stirparia* Goldstein. This genus is fairly abundant on this coast, and unlike the other members of the family possesses a jointed stem of varying length surmounted by delicate feathery tufts of zoœcia.

KEY TO THE GENERA OF BICELLARIIDÆ.

1. Colony erect 2
1. Colony creeping 5
2. Colony unstalked 3
2. Colony stalked 4
3. Zoœcia uniserial .... **Corynoporella**
3. Zoœcia bi- or multiserial .... **Bugula**
4. Zoœcia biserial .... **Stirparia**
5. Zoœcia uni- or multiserial, with tubular connections .... **Beania**

Bugula Oken.

Cellularia Pallas, 1766.
Bugula Oken, 1815.
Cellularia, Johnston, 1847.
Avicella Van Beneden, 1848.
Avicella Van Beneden, 1849.
Ornithopora d'Orbigny, 1851.
Ornithoporina d'Orbigny, 1851.
Bugula, Busk, 1852.
Bugula, Hincks, 1880.

Zoarium erect, branched. *Zoœcia* boat-shaped, or sub-quadrangular, elongate, united in two or more series; *aperture* occupying a large proportion, sometimes the whole of the front, not turned upward or oblique. *Avicularia* in the form of a bird's head, and jointed, usually one to each zoœcium. *Oœcia* sessile at summit of aperture, or pedunculate upon the side of the aperture.

This genus is abundant in this region, not only in the number of species but also in the luxuriance of growth, and is remarkable for the large size which some of the species attain. Nine species are found, all of which are new except three; one, *Bugula murrayana,* is circumpolar, and another, *B. neritina,* is cosmopolitan in range.

KEY TO SPECIES OF BUGULA.

1. Zoœcia biserial 2
1. Zoœcia multiserial 4
2. Avicularia, if present, at summit of aperture ....**B. neritina**
2. Avicularia at base of aperture ....**B. pacifica**
2. Avicularia between summit and base of aperture 3
3. Avicularia much elongated, half as long as zoœcium, slightly more than half way between summit and base of aperture ....**B. longirostrata**
3. Avicularia not elongated, less than half the length of a zoœcium, just half way between base and summit of aperture......**B. californica**
4. Avicularia present 5
4. Avicularia absent ....**B. laxa**
5. Avicularia at base of aperture .... **B. murrayana**
5. Avicularia between base and summit of aperture 6
6. Avicularia less than half way from base and summit of aperture........ ....**B. flabellata**
6. Avicularia near base of aperture, beak much curved ....**B. curvirostrata**

15. **Bugula neritina** (Linnæus) Oken.

Pl. IX, fig. 47; Pl. XVI, fig. 97.

Sertularia neritina Linnæus, 1758, ed. X, p. 38.
Cellularia neritina, Pallas, 1766, p. 67.
Snail-bearing Coralline Ellis, 1767, p. 40, Pl. 19, figs. a, A.
Cellaria neritina, Ell. and Sol., 1786, p. 22.
Bugula neritina, Oken, 1815, Ab. 2, p. 89.
Acamarchis neritina, Lamouroux, 1816, p. 58, Pl. 3, fig. 2.
Cellularia neritina, Johnston, 1847, p. 340, Pl. 60, figs. 3, 4.
Acamarchis neritina, d'Orbigny, 1850-52, p. 324.
Bugula neritina, Busk, 1852, p. 44, Pl. XLIII, figs. 1-6.
Bugula neritina, Waters, 1887, p. 91, Pl. IV, figs. 3, 15.

Zoarium consisting of large bushy tufts 75 to 100 mm. in height, brown or reddish brown, often tinged with purple. (Pl. XVI, fig. 97.) *Branching* dichotomous. *Zoœcia* biserial, quadrangular, truncate above; *aperture* occupying more than two-thirds of the front; a short spine or denticle at the summit of the sides of the zoœcium (Pl. IX, fig. 47, *den.*). *Oœcia* very conspicuous and numerous (*oc.*); globose, attached to the inner anterior angle of the zoœcium by a short peduncle. *Avicularia* none. *Rootlets* forming a tuft at the base of the colony.

This species is extremely abundant, especially on the southern coast of California. It is not only found on rocks, floats, kelp, etc., along the shore, but it is frequently taken by the dredge, and great brown masses are constantly cast on the beach by the waves. Its most northern limit is Monterey Bay, where it is obtained in small quantities.

16. **Bugula murrayana** (Johnston) Busk.

Pl. X, fig. 48; Pl. XVI, figs. 98, 99.

? *Eschara hispida* Pallas, 1766, p. 49.
Flustra murrayana Johnston, 1847, ed. II, p. 347, Pl. LXIII, figs. 5, 6.
Avicella multispina Van Beneden, 1848, Vol. 15, pt. I, p. 76, figs. 7, 8.
? *Ornithopora dilatata* d'Orbigny, 1850-52, p. 323.
Bugula murrayana, Busk, 1852, p. 46, Pl. LIX, figs. 1, 2.
Bugula murrayana, Smitt, 1867, p. 291, Pl. XVIII, figs. 19-27.
Bugula murrayana, Hincks, 1880, p. 92, Pl. XIV, figs. 2-9.

Zoarium composed of bushy tufts from 25–50 mm. in height, sometimes consisting of masses of Flustra-like fronds 50 or more mm. in diameter (Pl. XVI, fig. 98), or of much elongated, narrow, strap-like branches (fig. 99). *Zoœcia* multiserial, the branches having from three or four, to twelve or fourteen rows; alternate, oblong, slightly narrower below, truncate above (Pl. X, fig. 48); *aperture* occupying more than half the front; an erect spine at each upper outer angle (*sp.*); a varying number of marginal spines, two to five on the inner margin, one to three on the outer, curving inward; occasionally in the absence of an avicularium, a spine at the bottom of the aperture, curving upward (*ba. sp.*). *Avicularia* pedunculate, those on the marginal zoœcia, when present, much larger than those on the intermediate zoœcia; often absent from both marginal and intermediate zoœcia. *Oœcia* (*oe.*) large, subglobose, marked by radiating lines. Rootlets given off from marginal zoœcia near base of colony.

B. murrayana is found at Kadiak, Orca, Pribilof Islands, Alaska, and in Puget Sound, but does not extend farther south.

The specimens from Orca, Prince Williams Sound, are robust, often possessing a large number of zoœcia in a series forming broad strap-like segments or branches (Pl. XVI, fig. 98). Those from Kadiak and Puget Sound are more delicate in appearance, forming smaller colonies (fig. 99). Those dredged at ten fathoms in Puget Sound do not possess more than six or eight rows of zoœcia in a series. There is great range of variation in the number of spines, and in the number and size of avicularia, among the specimens from the different localities. A considerable quantity of material from Pribilof Islands possesses the large marginal avicularia, while most of the material from other localities lacks them.

17. **Bugula californica** sp. nov.

Pl. X, fig. 49; Pl. XVI, fig. 100.

Zoarium consisting of a number of masses whose branches have a distinctly spiral arrangement about a central axis, sometimes forming a coarse growth 75 mm. in height and from 25 to 50 mm. in diameter in the broadest place (Pl. XVI, fig. 100).

Each branch composed of many strap-like branchlets consisting of two series of zoœcia, dichotomously divided to form a fan or frond. *Zoœcia* narrow below, elongated, bearing three spines at the distal extremity, one stout and long (Pl. X, fig. 49, *sp.*), extending in a direction parallel with the branch, longer than the other two, a continuation of the wall of the zoœcium; two (*sp.*) at the top of the aperture projecting forward at right angles to the front surface. *Aperture* occupying more than two-thirds of the front of the zoœcium. *Avicularia* large, pedunculate, situated near the top or not more than half the length of the zoœcium below the top. *Oœcia* large, high, globose, extending above the lower margin of the aperture of the next upper zoœcium. *Rootlets* developed on lower zoœcia, springing from front or ventral surface of zoœcium below the aperture.

The zoœcia in this species are usually arranged biserially, but sometimes, especially near the point where the branch is about to divide it may contain for a short distance three or four rows of zoœcia in the series (fig. 49). *B. californica* is most nearly allied to *B. turbinata*, but the zoœcia are somewhat shorter and stouter; the avicularia are of much the same form and size, but are placed lower down on the zoœcium; and the spines are constantly three instead of two, and of a different character from those of *B. turbinata*. The oœcia also differ, those of *B. californica* lacking the prominent process or peak described for *B. turbinata*.

Colonies of large size occur abundantly at Dillons Beach, California; *B. californica* is also found, but of less luxuriant growth at Lands End, San Francisco Bay, and at Pacific Grove, Monterey Bay.

18. **Bugula pacifica** Robertson.

Pl. X, fig. 50; Pl. XVI, fig. 101.
Bugula purpurotincta, Robertson, '00, p. 320.
Bugula pacifica Robertson, '00, p. 321.

Zoarium consisting of large bushy tufts having a somewhat spiral growth, often 75 mm. in height (Pl. XVI, fig. 101); colonies frequently united by a sort of cable formed by union of the root fibres. More delicate in appearance than the preceding species, often tinted purple. *Zoœcia* elongated, biserial, armed at the distal extremity with three spines, the outer one long (300 μ), projecting outward (Pl. X, fig. 50, *sp.*) ; the other two shorter (100 μ), being continuations of the margin of the aperture (*sp.′*) ; *Aperture* occupying almost the whole of the front of the zoœcium. *Avicularia* large, pedunculate, at the base and to the outer side of the aperture. *Oœcia* remarkably small, not rising more than 60 or 80 μ above the zoœcium, while the embryo (*emb.*), in many cases measuring 200 μ, extends downward into the upper part of the zoœcium. *Rootlets* numerous, extending from the lowest zoœcia of a colony.

This species was formerly ('00) somewhat tentatively identified as *B. purpurotincta* Norman, but after more extended study of specimens from many different localities it is unquestionably a new species. As formerly suggested by the writer, it is given the specific name *pacifica*, since it seems to be characteristic of the Pacific Coast. It ranges from Pribilof Islands, Bering Sea, to San Francisco Bay, the climax of growth, both in quantity and size being reached at Yakutat, Alaska. The purple color of the specimens obtained at this place is particularly noticeable. This, as I have said, resides in part in the tissue lining the zoœcia, and in part in the degenerated polypides or "brown bodies," and is quickly lost after the material has been placed in alcohol. From one locality in Puget Sound where the species was obtained in abundance, it possessed a distinctly greenish hue, while at many other places it is white or colored slightly yellow. The extreme shallowness and flatness of the oœcia are remarkable characters but are not peculiar to this species being found in at least one other species from this coast, *Bugula longirostrata.* The ovum matures in the upper part of the zoœcium rather than in the oœcium, the embryo frequently blocking the mouth of the former. In all cases, where an embryo has formed, the polypide has degenerated into a "brown (purple) body." Unlike those species which possess oœcia elevated above the mouth or orifice of the zoœcium, functional polypides and embryos cannot exist simultaneously in the same zoœcium, and probably on account of the purely mechanical obstruction caused by the embryo.

The distribution of *B. pacifica* extends from Pribilof Islands, Bering Sea, to San Francisco Bay. It has been obtained from St. Paul, Pribilof Islands; is very abundant at Yakutat, and is found in smaller quantity at Orca, Prince William Sound, Alaska; abundant, but colonies smaller, at Sidney, opposite Port Orchard Navy Yard, Puget Sound, less abundant on Channel Rocks, Puget Sound; fine colonies obtained from rocks at Dillons Beach, California; smaller quantity obtained from Lime Point and Fort Point, San Francisco Bay, California.

19. **Bugula flabellata** J. V. Thompson.

Pl. X, figs. 51, 52.

Bird's Head Coralline Ellis, 1767, Ger. ed., p. 109, Pl. XXXVIII, fig. 7.
Cellularia avicularia (part) Pallas, 1766, p. 68.
Flustra avicularis, Johnston, 1847, p. 346, Pl. LXIII, figs. 3, 4.
Avicularia flabellata Thompson, 1847, MS. Brit. Mus.; Gray, Brit. Mus. Radiata, p. 106.
Avicella avicularia Van Beneden, 1848, p. 75.
Ornithoporina avicularia, d'Orbigny, 1850, p. 322.
Bugula flabellata, Busk, 1852, p. 44, Pls. LI, LII.
Bugula avicularia forma 2, *B. flabellata*, Smitt, 1867, pp. 290, 345.
Bugula flabellata Thompson, 1868, Pl. VI, fig. 9.
Bugula flabellata, Norman, 1868, Pl. VI, fig. 9.
Bugula flabellata, Smitt, 1871-72, pt. 1, p. 18, Pl. V, figs. 48-52.
Bugula flustroides, Verrill, 1879, p. 52.
Bugula flabellata, Hincks, 1880, p. 80, Pl. XI, figs. 1-3.
not Bugula flabellata, Robertson, 1900, p. 431.

Zoarium from 12–25 mm. in height, consisting of a number of fan-shaped fronds divided into narrow branches (fig. 51). Branching dichotomous, occurring where a branch reaches a width of six or seven rows of zoœcia. *Zoœcia* elongated, of about equal length throughout, *aperture* occupying the whole or almost the whole of the front; usually two *spines* placed one above the other at each upper angle, the upper spines stiff and flaring, the lower often of great length and frequently crossed in front; on marginal zoœcia there are generally three spines on the outer side and two on the inner (fig. 52). *Avicularia* less than half way from the top of each zoœcium; those on the intermediate zoœcia smaller than those on the margin; marginal avicularia of medium size, point of mandible bent abruptly downward. *Oœcia* small, globular, smooth, well elevated above the top of the zoœcium, with a double line forming a band on the oral rim; opening wide.

This species differs slightly from Hincks' description of *B. flabellata,* in the number of spines, the English species apparently having but two on each side of the zoœcium. It agrees, however, with the figure given by Busk in which he represents three spines on the outer side of the marginal zoœcia. In other respects the English and American species seem to be identical.

Bugula flabellata has been obtained in small quantity on the piles in San Diego Bay.

20. **Bugula pugeti** sp. nov.

Pl. X, figs. 53, 54; Pl. XI, fig. 55.
Bugula flabellata, Robertson, 1900, p. 321.

Zoarium composed of numerous small somewhat spiral tufts from 10 to 25 mm. in height (fig. 53). *Zoœcia* multiserial, each branch consisting of from four to seven rows (fig. 54); long, narrowed slightly below; *aperture* occupying two-thirds or more of the front; three spines on the marginal zoœcia, two on the outer side (*ou. sp.*), one on the inner (*in sp.*); intermediate zoœcia with two spines only; the middle of the anterior edge of each zoœcium occupied by a round knob or process whose significance is unknown (*k.*). *Avicularia* (*av.*) found only on the marginal zoœcia, large, beak somewhat curved, situated half way from the top, or just below the middle of the zoœcium. *Oœcia* none. Embryos (Pl. XI, fig. 55 *emb.*) developing in the anterior part of the zoœcium, and no additional oœcium being formed. Embryos abundant in the older parts of the colony, and those zoœcia possessing well developed embryos containing no polypide. *Rootlets* extending from the lower zoœcia of the colony, forming a cluster at its base and attaching it to shells, rocks, or sea weed.

This species resembles *B. flabellata* in some respects, and was previously so identified ('00), but it is characterized by a total lack of oœcia and is believed to be an undescribed species. A negative character is, to be sure, an unsound basis, in most cases, upon which to establish species, but there can be no doubt in this instance, that oœcia are not developed. A well matured colony gives many branches in which the life cycle can be read. At the anterior edge of a branch the younger polypides are found in all stages of development. In the zoœcia just posterior to these, full grown polypides appear and the genital products are abundant. In still older zoœcia, a young embryo appears close to the anterior edge of the orifice of each zoœcium, and the polypide in such a zoœcium begins to degenerate. In older zoœcia, nothing is left of the polypide but a brown body, while the embryos are well developed, almost ready to hatch (Pl. XI, fig. 55, *emb.; b. b.*); in still older zoœcia, regenerating polypides (*re. pd.*) are found in zoœcia containing no embryos and from which the larvae, presumably, have escaped. The lack of the ovicell and the development of the embryo entirely within the zoœcium, are not the only characters which separate this form from *B. flabellata*. The shape of the avicularia, and the number and position of the spines are sufficient and constant specific differences.

This species has been obtained mainly in Puget Sound. It is abundant on Channel Rocks at extreme low tide, and has been dredged at San Juan Island, Puget Sound. A small quantity, dredged at ten fathoms, was obtained at Sitka, Alaska.

21. **Bugula curvirostrata,** sp. nov.

Pl. XI, figs. 56, 57, 58.

Zoarium consisting of numerous strap-like, dichotomously branched tufts, from 35 to 75 mm. in height (fig. 56); the branches much tangled, due to the binding fibres (*b. f.*) given off from the different parts of the colony which unite adjacent branches or portions of a branch. *Zoœcia* multiserial, alternate, varying from one or two, to four or five, or even seven or eight rows (fig. 57); long, somewhat truncate above, narrow below, the sides of the zoœcia frequently terminating above in a minute denticle (*d.*); *aperture* occupying two-thirds of the front; below the terminal denticle a spine (*sp.*) sometimes occurs. *Avicularia* characteristic, occurring on the lower half of the zoœcia, to the side of the aperture and either just below, or just above its basal margin; on the intermediate zoœcia, below the aperture; on marginal zoœcia, usually above the base of the aperture; marked by great relative length of beak (*bk.*) and by the distinct sharp curve at its extremity; mandible also curved so that at rest the ''jaws'' do not approximate each other except at the tip of the mandible (*man.*). As is often the case in multiserial species the appendages of the marginal rows are larger than are those on the intermediate ones. In this case the marginal avicularia (*av.*) are often gigantic in comparison with the intermediate ones (*av.′*). *Oœcia* (fig. 58, *oe.*) globose, large, marked by faint striæ. *Rootlets* (fig. 56, *r.*) very abundant, more numerous in the lower part of the colony, arising from the dorsal side of the marginal zoœcia. Those arising on zoœcia in upper part of colony frequently attach themselves to adjacent branches to one side or below.

In habit of growth and general appearance this species resembles *B. murrayana*. The difference, however, in the size of the various units of the colony in the two species will be clearly seen in a comparison of figs. 57 and 58, Pl. XI, with fig. 48, Pl. X, drawn to the same scale. In *B. curvirostrata* the spines are small, weak, and few in number, while the large size of those of *B. murrayana* is one of its distinguishing features. The avicularia are also very different both in size and shape; both species possess the curved beak, but the greater relative length of the beak of *B. curvirostrata* and its curvature which prevents its complete approximation with the mandible, separate this species from *B. murrayana*.

B. curvirostrata has not been obtained north of Pacific Grove, but is found in considerable abundance at various localities south of this point. It appears to be characteristic of southern waters, and may perhaps occupy the place in the southern fauna taken in the north by *B. murrayana*.

22. **Bugula longirostrata,** sp. nov.

Pl. XI, figs. 59, 60.

Zoarium consisting of delicate feathery tufts, branches somewhat spirally arranged (fig. 59). *Branching* dichotomous, the branches long and slender. *Zoœcia* (fig. 60, *zoe.*) biserial, much elongated, slightly narrowed below, the lateral walls rolling forward, terminating at the summit on each side of the margin in a minute denticle (*d.*). *Aperture* occupying more than three-fourths of the front of the zoœcium. *Avicularia* (*av.*) extremely slender and long, being more than half the length of a zoœcium; the beak (*bk.*) alone being almost half as long as the whole appendage; pedunculate, arising on the outer, lateral wall of the zoœcium about half way from its summit; when extended in a direction parallel with the zoœcium, the tip of the beak of the avicularium extends beyond the summit. *Oœcia* (*oc.*) small and shallow, just sufficiently high to inclose the ovum (*o.*), but covering only a portion of the embryo (*emb.*), the major portion of which occupies the upper part of the zoœcium. *Rootlets* arising from the dorsal wall of the lower zoœcia.

This species is the most delicate of all the California Bugulas. In the relatively large size of its avicularia it resembles the preceding species, *B. curvirostrata*. In the Bugulas generally, the muscular part of the avicularium exceeds the beak in size; in the two forms, *B. curvirostrata* and *B. longirostrata,* the relative size of these two parts is reversed. and the beak in each is the longer. *B. longirostrata* also resembles *B. pacifica* in the shallowness of its oœcia, these being insufficient to inclose the embryos when fully grown. The oœcium of *B. longirostrata* is slightly larger than that of *B. pacifica,* but relatively to the length of the zoœcium it is much the same in both species.

B. longirostrata has been obtained from one locality only, in the submerged valley off La Jolla at a depth of 125 fathoms. The specimens consist of a few detached pieces, one of which possesed rootlets as shown in the habit sketch (fig. 59).

23. **Bugula laxa,** sp. nov.

Pl. XII, figs. 61, 62.

Zoarium consisting of numerous fronds much divided into segments possessing from two to fifteen rows of zoœcia in a series (fig 61). The fronds forming tangled masses due to the great number of rootlets which attach themselves to other fronds or to other objects with which they are growing. *Zoœcia* adhering very loosely together; narrowed below, having at each anterior angle a stiff prominent spine (fig. 62, *st. sp.*), and on each margin of the *aperture* a varying number of smaller spines (*c. sp.*) curving over and frequently meeting and overlapping in the middle line; the number of *spines* on a side varying from three or four, to six or nine, according to the position of the zoœcium, the outer, marginal zoœcia usually possessing, besides the stiff spines at the summit, nine spines at regular intervals along its length; the intermediate zoœcia having a smaller number; *aperture* occupying the whole of the front of the zoœcium. *Avicularia* lacking. *Oœcia* (*oe.*) rounded, prominent, with faintly radiating striæ. *Rootlets* (fig. 62, *r.*) numerous, arising from the right or left dorsal anterior angle of the marginal, and of many of the intermediate zoœcia.

This species resembles both *Bugula* and *Flustra* so greatly that it is difficult to decide into which genus it should be placed. The shape of the zoœcia, the looseness of their connection with each other, and more especially the fact that each individual zoœcium arises from a bud formed independently from a parent zoœcium, and not from a common growing marginal region as in the *Flustras*, indicate a closer relationship to *Bugula*. Its habit is very characteristic. The great number of root fibres developed on its dorsal surface cause it to adhere somewhat closely to the substratum, in this case a sponge, and to form a tangled mass from which it is difficult to separate large pieces. The colony begins in a single zoœcium from which either one or two buds arise forming branches which extend sometimes as long narrow strips of one or two series of zoœcia, sometimes as broad fronds of many series. The adjacent rows of zoœcia are so loosely connected that in the broader frond-like portions, lacunæ frequently occur where zoœcia have apparently failed to form, thus producing the open and irregular appearance peculiar to this species.

B. laxa occurs in considerable abundance on Channel Rocks, Puget Sound. Found in small quantity in material from Pacific Grove.

Beania Johnston.

Beania Johnston, 1847, ed. II, p. 372.
Diachoris Busk, 1852, pt. I, p. 53.

Zoarium subcorneous or calcareous, erect or decumbent. *Zoœcia* sessile or suberect, scattered, or in loosely connected groups, united to one another by slender tubes originating from the dorsal or lateral surfaces; *aperture* occupying the entire front, the margin usually furnished with hollow spinous processes arching over the opening; mouth terminal.

As here defined, *Beania* is intended to include the genus *Diachoris* of Busk, Hincks, Jullien, and others, following the usage of MacGillivray and Waters. Hincks ('85) regards Diachoris of Busk as an artificial division but considers it to be more nearly related to *Bugula* because of its boat-shaped zoœcia and articulated avicularia. These characters do not, however, distinguish *Bugula* alone, whereas the peculiar mode of connection of the zoœcia by tubes of varying length forms a good diagnostic character common to both *Beania* and *Diachoris* as originally defined.

24. **Beania mirabilis** Johnston.

Pl. XII, figs. 63, 64, and text figure 1.

Beania mirabilis Johnston, 1847, p. 372, text figs. 69, 70.
Beania mirabilis, Busk, 1852, pt. I, p. 32, Pl. XXIV, figs. 4, 5.
Beania mirabilis, Smitt, 1867, pp. 295 and 357.
Beania mirabilis, Hincks, 1880, p. 95, Pl. IV, figs. 8-10.

Zoarium consisting of numerous minute branching tufts, some of which are free, some adherent to the substratum by means of rootlets given off from each zoœcium (fig. 63). *Zoœcia* boat-shaped (fig. 64, *zoc.*), having two erect spines (*e. sp.*) above the mouth, and a variable number of marginal spines, six, seven, or eight on each side of the aperture; *tubes* (*con. t.*) connecting the zoœcia arising near the base of each zoœcium laterally or on the dorsal surface, *i.e.*, the side opposite the aperture; near the point of origin of a tube a septum (*sep.*) forms, the longer portion of the tube being continuous with the zoœcium of which it forms a sort of pedicel; opposite branches may be given off from the base of each zoœcium (*br.*). *Oœcia?* *Rootlets* (text fig. 1, *r. f.*) consist of tubular processes of varying length given off from the basal surface of each zoœcium and terminating in a disk from which finger-like processes extend anchoring the colony to the substratum.

Beania mirabilis is obtained in considerable quantity growing over *Alcyonaria* and *Bowerbankia* at Dead Mans Island and Santa Catalina Island.

25. **Beania longispinosa** sp. nov.

Pl. XII, figs. 65, 66.

Zoarium sub-erect, consisting of groups of zoœcia united by tubular connections (fig. 65). *Zoœcia* boat-shaped, slightly contracted above, alternate; *aperture* membranous occupying the whole of the front; *orifice* terminal; *spines* remarkable for their length, the two upper ones (fig. 66, *st. sp.*) stiff and flaring outward; seven to nine pairs (*cr. sp.*) on the margin, inclined inward, crossing above the aperture, their tips frequently extending beyond the lateral edges. Connecting *tubes* very short, often hidden by the overlapping lateral walls of the zoœcia, usually two on each side, uniting lateral zoœcia, one at each end uniting with a zoœcium laterally and proximally. No *avicularia*. *Oœcia* (*oc.*) small, situated at the summit of the zoœcia, marked by parallel striæ extending longitudinally. *Rootlets* very long, extending from the dorsal surface of many of the zoœcia, sometimes 50 or more mm. in length (fig. 65, *r.*).

This species seems to be related to *Diachoris hyadesi* Jullien ('88) in the number of spines and the arrangement of the connecting tubes, but the difference in both these characters are sufficiently distinctive to constitute another species. The number of connecting tubes varies somewhat, there being six, seven, and sometimes eight from one zoœcium.

Beania longispinosa was obtained in several fathoms of water off La Jolla, California, growing upon rock.

Stirparia Goldstein.

Stirparia Goldstein, 1879 or 1880.
Stirparia, Hincks, 1883.
Bicellaria (part), Busk, 1884.

Zoarium consisting of erect segmented stalks, bearing on their summits feathery tufts whose branches consist of zoœcia biserially arranged. *Zoœcia* of the normal Bicellarian or Bugulan type, *i.e.*, turbinate, with *aperture* looking more or less upward, turned obliquely inward; or boat-shaped, with *aperture* occupying almost all of the front wall, not directed upward and zoœcia not turned inward; lower portion tubular. *Avicularia* and *oœcia* pedunculate.

The diagnosis of this genus as given by Hincks ('83) is here amended in order to include the two types of zoœcia found in the species from this coast, as well as the oœcia, of which Hincks makes no mention. Oœcia are abundant on all the specimens and are of the Bicellarian type, being pedunculate upon the inner side of the zoœcium near the top.

KEY TO SPECIES OF STIRPARIA.

1. Zoœcia with aperture turned upward 2
1. Zoœcia with aperture not turned upward 3
2. Aperture occupying less than half the front, and armed with five or six spines ....**S. ciliata**
2. Aperture occupying half or more of the front wall 3
3. Margin of zoœcia armed with two, three, or four spines .... **S. occidentalis**
3. Margin of zoœcia armed with two spines on the upper outer angle.................... **S. californica**

26. **Stirparia ciliata,** sp. nov.

Pl. XII, figs. 67, 68, 69; Pl. XIII, figs. 70, 71.

Zoarium composed of numerous flabellate tufts borne on the summits of a number of erect, stiff, segmented branching stalks, the whole attaining the height of 25 or more mm. (fig. 67). The segments (fig. 68, *seg.*) of the stalk aborted zoœcia, the lateral disk at the distal end of each representing the aborted aperture (*ab. ap.*). *Stalks* branching at irregular intervals, branches (*br.*) frequently arising from the aborted aperture. *Segments* of about equal length and formed by rather deep constrictions, there being no distinct joint or articulation, the segments of the stalk passing insensibly into the normal zoœcia forming the tufts at the distal end of the stalk; the first zoœcium of the branching tufts similar to the distal segment (*dis. seg.*) of the stalk, being often but little shorter, and but slightly modified in other respects from the ordinary stalk segments. This first zoœcium tubular, elongated, possessing a circular aperture occupying about one-third the length of the zoœcium, and surrounded by spines; from its anterior extremity two zoœcia arise, and as growth proceeds the zoœcia that subsequently appear in the branch acquire the typical form. *Zoœcia* of the Bicellarian type, broadly ovate above, tubular below, the aperture looking upward, the tubular portion inclined inward (Pl. XIII, fig. 70). *Aperture* occupying about half the front or less, margin thin, surrounded by six or seven spines (*c. sp.*) which tend to curve inward. Five or six spines on the outer edge, one on the inner just opposite the lowest outer spine; zoœcium at bifurcation (*bi. zoe.*) usually lacking all spines except the two opposite lowest ones. *Avicularia* (*av.*) pedunculate, small, situated just below the aperture on the outer side, usually developed sparingly. *Oœcia* (Pl. XIII, fig. 71, *oe.*) pedunculate, globose, developed on the side of the aperture just above the spine on the inner margin; found on every zoœcium of some of the branches, especially of those at the tips. *Rootlets* springing from the lower segments of the stalk, proceeding downward close to the stalk, often enclosing it with a sheath, then becoming free at its base, spreading, often becoming branched, and attaching themselves to grains of sand, to hydroid stems, or other substrata.

In the possession of a chitinous stalk marked by constrictions more or less deep but not distinctly articulated, *S. ciliata* is related to *S. annulata*, Maplestone ('79). It differs markedly from that species, however, in the total lack of the annulations found on the segments of the stalk of *S. annulata* and for which it is named. Many evidences are afforded of the zoœcial origin of these segments. Instances are found where a segment assumes the shape externally of an ordinary zoœcium, *i.e.*, it becomes wider at the distal end and possesses an aperture on whose margin are two and sometimes three spines (Pl. XII, fig. 68, *ab. ap.*). The contents of such a segment, however, are similar to that of adjacent segments. The avicularia which are usually minute often become more numerous and slightly larger near the tips of the branches.

This is a rather widely distributed California species, being found among the material from Lands End, Fort Point, and Lime Point, San Francisco Bay; Pacific Grove, Mendocino City, and Dillons Beach, California.

27. **Stirparia occidentalis**, sp. nov.

Pl. XIII, figs. 72, 73, 74.

Zoarium composed of flabellate tufts borne on the summit of a number of erect, stiff, segmented branching stalks, the whole an inch or a little more in height (fig. 72). The segments (*seg.*) of the stalk not so evidently aborted zoœcia as are those of the preceding species, the lateral aborted apertures appearing only occasionally; the articulation (*art.*) of the segments distinct; segments differing in length, growing noticeably shorter toward the distal end of the stalk, and the transition (*tr.*) from stalk to zoœcial tuft being very sudden. Zoœcial tufts relatively short, not half as long as the main stalk, branching dichotomous. *Zoœcia* biserial, alternate; at the formation of a branch, the series of zoœcia separated by the interpolation of two new zoœcia on the inner side so that no one zoœcium can be said to be at the bifurcation (fig. 74, *bi.*), *i.e.*, the branches bifurcate between two series of zoœcia forming the proximal branch and not upon a single zoœcium. *Zoœcia* (*zœ.*) of the Bugulan type, elongated, turned outward, but aperture not turned distinctly upward; *aperture* elongated, occupying more than half the front surface, the lateral margins raised and terminating at the upper angles in long curving spines (*c. sp.*). Two or three spines (*sp.*) on the upper, outer margin, and one on the inner (*sp.*). *Avicularia* (*av.*) pedunculate, situated below and to one side of the aperture; present usually on every zoœcium. *Oœcia* (*oc.*) pedunculate, to one side of the summit of the zoœcium. *Rootlets* arising from the lower segments of the stalk, proceeding downward close to it, and at its base spreading freely and attaching themselves to the substratum, becoming entangled with those of other colonies and forming a sort of cable whose strands are further bound together by organisms parasitic upon them.

These two species *S. ciliata* and *S. occidentalis* resemble each other in habit of growth, but the zoœcial portion of the latter is relatively shorter and the stalks relatively longer than are those of *S. ciliata*. This is so evident that a macroscopic examination is sufficient to separate them. The greater length of the stalks of *S. occidentalis* is due probably to the greater length of many of the segments and not to a greater number of segments. Thus a segment of the lower part of a stalk shown in Pl. XIV, fig. 76, is twice the length and thickness of those of the upper portion of the same stalk represented in Pl. XIII, fig. 73.

This species is found in several localities on the coast of California and Puget Sound.

28. **Stirparia californica** sp. nov.

Pl. XIII, fig. 75; Pl. XIV, figs. 77, 78, 79, 80.

Zoarium consisting of tall stalks surmounted by large, feathery, branching tufts of zoœcia (Pl. XIII, fig. 75); the stalk, both absolutely and relatively, longer in this species than in the two preceding, being two and a half or three times as long as the zoœcial tufts. *Segments* of the stalk stout, some very long, others short, showing a kind of alternation sometimes, and growing decidedly shorter toward the distal end: zoœcial origin of stalk segment not always apparent, and transition into ordinary zoœcia, abrupt. Single stalks broad at point of attachment to substratum, sending out ribs (Pl. XIV, fig. 77, *rb.*) of chitinous material which are connected by a flat web-like disk of cuticle. In older stalks, branching occurs a short distance above the base. Colonies solitary, no instance found of runners or stolon-like processes uniting several. *Zoœcia* resembling those of *Bugula*, especially of *B. pacifica*; elongated, only slightly narrower below than above; *aperture* occupying nearly the whole of the front; zoœcia not turned outward nor is the aperture upturned (Pl. XIV, fig. 80). Lateral margins of aperture raised, especially at the summit of the zoœcia where each angle terminates in a long jointed *spine;* from the distal margin of a zoœcium a second longer spine (*sp.*) appears, making two, less frequently three, on the outer margin, and one on the inner. *Avicularia* (*av.*) small, often minute, pedunculate, on the lower part of each zoœcium just below the aperture. *Oœcia* (*oe.*) globose, pedunculate, on the inner side at the summit of each zoœcium. *Rootlets* springing from lower segments of the branches of the stalk, passing downward close to stalk and attaching themselves to basal disk. (Pl. XIII, fig. 75, *r.*)

But two species of *Stirparia* have been hitherto described, *S. glabra*, Hincks ('83), and *S. annulata*, Maplestone ('79), both from Australian waters. To these, three others from the collections on this coast are here added. In the three West American species, two types of zoœcia are discernible, and two types of stalk segments. In all accounts hitherto given of this genus the Bicellarian form of the zoœcium is considered characteristic, so much so that Busk ('84) retains *S. glabra* in the genus *Bicellaria*. In the three species here described, there is shown a transition from the Bicellarian type to the Bugulan. Thus, *S. ciliata* closely resembles *Bicellaria ciliata* in shape and ornamentation of zoœcium, but in *S. occidentalis* there is a decided approach to the Bugulan type, and in *S. californica* we find the boat-shaped zoœcium characteristic of *Bugula*. In all, the avicularia and oœcia are much alike both as to size and position, and resemble those of *Bicellaria*. The stalk of these three species shows variation tending toward greater specialization. Attention has already been called to the fact that, as Hincks ('83) observed, the segments of the stalk are probably aborted zoœcia. Their zoœcial nature is most plainly shown in *S. ciliata*, in which as shown in Pl. XII, fig. 68, the distal segment (*dis. seg.*) of the stalk is not unlike a normal zoœcium in shape, and in the possession of a definite aperture round whose margin seven spines may be counted. This zoœcium-like segment, however, does not contain a polypide, but instead, a strand of tissue similar to that found in other segments of the same stalk. In the remaining species, *S. occidentalis* and *S. californica*, the zoœcial character of the segments of the stalk is much less apparent, the aperture on each being inconspicuous and the articulation of the stalk being much more definite, showing a higher grade of specialization than is found in *S. ciliata*. With the specialization of the segments of the stalk there is correlated greater size, both in length and thickness, not only of the stalk as a whole but of the individual segments as well.

Attention has already been called to the difference in size between the lower and upper segments of the stalk of *S. occidentalis* (Pl. XIII, fig. 73; Pl. XIV, fig. 76). A similar difference exists in the segments of the stalk of *S. californica*, fig. 78 representing in outline one of the longer, fig. 79, one of the shorter segments, all the figures being drawn to the same magnification. Furthermore, a distinction is made between *S. californica* and any other members of the genus in the possession of a foot disk by which the colony adheres to the substratum. Fig. 77 represents the mode of attachment of a small colony consisting of a single segmented stalk. Where the stalk approaches the substratum it spreads out in a thin membranous disk, strengthened at intervals by chitinous ribs (*rb.*) which form in the ectocyst of the lower portion of the stalk and extend to the circumference of the disk. A colony may consist of a single stalk arising from such a disk and surmounted by a zoœcial tuft; or as in Pl. XIII, fig. 75, the stalk which forms the foot disk may divide into a number of secondary stalks (*br.*) each surmounted by its zoœcial tuft and sending down rootlets which attach themselves to the base. The colonies of *S. californica* grow in isolated groups, thus differing from *S. ciliata* and *S. occidentalis*, which form tangled masses of stems springing from many interwoven rootlets.

S. ciliata and *S. occidentalis* are shore forms, being found between tides growing on sea weed, other bryozoa, etc. *S. californica*, on the other hand, is a deep water form, being dredged at a depth of 125 fathoms in the submerged valley off La Jolla.

Corynoporella Hincks.

Corynoporella Hincks, 1888.

Zoarium forming delicate white tufts, consisting of zoœcia disposed in a single series, and facing one way; dichotomously branched. *Zoœcia* more or less clavate, each originating from the dorsal surface of the one beneath it, immediately below the summit; elongated, attenuated, tubular; *aperture* occupying a half or less of the front surface. *Avicularia* articulated, attached to the side of the aperture. *Oœcia* globose.

29. **Corynoporella spinosa** sp. nov.

Pl. XIV, figs. 81, 82, 83.

Zoarium erect, much branched, each internode consisting of a single zoœcium (fig. 81); *branches* (fig. 82, *br.*) arising on the dorsal surface near the summit, singly or in pairs. *Zoœcia* sub-clavate, narrowed below, widened above, the distal margin truncate or only slightly rounded; *aperture* membranous, occupying a third or more often a half of the front surface; surrounded by a thin raised margin on the distal edge of which are three minute spines or denticles, two lateral and one median, the latter being frequently absent. *Avicularia* (*av.*) large, rounded, pedunculated, situated half way between the summit and the base on the side of the aperture; mandible flat and rather broad and short, terminating in a point below the abruptly bent beak. *Oœcia* (fig. 83, *oe.*) globose, prominent, as wide as the zoœcial aperture, with lines radiating from the front rim; few in number. *Rootlets* (fig. 82, *r.*) springing from a disk on the side of most of the zoœcia, just below where the branches arise.

But one other species of this genus is described, viz., *C. tenuis*, Hincks ('88) from the St. Lawrence. As Hincks remarks, "the zoœcia bear a strong resemblance to those of the genus *Brettia*, but the articulated avicularium is a link connecting it with *Bugula*." The species *C. spinosa* has a decided resemblance to *Bugula* in that its zoœcia approximate the boat shape typical for that genus. It seems also to bear a resemblance to *Bugulella* Verrill ('79), but in *Corynoporella* the method of branching as well as the mode of union of the zoœcia are distinctly different from that in this genus.

Obtained from material from Alaska growing on a crab. Exact locality unknown.

Notamiidae Hincks.

Gemellariadæ (part) Busk, 1852.
Notamiidæ Hincks, 1880.

Zoœcia in pairs, each pair arising by two tubular prolongations, one from each member of the pair next below it; at each bifurcation a new series of zoœcia intercalated into the branches.

Synnotum Hincks.

Notamia, Waters, 1885.
Synnotum Hincks, 1886.
Synnotum, Waters, 1896.

Zoarium consisting of erect, slender, bifurcating shoots, attached by a mass of tubular fibres given off from the base of the primary zoœcium. (Fig. 93.) *Zoœcia* in pairs joined back to back, elongated, expanding from the base upward, the front surface occupied by a membranous *aperture;* sessile *avicularia* and an articulated avicularium between the zoœcia in each pair at the summit. *Oœcia?*

30. **Synnotum aviculare** (Pieper) Hincks.

Pl. XIV, figs. 84, 85.

Gemellaria avicularis Pieper, 1881, Vol. IX, p. 43, Pl. II, fig. 5-6.
Notamia avicularis, Waters, 1885, Ser. 2, Vol. 5, p. 6.
Synnotum aviculare, Hincks, 1886, Ser. 5, Vol. 17, p. 257.
Synnotum aviculare, Waters, 1896, p. 14, Pl. I, fig. 6, 7.

Zoarium minute, slender, of delicate texture, glossy, simple in habit, consisting of long branches which bifurcate at rather distant intervals (fig. 84). *Zoœcia* attenuated below, expanded above (fig. 85); *aperture* occupying more than two-thirds of the front, narrowing below, the margin thin and unarmed: *lateral avicularia* (*lat. av.*) small, sessile placed at the top of the zoœcium on the inner side, developed on every pair of zoœcia, widening from the base upward with a minute beak; *median avicularia* (*me. av.*) pedunculate, capitate, placed at the top of each pair of zoœcia in the median plane, subglobular, smooth, the beak very slightly produced, with a sharp spike-like extremity.

The sessile avicularia in the California specimens are not alternate as Hincks ('86) describes for those from the Adriatic, but appear rather on every pair. The capitate avicularia are frequently lacking in our colonies but this may be due to mutilation. The *rootlets* (fig. 85, *r.*) frequently arise quite high up on a branch from the front surface on the line midway between the top and base of a pair of zoœcia, sometimes even upon the aperture of a zoœcium.

S. aviculare occurs with other minute forms of bryozoa at Dead Mans Island, San Pedro, and Ballast Point, San Diego, California.

Cellariidae Hincks.

Escharidæ (part) Johnston, 1847.
Salicornariadæ Busk, 1852.
Cellarieæ Smitt, 1867.
Cellariidæ Hincks, 1880.

Zoarium erect, calcareous, articulated; *branching* dichotomous or non-dichotomous. *Zoœcia* usually rhomboidal or hexagonal, disposed in series around an imaginary axis so as to form cylindrical shoots.

Cellaria Lamouroux.

Cellaria Lamouroux, 1812.
Salicornaria Cuvier, 1817.
Cellaria (part), Johnston, 1847.
Salicornaria, Johnston, 1847.
Cellaria (part) d'Orbigny, 1850.
Salicornaria, Busk, 1852.
Cellaria, Hincks, 1880.

Zoarium jointed at intervals, internodes connected by horny tubes. *Zoœcia* alternate, depressed in front, and surrounded by a raised border. *Avicularia* immersed, irregularly distributed, situated above a zoœcium, or in place of one. *Oœcia* immersed.

KEY TO SPECIES OF CELLARIA.

1. Branching dichotomous; avicularia with triangular mandible directed downward .... **C. borealis**
1. Branching not dichotomous 2
2. Internodes small, avicularia large, twice the size of an ordinary zoœcium, mandible rounded, directed upward .... **C. mandibulata**
2. Internodes long, few, avicularia small, mandible rounded, directed upward or outward .... **C. diffusa**

31. **Cellaria borealis** (Busk) Smitt.

Pl. XIV, fig. 86; Pl. XVI, fig. 102.
Salicornaria borealis Busk, 1855, p. 254, Pl. I, figs. 1, 2, 3.
Cellaria borealis, Smitt, 1867, pp. 383 and 361, Pl. XX, fig. 17.

Zoarium growing in luxuriant masses 75–100 mm. in height (Pl. XVI, fig. 102), branching dichotomous, except at the extremities where the internodes are frequently tipped with three or four very small terminal internodes. *Internodes* of varying length, about a centimeter on an average, club-shaped; *joints* not black; young actively growing portions of the colony bright flesh pink. *Zoœcia* (Pl. XIV, fig. 86, *zoc.*) elongate, very little wider toward the middle than at the two ends; alternate, surrounded by a raised crenulate border, the rows of zoœcia separated by sinuous lines; front wall calcareous, and except upon the operculum which is large and semicircular on the distal edge, is marked by rather coarse punctures; *orifice* at summit of zoœcium. *Avicularia* (*av.*) above the zoœcia distributed at irregular intervals; mandible triangular, pointing downward. *Oœcia?* *Rootlets* not very numerous, springing from the lower internodes of a colony.

This is a handsome, well marked species, originally figured and described by Busk from the west Greenland shore. It is abundant on the rocks at Orca, Prince Williams Sound. It seems to be a strictly northern species not being reported south of Queen Charlotte Islands.

32. **Cellaria mandibulata** Hincks.

Pl. XV, figs. 87, 88, 89; Pl. XVI, fig. 103.

Cellaria mandibulata Hincks, 1882, p. 462.

Cellaria mandibulata Hincks, 1884, p. 203, Pl. IX, fig. 7.

Zoarium forming masses of delicate branches often growing from 75–90 mm. in height (Pl. XVI, fig. 103). *Internodes* slender, short, the longest from 6 to 8 mm. in length. *Branching* irregular, branches usually arising near the top of an internode, but often from the middle, or from any point on its surface; when arising from the top of an internode, two branches are seldom opposite, the one usually being higher than the other. *Joints* black. *Zoœcia* of various shapes depending apparently upon age. In young stages, they are slender, narrowed almost to a point above and below, widest about the middle (Pl. XV, fig. 87); in older stages they are somewhat wider, truncate above and below (fig. 88); in the oldest stage, zoœcia broader and shorter relatively (fig. 89); alternate, in a line from one end of the internode to the other, surrounded by a broad more or less crenulate border (fig. 88, *cr. bor.*). In young stages, this border follows the length of the internode in sinuous lines which approach each other but do not meet above and below the zoœcia (fig. 87); in older stages, the sinuous border becomes united above and below the zoœcia, and the crenulations are less marked (fig. 89). Zoœcial wall convex, covered with minute punctures, which in the oldest stage seem to cover the border with one continuous slightly punctate mantle (fig. 89). *Operculum* (*op.*) semicircular, with straight lower margin, a denticle at each lower corner, and two others opposite at the corners of the upper margin. *Avicularia* (*av.*) characteristic, large, few in number, only one or two in an internode, of simple form, almost exactly like extra large zoœcia; much broader than ordinary zoœcia, with a large semicircular chitinous mandible extending upward, whose upper margin is considerably elevated above the surface of the internode; above the avicularium is a small orifice resembling in shape and position an immature oœcium (*or.*) *Oœcia* not found in the youngest zoœcial stage described above. In older stages the orifice of the oœcium (fig. 88, *oe.*) appears circular, or somewhat oblong, occupying the space on each zoœcium above the operculum; in the fully developed stage (fig. 89, *oe.*), the oœcia resemble minute avicularia, with a straight lower margin, semicircular above and slightly raised above the surface of the zoœcium. Numerous fine brown *rootlets* spring from the lower zoœcia of the colony.

Without doubt this is the species described by Hincks from Queen Charlotte Islands. It is readily distinguished from other *Cellaria* of this region by its large dark avicularia which may be seen easily with a lens of low power. The method of branching, which Hincks seems to think is probably not characteristic of the species, is certainly typical both of this and another species, *C. diffusa*, less commonly found here. *C. mandibulata* has a wide distribution but is most common in southern waters, being frequently dredged in the vicinity of both San Pedro and San Diego.

33. **Cellaria diffusa** sp. nov.

Pl. XV, fig. 90; Pl. XVI, fig. 104.

Zoarium consisting of a relatively small number of rather long cylindrical internodes connected by dark chitinous joints; *internodes* varying in length, the longest attaining a length of 35 or 40 mm., the whole colony often 75 mm. high, and having a straggling diffuse appearance due to its method of branching. *Branching* irregular, branches arising at any point on an internode, always in the middle of a zoœcium; two branches, sometimes three or four arising at the distal end of the internode

(Pl. XVI, fig. 104). *Joints* black. *Internodes* club-shaped, stout. *Zoœcia* depressed, narrower below and above than in the middle, truncate at each end; front wall calcareous, covered with minute protuberances. (Pl. XV, fig. 90.) *Operculum* (*op.*) some distance below the top of the zoœcium, lower edge slightly curved, bearing a denticle (*d.*) near each corner, upper edge semicircular. *Oœcial orifice* (*oc. or.*) situated just above the operculum and resembling it in shape; a broad mucro (*m.*), a continuation of the calcareous zoœcial wall in the middle of its lower edge. *Avicularium* (*av.*) in place of a zoœcium, almost square. *Rootlets* springing from the lower zoœcia of the proximal internode, passing down close to the wall of the internode, then spreading out disk-like around the base of the colony.

In its habit of growth this species resembles *C. australis* Hincks ('84). The stems are not divided into internodes of definite and equal length by a regular dichotomous branching as is usual in typical *Cellaria*, but consist of rather stout, long, club-shaped cylinders giving off branches at any point apparently, though as in *C. australis* and *C. mandibulata* which it resembles in habit of growth and method of branching, always from the middle of a zoœcium. The zoœcia resemble those of *C. australis* in shape, but the position and shape of opercula and oœcia are different. Both have avicularia of the same general type, and of a character similar to *C. fistulosa*.

Fine colonies have been obtained at San Juan Island, and in Port Orchard Channel, Puget Sound. It has also been dredged both at San Pedro and San Diego.

Flustridae Smitt.

Escharidæ (part), Johnston, 1847.
Flustridæ (part), d'Orbigny, 1850.
Flustradæ (part), Busk, 1852.
Flustridæ Smitt, 1867.
Flustridæ, Hincks, 1880.

Zoarium corneous and flexible, expanded, foliaceous, erect or sub-erect. *Zoœcia* contiguous, multiserial. *Avicularia* usually of a simple type.

Flustra Linnæus.

Flustra sp., Linn., 1758.
Eschara (part) Pallas, 1766.
Flustra, Smitt, 1867.
Flustra, Busk, 1852.
Carbasea Busk, 1852.
Flustra, Hincks, 1880.

Zoarium erect or sub-erect. *Zoœcia* disposed in a single or double layer, more or less quadrangular or linguiform, with a raised margin, the aperture occupying the whole or a considerable portion of the front, and closed in by a membranous covering. *Oœcia* immersed or raised.

34. Flustra lichenoides Robertson.

Pl. XV, figs. 91, 92; Pl. XVI, fig. 105.

Flustra lichenoides Robertson, 1900, p. 322, Pl. XX, figs. 7, 7a, 8.

Zoarium unilaminar, consisting of broad foliaceous green or brownish green fronds. (Pl. XVI, fig. 105.) *Zoœcia* in alternate rows, slightly arched above, narrowed below, the distal margin raised and armed at each corner with an erect stiff spine (fig. 91 *e. sp.*), often slightly curved; below on each side of the aperture two other spines (*c. sp.*), flattened and curving inward, often meeting in the middle above the aperture; *aperture* occupying the whole front. *Oœcia* (*oe.*) rather low, but raised above the surface of the zoœcia; not as high as the erect spine at its base. Avicularia? *Rootlets* (fig. 92 *r. f.*) arising from the upper corner of most of the zoœcia by means of which the fronds are attached to the substratum, and above which the colony does not rise to any height but spreads out in convoluted masses.

Considerable variation occurs in the development of the spines. Specimens are found in which no spines are visible except those at the corners; others which have but one pair of lateral spines, or in which the spines are unevenly developed on the two sides. Variation also occurs in the root fibres. These frequently anastomose and form a net work of fibres below the lowest frond. Root fibres from overlapping fronds often attach themselves to the margin of the zoœcia of a lower frond. The laminæ are sometimes united back to back, but are easily separable, their union being effected by means of short fibres.

This species occurs sparingly on the Alaska coast; in Puget Sound in considerable abundance; to some extent on the coast of California as far south as San Francisco.

35. **Flustra membranaceo-truncata** Smitt.

Pl. XV, figs. 93, 94.

Flustra membranaceo-truncata Smitt, 1867, p. 358, Pl. XX, figs. 1-5.

Zoarium composed of a number of erect, unilaminate fronds (fig. 93). *Zoœcia* irregularly quadrangular, truncate above and below, often narrowed below (fig. 94); armed with a delicate spine (*sp.*) at the distal corners; *aperture* occupying the whole of the front; *operculum* (*op.*) semicircular. *Avicularia* (*av.*) sparingly developed, in place of a zoœcium; mandible semicircular, directed upward. *Oœcia* (*oc.*) small, immersed, not quite as wide as the zoœcium against which each projects.

This appears to be the species which Smitt ('67) describes and figures, and which he finds in Arctic Seas growing on ascidians, sertularians, etc., either creeping or erect. The material in this collection consists of a few small erect fronds obtained at Pribilof Islands, Bering Sea.

University of California,
Berkeley, February 15, 1905.

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ABBREVIATIONS IN THE PLATES.

a.—area.
ab. ap.—aborted aperture.
ad.—adnate part of zoœcium.
ap.—aperture.
b. sp.—basal spine.
b. f.—binding fibre.
bi.—bifurcation.
bi. av.—avicularium at bifurcating zoœcium.
bi. sc.—bifid scutum.
bi. sp.—bifid spine.
bk.—beak.
br.—branch.
c. av.—curved avicularium.
cr. sp.—crossed spine.
c. sp.—curved spine.
car. val.—cardiac valve.
con. tu.—connecting tube.
cr. bor.—crenulate border.
cr. br.—creeping branch.
d.—denticle.
dis. zœ.—distal zoœcium.
e. br.—erect branch.
e. sp.—erect spine.
fr. av.—frontal avicularium.
fr. zœ.—frontal zoœcium.
fst. zœ.—first zoœcium.
giz.—gizzard.
gr.—groove.
i.—intestine.
in. sp.—inner spine.
int.—internode.
j.—joint.
k.—knob.
lat. av.—lateral avicularium.
lat. zœ.—lateral zoœcium.
m.—mouth.
man.—mandible.
me. av.—median avicularium.
mem. ap.—membranous aperture.
mus.—muscle.
o.—ovum.
oe.—oœcium.
oe. or.—oœcial orifice.
œs.—œsophagus.
op.—operculum.
or.—orifice.
ou. sp.—outer spine.
ov.—ovary.
p.—pore.
par. mus.—parieto-vaginal muscle.
pd.—polypide.
ped. av.—pedunculate avicularium.
ph.—pharynx.
pr. br.—primary branch.
py. val.—pyloric valve.
r.—rootlet.
rb.—rib.
r. ch.—root chamber.
r. fb.—root fibre.
re. mus.—retractor muscle.
re. sh. mus.—retractile sheath muscle.
re. pd.—regenerated polypide.
s. h.—snake's head.
sc.—scutum.
sec. br.—secondary branch.
seg.—segment.
sep.—septum.
sh. mus.—sheath muscle.
sm. av.—small lateral avicularium.
sp.—spine.
st.—stalk.
ter. br.—tertiary branch.
tr.—transition from segment of stalk to zoœcium.
tu.—tubular part of the zoœcium.
u. r.—upward extending rootlet.
v.—vibraculum.
v. c.—vibracular cell.
v. ch.—vibracular chamber.
zœ.—zoœcium.
zœ. bi.—zoœcium at bifurcation.
zœ. br.—zoœcial branch.
zœ. or.—zoœcial orifice.

PLATE IV.

Fig. 1.—*Aetea anguina* Linnæus. Habit sketch, about natural size.

Fig. 2.—*A. anguina.* Portion of a colony enlarged showing variations in height of the erect, tubular part (*tu.*) of the zoœcia. Adherent (*ad.*) portion attached to the substratum like a stolon is part of the zoœcium which rises at its anterior end into the ringed tubular portion (*tu.*). The polypide (*pd.*) can be seen inside several of the zoœcia; when fully expanded it protrudes through the operculum (*op.*) at the summit of the tube. The zoœcia are separated from each other by a septum (*sep.*) at the anterior end of each. × 30.

Fig. 3.—*A. anguina.* Part of a zoœcium in which the polypide (*pd.*) is in a state of retraction; upper part of tubular portion broken away. Polypide retracted by contraction of retractor muscle fibres (*mus.*) attached to the wall of the adherent portion (*ad.*) of the zoœcium. In the adherent portion the ovary (*ov.*) is visible. × 70.

Fig. 4.—*A. anguina.* A single zoœcium much enlarged showing position of oœcium (*oe.*) just outside the aperture (*ap.*), below the operculum on the ventral side of the zoœcium. Within the oœcium is an ovum in early cleavage stage (*emb.*). × 70.

Fig. 5.—*Aetea truncata* Landsborough. Portion of a colony enlarged to show variations in height of the erect, tubular portions (*tu.*), also length and slenderness of the adherent portions (*ad.*) of the zoœcia. × 30.

Fig. 6.—*A. truncata.* Habit sketch, about natural size.

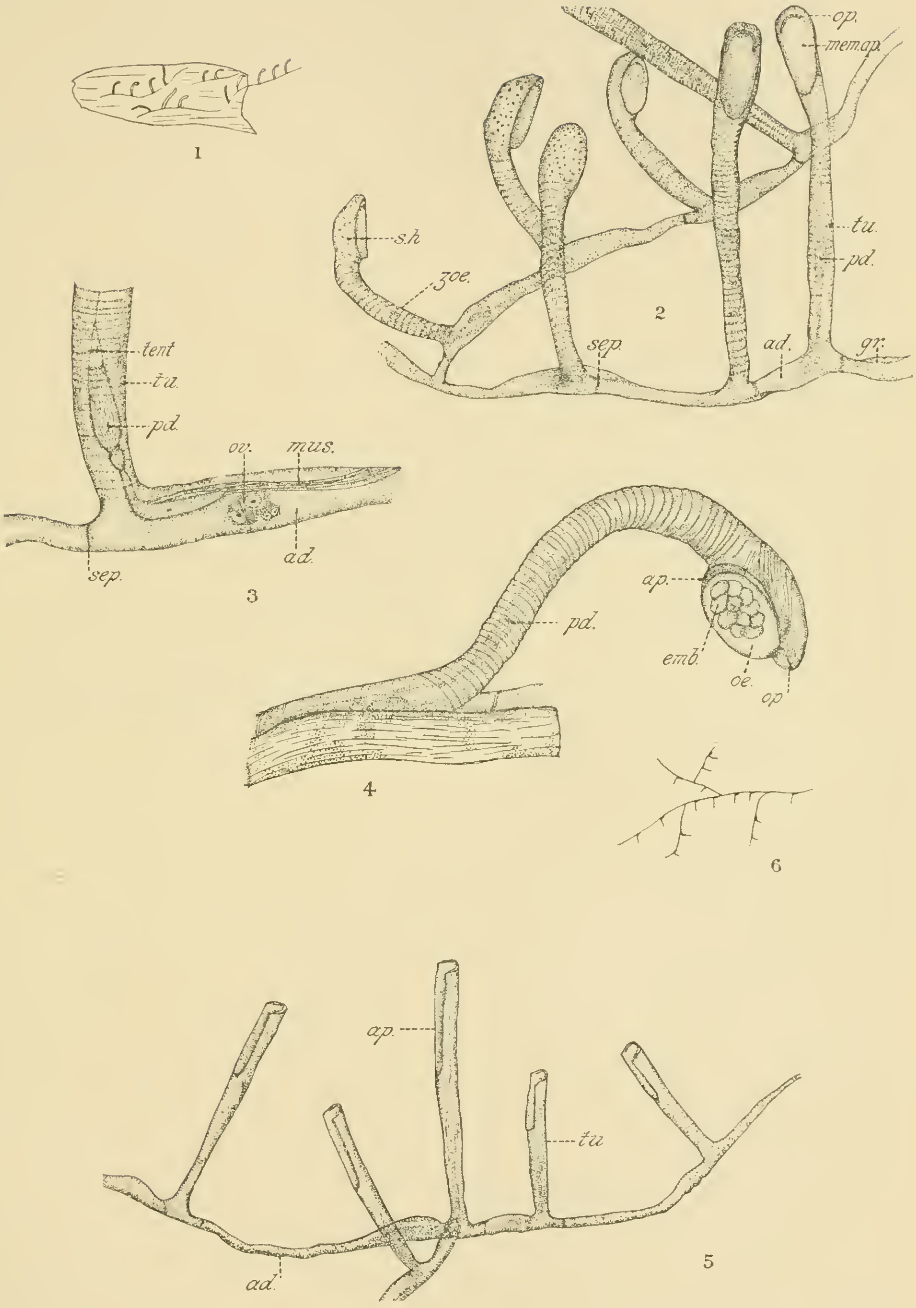

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PLATE V.

Fig. 7.—*Eucratea chelata* Linnæus. Habit sketch, about natural size.

Fig. 8.—*E. chelata.* Enlarged to show zoœcia and method of branching (*c. br.*) just below the aperture (*ap.*), and the creeping branches (*cr. br.*) given off from the sides of the zoœcia. × 50.

Fig. 9.—*E. chelata.* Showing oœcium (*oc.*) on a small aborted zoœcium. (After Hincks.) × 50.

Fig. 10.—*Gemellaria loricata* Linnæus. Habit sketch, natural size.

Fig. 11.—*G. loricata.* Portion of a branch enlarged to show arrangement of zoœcia and method of branching. × 30.

Fig. 12.—*Menipea ternata* Ellis and Solander. Habit sketch of specimen from Puget Sound.

Fig. 13.—*M. ternata.* Habit sketch of specimen from California.

Fig. 14.—*M. ternata.* Enlarged portion of colony from Puget Sound showing zoœcia in groups of three, except the oœcial internodes (*oc.*). Lateral avicularia (*av.*) well developed. × 30.

Fig. 15.—*M. ternata.* Dorsal view of the zoœcium at the bifurcation of a branch (*bi. br.*) showing the adjoining zoœcia (*lat. zœ.*) and root chamber (*r. ch.*) with upward extending rootlet (*r.*). × 30.

Fig. 16.—*M. ternata.* A single zoœcium to show the position of the two kinds of root fibres, those anchoring the colony (*r.*), arising in a simple root disk (*r. d.*) on the front wall of the zoœcium; those extending upward (*u. r.*), arising from a rather large chamber (*r. ch.*) projecting from the zoœcial wall just above the lateral avicularium. × 30.

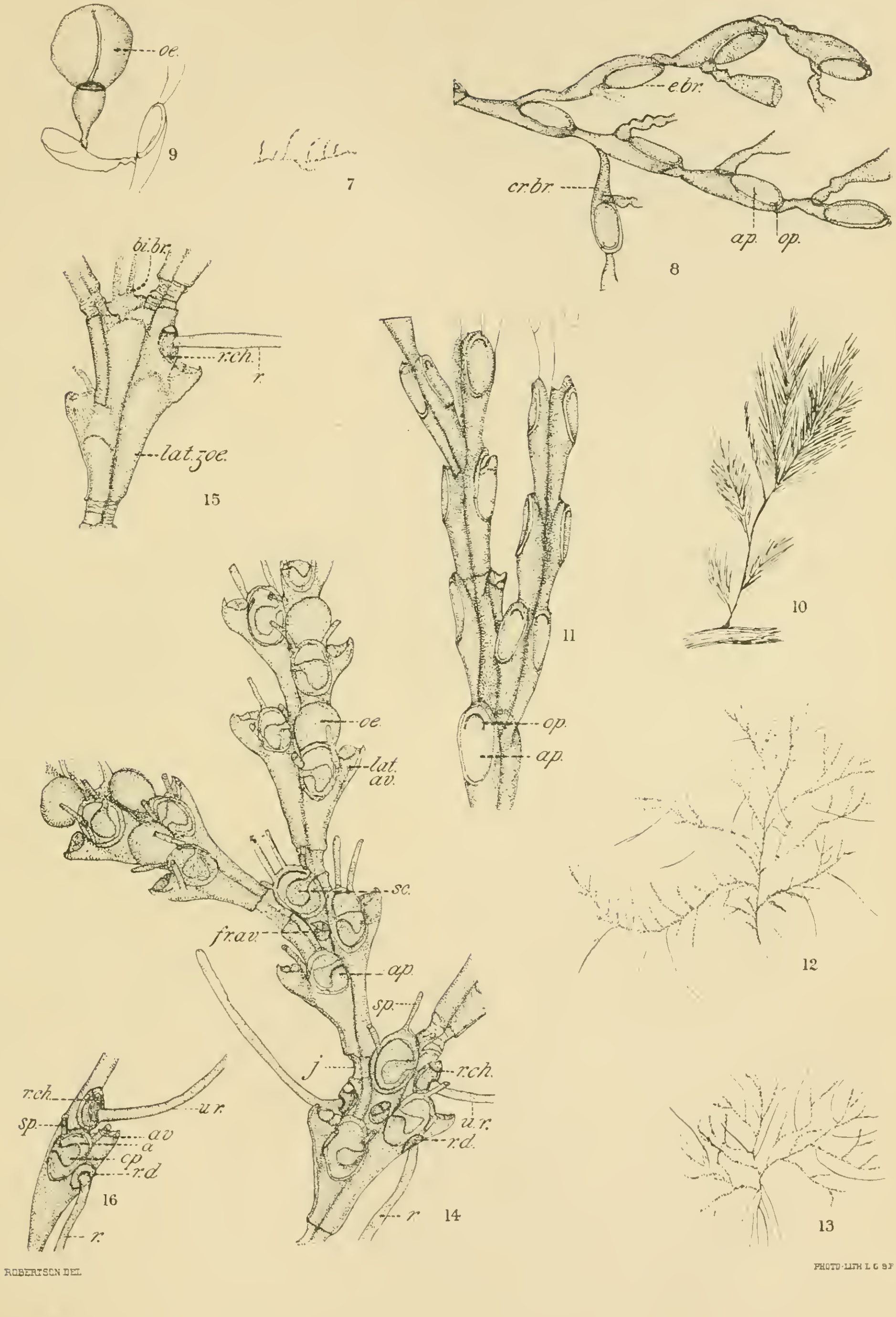

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PLATE VI.

Fig. 17.—*M. ternata.* Enlarged portion of colony from California. Much like the preceding except that the lateral avicularia are often lacking.

Fig. 18.—*M. gracilis* Busk. Habit sketch, natural size.

Fig. 19.—*M. gracilis.* Portion of a branch enlarged to same scale as figs. 14 and 17, showing the greater length of the zoœcia, the large flabellate scutum (*sc.*), the relatively small size of the avicularia (*av.*), and the shape and position of the two sorts of root chambers (*r. d.* and *r. ch.*) similar to these of *M. ternata.* × 30.

Fig. 20.—*M. gracilis.* Portion of an oœcial internode showing development of avicularia (*av.*) on the front of the zoœcium close to the oœcia (*oc.*). × 30.

Fig. 21.—*M. gracilis.* Dorsal view of the zoœcium at the bifurcation of a branch (*bi. zœ.*), showing the lateral adjoining zoœcia (*lat. zœ.*), and root chamber (*r. ch.*) with upward extending rootlet (*u. r.*). × 30.

Fig. 22.—*M. occidentalis* Trask. Habit sketch of a single branch to show method of branching. Somewhat diagrammatic.

Fig. 23.—*M. occidentalis.* A few internodes enlarged to show size of avicularia (*av.*), position and size of scutum (*sc.*), the nature of the jointed spines (*sp.*), and the crossed spines (*c. sp.*). Drawn to the same scale as figs. 14, 17, and 19. × 30.

Fig. 24.—*M. occidentalis.* An oœcial (*oc.*) internode consisting of five zoœcia. × 30.

Fig. 25.—*M. occidentalis.* Lateral view of a zoœcium, showing a root chamber (*r. ch.*) from which there extends a downward extending rootlet (*r.*). × 30.

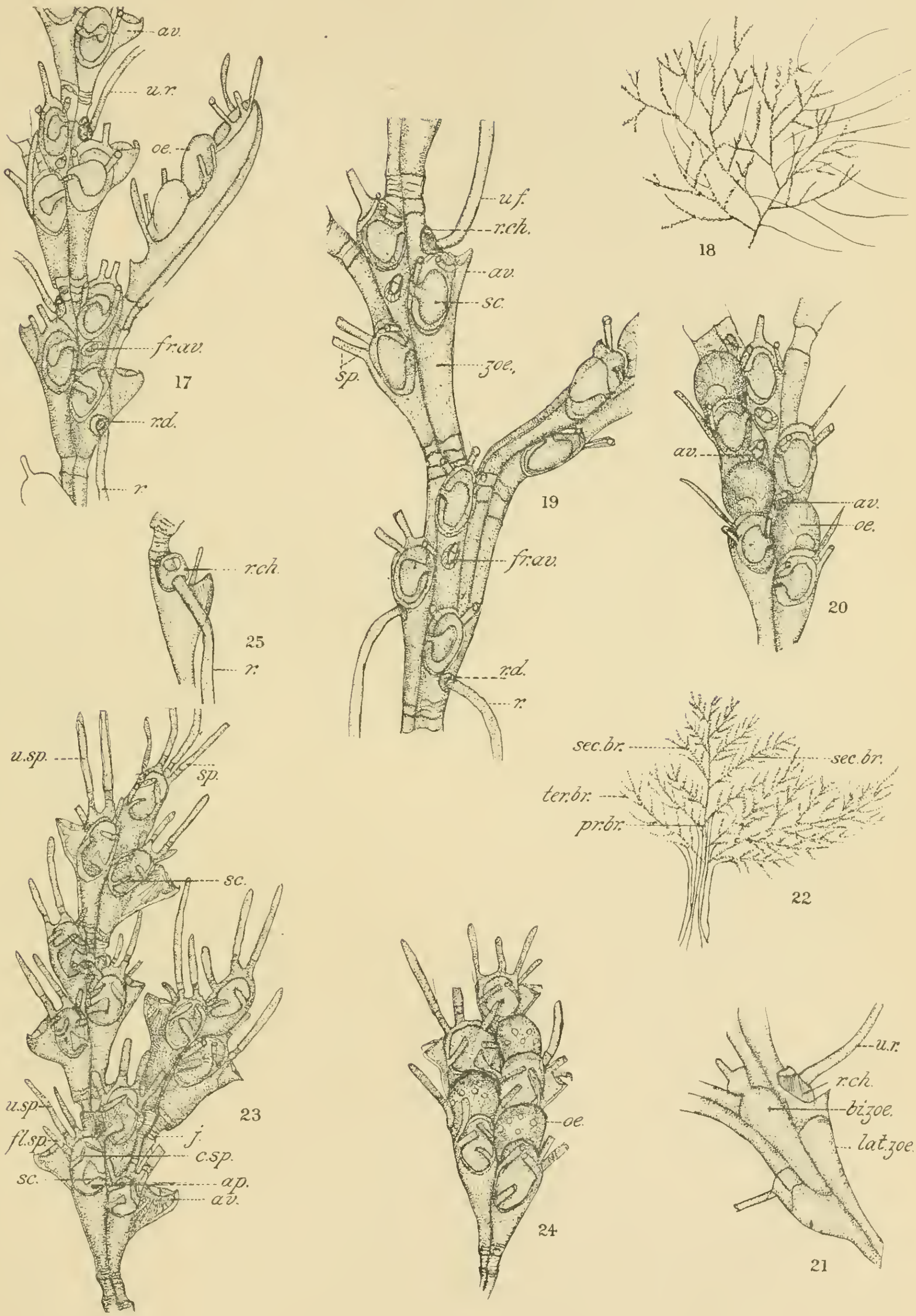

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PLATE VII.

Fig. 26.—*M. occidentalis catalinensis*, subsp. nov. Portion of a branch showing finger-like processes on scutum (*sc.*), and bifid spines (*c. sp.*). × 50.

Fig. 27.—*M. occidentalis catalinensis.* Lateral view of a zoœcium showing root chamber (*r ch.*) and downward extending root fibre (*r.*).

Fig. 28.—*Menipea erecta* Robertson. Habit sketch, natural size.

Fig. 29.—*M. erecta.* Enlarged portion of a colony from Kadiak showing lateral avicularia (*lat. av.*), frontal avicularia (*fr. av.*), and spines (*sp.*). × 30.

Fig. 30.—*M. erecta.* Enlarged portion of a colony from Sitka showing absence of lateral avicularia (*lat. av.*); showing also rootlet (*r.*) springing directly from zoœcial wall. × 30.

Fig. 31.—*M. erecta.* Enlarged portion of colony from San Juan showing absence of spines. × 30.

Fig. 32.—*Menipea pribilofi*, sp. nov. Habit sketch, natural size.

Fig. 33.—*M. pribilofi.* Oœcial internode (*oe.*). × 30.

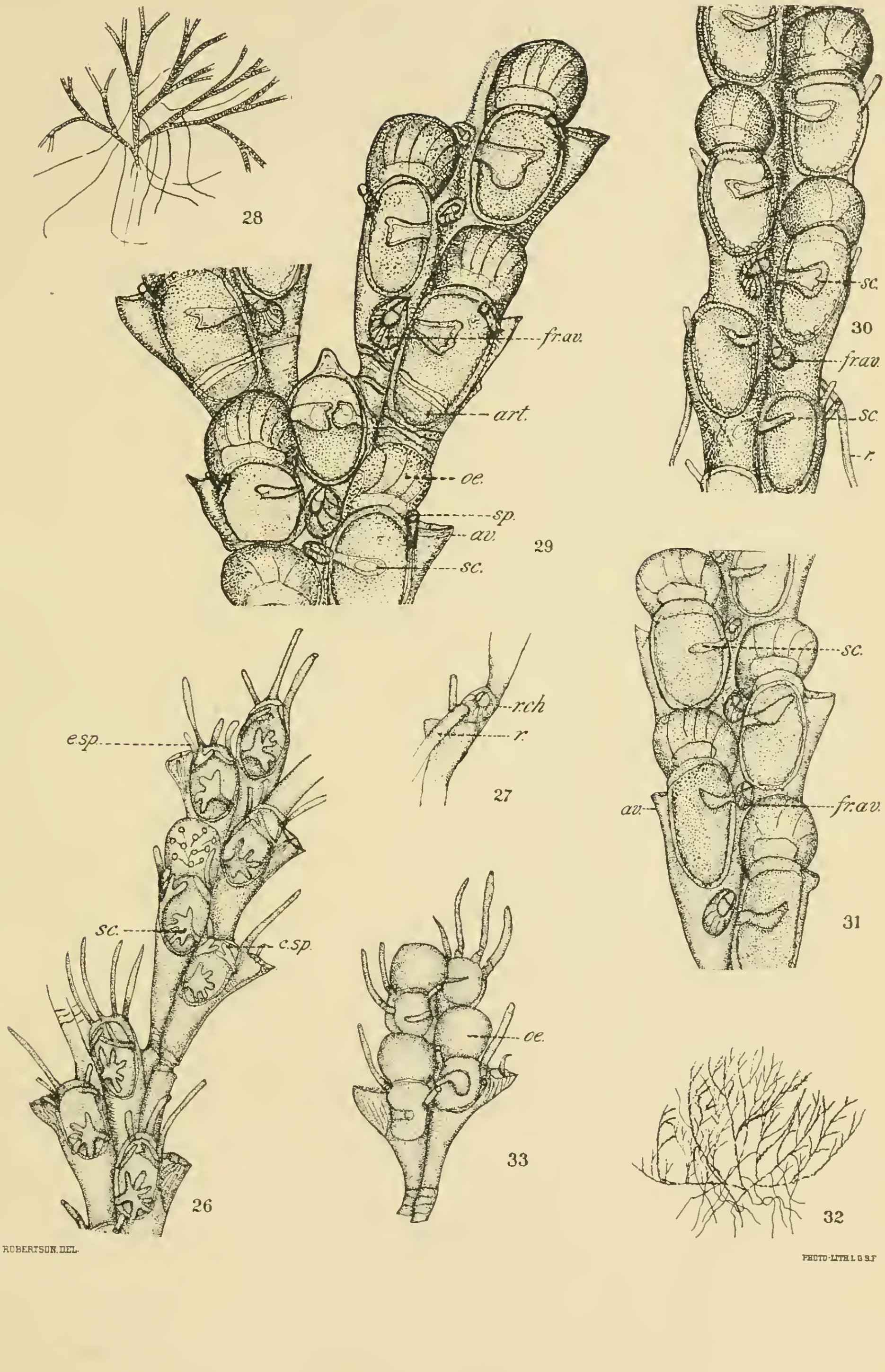

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PLATE VIII.

Fig. 34.—*M. pribilofi.* Portion of a branch enlarged showing number and length of jointed spines (*sp.*), size of lateral avicularia (*lat. av.*), frontal avicularia (*fr. av.*), and root chambers in the two positions (*r. ch.* and *r. d.*). × 30.

Fig. 35.—*Scrupocellaria californica* Trask. Dorsal view of part of two zoœcia to show vibracular chamber (*v. ch.*), short vibraculum (*v.*), groove of vibraculum (*gr.*), and lateral avicularium below (*av.*). × 50.

Fig. 36.—*S. californica.* Portion of a branch enlarged showing variation in size of lateral avicularia (*lat. av.*), the vibracular cell (*v. c.*), on zoœcium at bifurcation (*zoe. bi.*), visible from the front, while on other zoœcia only the short vibraculum (*v.*) is seen from the front, and only on the lower zoœcia which possess root fibres (*r.*). × 50.

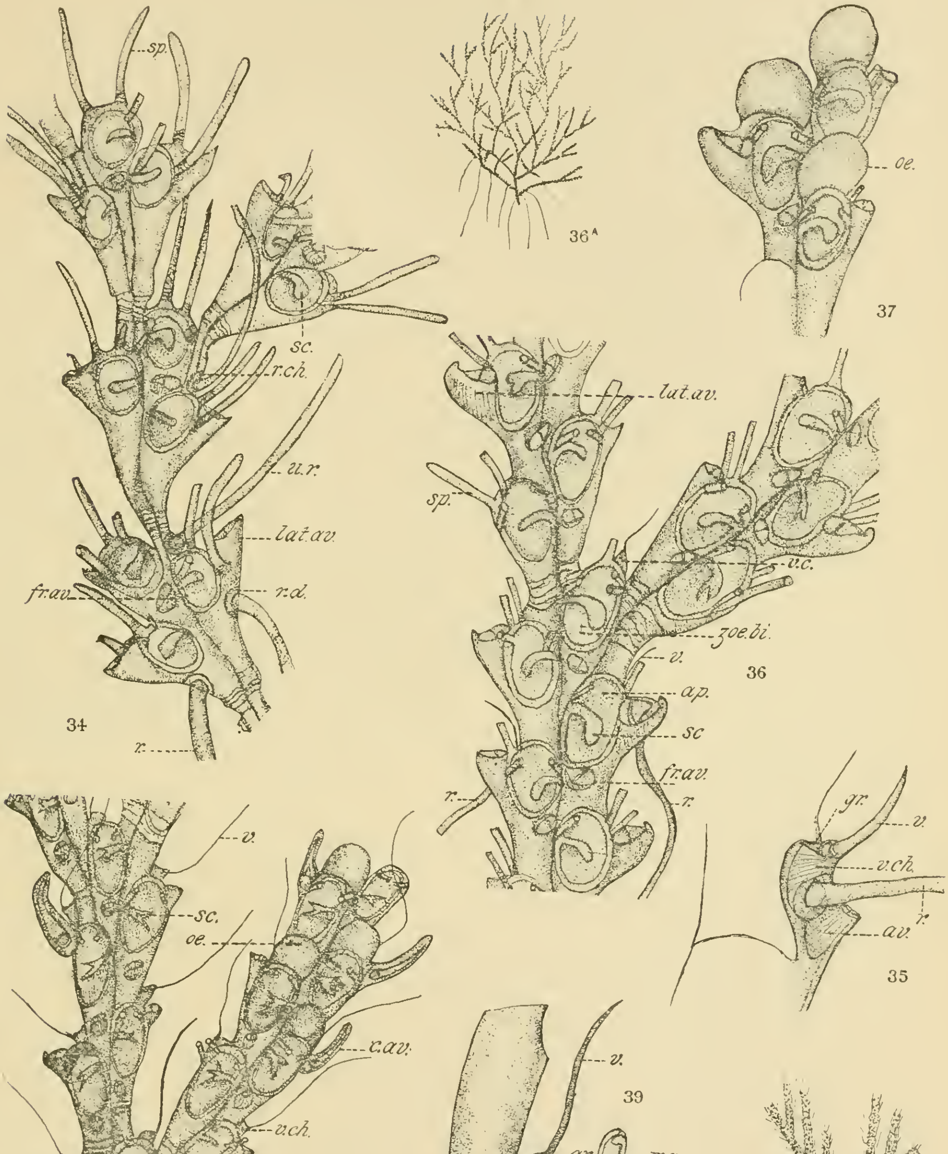
Fig. 36A.—*S. californica.* Habit sketch.

Fig. 37.—*S. californica.* Three zoœcia with oœcia (*oc.*). × 50.

Fig. 38.—*Scrupocellaria varians* Hincks. Portion of a branch enlarged to show bifid and trifid scutum (*sc.*), lateral avicularia varying in size from very small (*s. av.*) to the large curved variety (*c. av.*); also the vibracular cell visible from the front (*v. ch.*), and the long vibraculum (*v.*) present on each zoecium. × 20.

Fig. 39.—*S. varians.* Dorsal view of a portion of two zoœcia to show position of vibracular chamber (*v. ch.*) with its long vibraculum (*v.*) and its groove (*gr.*), with the root disk (*r. d.*) and root fibre (*r. f.*) on its basal margin; also lateral avicularium with its much elongated curved beak (*c. av.*). × 20.

Fig. 40.—*Caberea ellisi* Fleming. Habit sketch.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38
gr.
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r.
av.
35
v.
gr.
man.
v.ch.
c.av.
r.d.
mus.
r.f.
39
40

PLATE IX.

Fig. 41.—*S. diegensis* sp. nov. Portion of a branch enlarged showing form of zoœcia (*zœ.*) with large scutum (*sc.*), spines on the upper margin of the aperture (*ap.*) one or more of which are bifid (*bi. sp.*); also lateral avicularium (*lat. av.*) and frontal avicularium on the zoœcium at bifurcation (*bi. av.*). On those zoœcia not possessing oœcia the vibracular chamber (*v. ch.*) plainly visible with its long vibraculum (*v.*). × 50.

Fig. 42.—*S. diegensis.* Dorsal view of a few zoœcia to show vibracular chamber (*v. ch.*) sustaining the long vibraculum (*v.*) at its summit, and showing the groove (*gr.*) extending in the direction of the length of the zoœcia. At the base of the vibracular chamber and to one side of the groove is the pore (*p.*) from which the root fibre extends (*r.*). × 50.

Fig. 43.—*S. diegensis.* A vibracular chamber enlarged to show detail.

Fig. 44.—*S. diegensis.* The avicularium on zoœcium at bifurcation enlarged to show its large muscular portion (*mus.*) and the obliquely directed mandible (*man.*).

Fig. 45.—*Caberea ellisi* Fleming. A few zoœcia enlarged. Vibracular chamber visible from the front (*v. ch.*); the minute lateral avicularia (*lat. av.*); serrated vibraculum (*v.*). × 50.

Fig. 46.—*C. ellisi.* Dorsal view of a few zoœcia to show vibracular (*v. ch.*) chambers extending obliquely across the back of each zoœcium, the groove (*gr.*), and the long vibraculum (*v.*); also the rootlets (*r.*) arising from each vibracular chamber and proceeding downward through the middle of the branch. Rootlets from one side only shown. × 50.

Fig. 47.—*Bugula neritina* (Linn.) Oken. Portion of a branch enlarged showing zoœcia (*zœ.*) with large aperture (*ap.*), margins of which terminate in denticles (*d.*); also pedunculated oœcium (*oc.*). × 30.

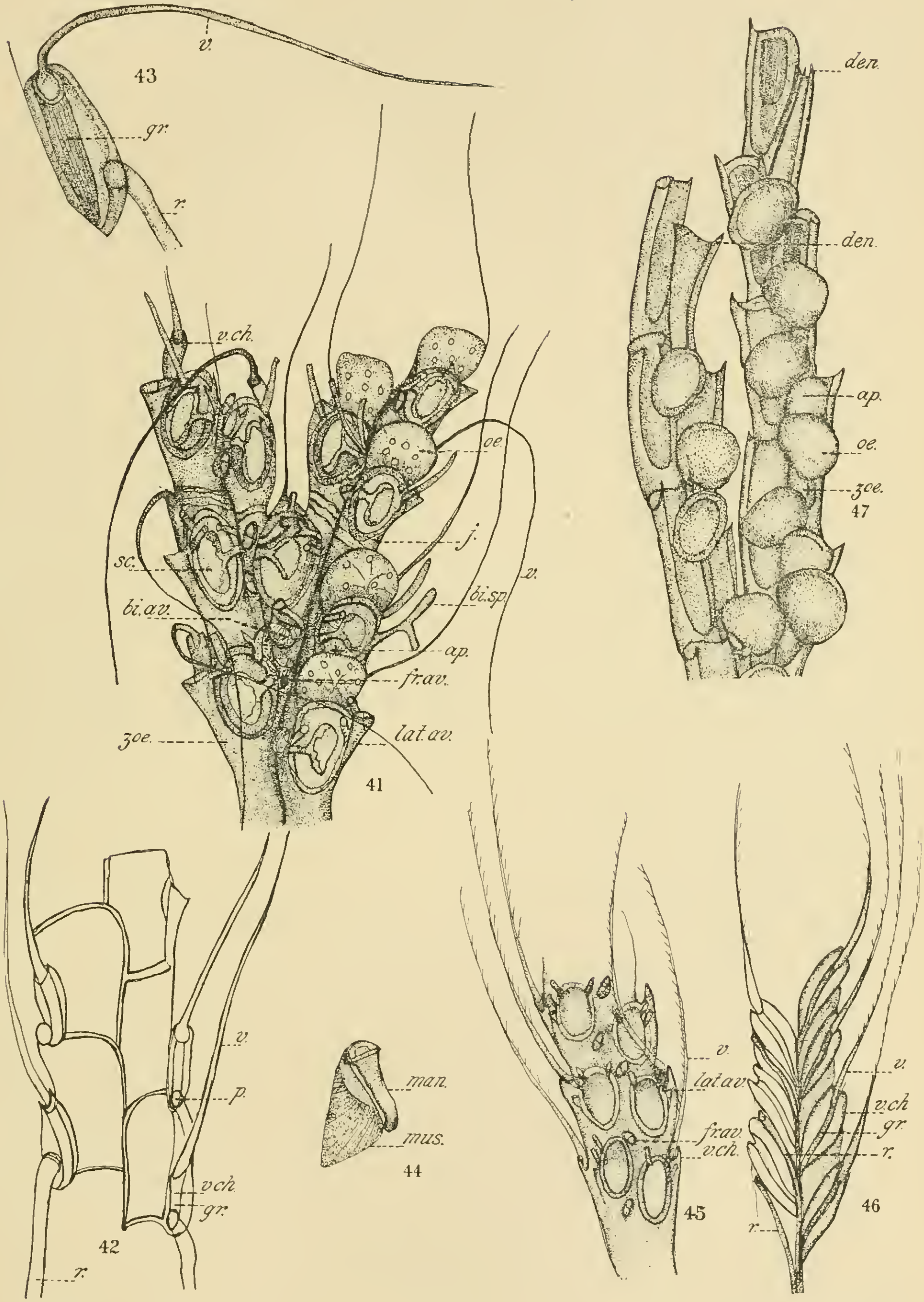

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PLATE X.

Fig. 48.—*Bugula murrayana* Johnston. Portion of a branch enlarged showing zoœcia (*zœ.*) with margins of aperture armed with variable number of spines (*sp.*); avicularium (*av.*) or spine (*sp.*) at base of aperture. Marginal avicularia lacking on this specimen. × 30.

Fig. 49.—*B. californica* sp. nov. Portion of a branch enlarged to show spines terminating the upper margins of the aperture (*sp.*), long outer spine (*ou. sp.*), and position of avicularia (*av.*). × 50.

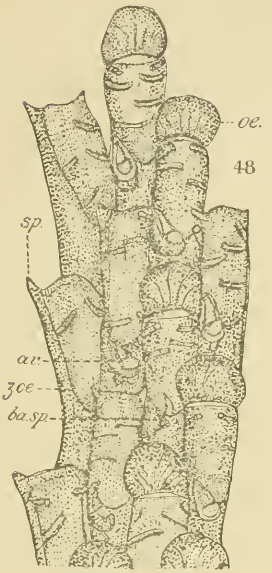
Fig. 50.—*B. pacifica* sp. nov. Portion of a branch enlarged to show zoœcia (*zœ.*), spines (*sp.* and *sp.'*), and the shallow oœcia (*oe.*); also the embryo (*emb.*) in the upper part of the zoœcium. × 50.

Fig. 51.—*Bugula flabellata* Thompson. Habit sketch, natural size.

Fig. 52.—*Bugula flabellata.* Portion of a colony enlarged to show arrangement and branching of zoœcia, the spines (*sp.*), avicularia (*av.*), and oœcia (*oe.*). × 30.

Fig. 53.—*Bugula pugeti* sp. nov. Habit sketch.

Fig. 54.—*B. pugeti.* Zoœcia with long aperture (*ap.*), marginal avicularia (*av.*), the three spines on the marginal zoœcia (*out. sp.*), and the process on the distal margin (*k.*). × 30.



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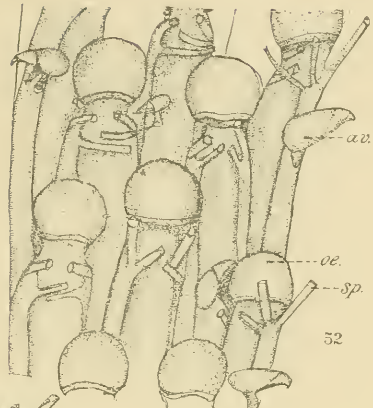

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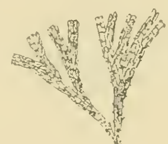

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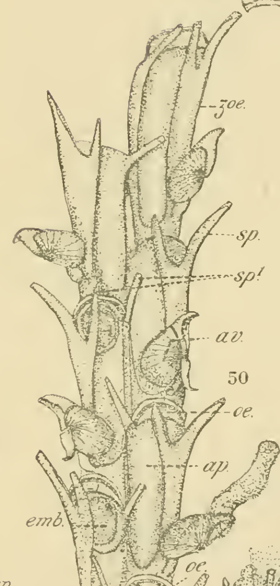

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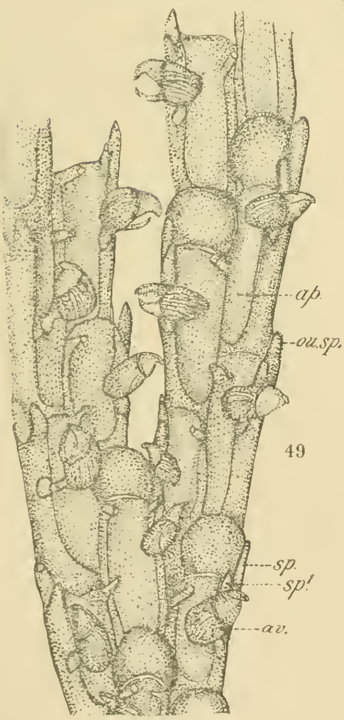

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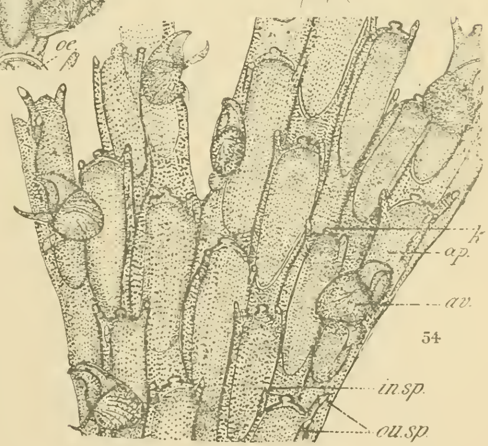

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PLATE XI.

Fig. 55.—*B. pugeti.* A few zoœcia of lower part of a branch enlarged to show the embryo (*emb.*) in the upper part of the zoœcium, and the brown body (*b. b.*) in each zoœcium containing an embryo; a regenerating polypide (*re. pd.*) in one zoœcium. × 30.

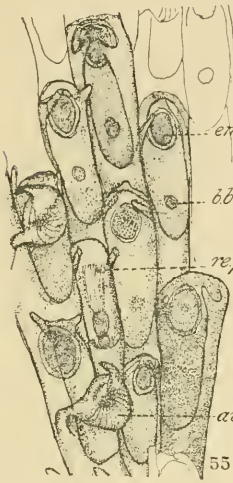
Fig. 56.—*Bugula curvirostrata* sp. nov. Habit sketch, about natural size.

Fig. 57.—*B. curvirostrata.* Portion of a branch enlarged to show zoœcia and the two sorts of avicularia (*av.* and *av'.*). × 30.

Fig. 58.—*B. curvirostrata.* Portion of a branch showing three zoœcia with oœcia (*oc.*). × 30.

Fig. 59.—*Bugula longirostrata* sp. nov. Habit sketch, about natural size.

Fig. 60.—*B. longirostrata.* Portion of a branch showing attenuation of zoœcia, and avicularia (*av.*), and the shallowness of the oœcia (*oc.*) which only partially cover the embryos (*emb.*). × 50.



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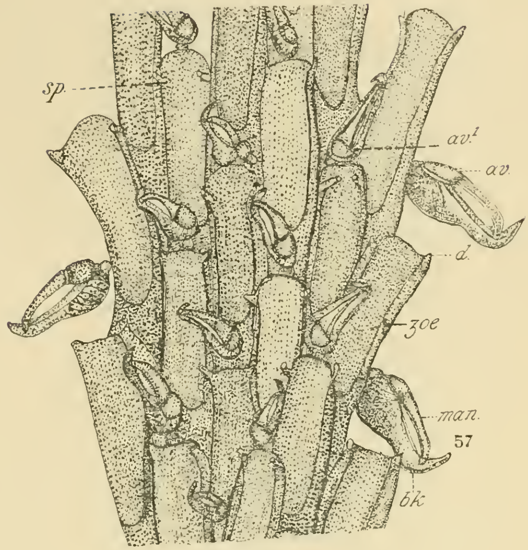

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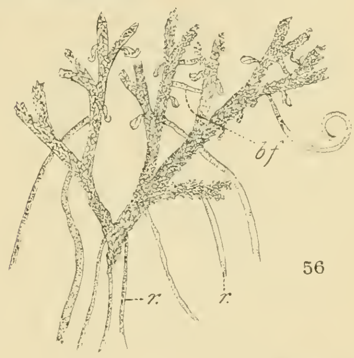

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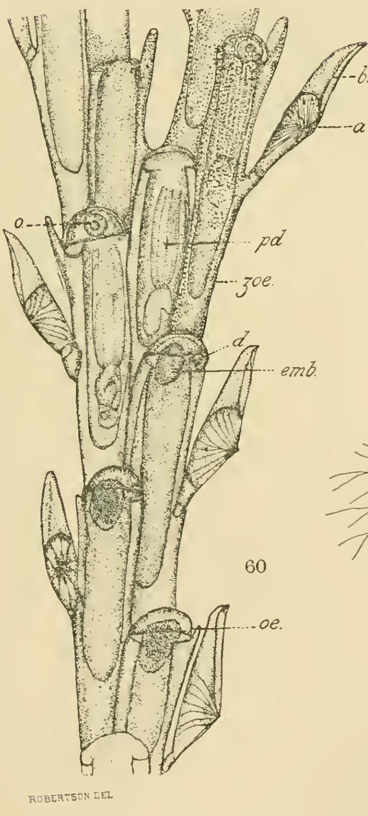

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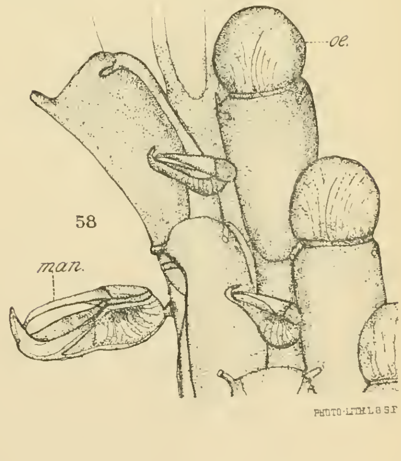

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PLATE XII.

Fig. 61.—*Bugula laxa* sp. nov. Habit sketch.

Fig. 62.—*B. laxa.* Portion of a branch enlarged showing form of zoœcia, marginal spines (*sp.*) and oœcia (*oc.*). × 50.

Fig. 63.—*Beania mirabilis* Johnston. Habit sketch.

Fig. 64.—*B. mirabilis.* A few zoœcia enlarged to show mode of connection (*con. t.*), the erect and decumbent portions, the former with margins armed with spines. × 50.

Fig. 65.—*Beania longispinosa* sp. nov. Habit sketch.

Fig. 66.—*B. longispinosa.* Portion of a colony enlarged to show character of zoœcia, spines, and the oœcia (*oc.*). × 30.

Fig. 67.—*Stirparia ciliata* sp. nov. Habit sketch.

Fig. 68.—*S. ciliata.* Portion of the stalk enlarged showing segmentation (*seg.*), also the beginning of the zoœcial branches (*zœ. br.*). × 50.

Fig. 69.—*S. ciliata.* Lower segment of stalk. × 50.

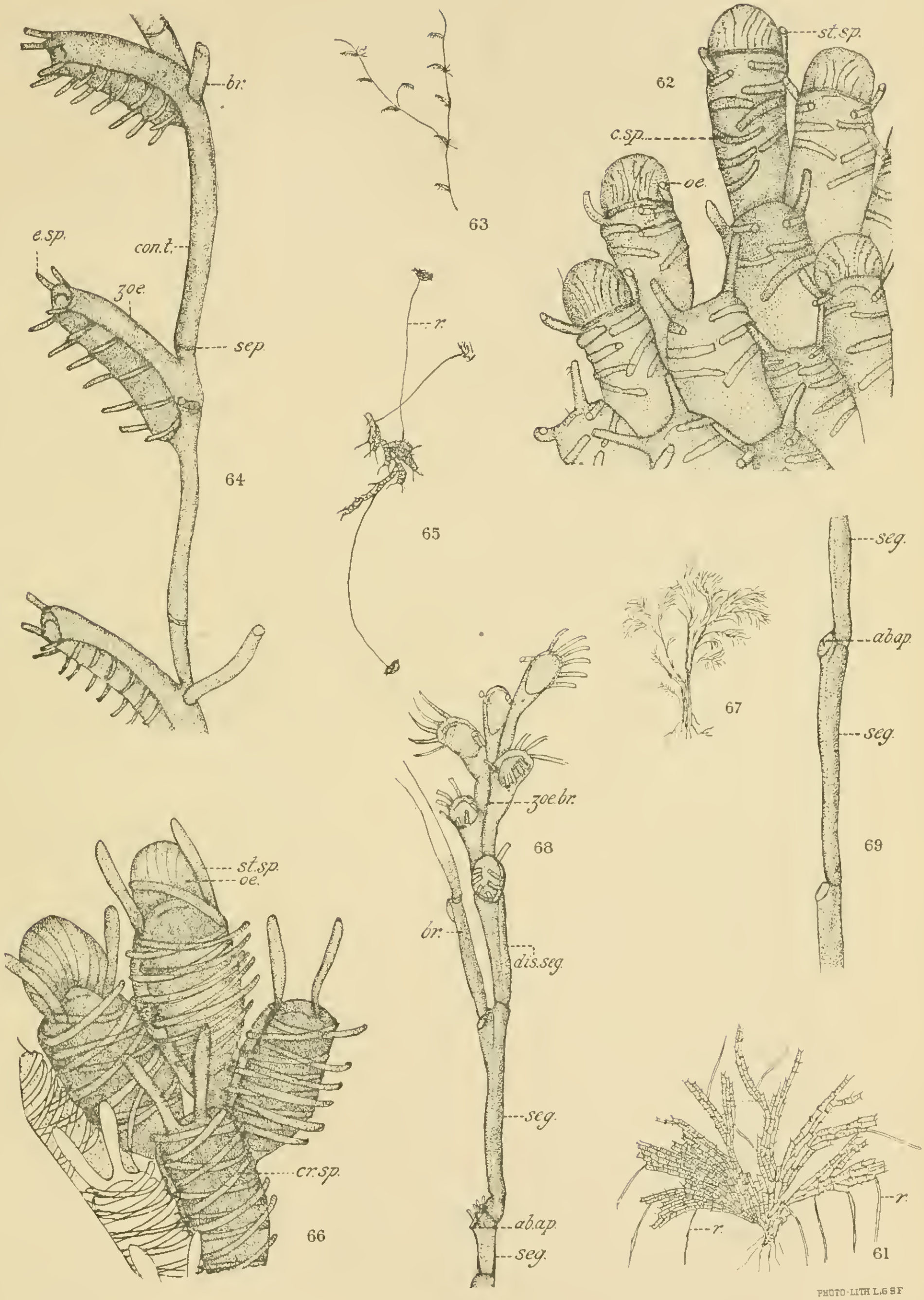

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PLATE XIII.

Fig. 70.—*S. ciliata.* Portion of zoœcial branch enlarged to show shape and arrangement of the zoœcia (*zœ.*), the curved marginal spines (*c. sp.*), and the minute avicularia. × 50.

Fig. 71.—*S. ciliata.* A few zoœcia enlarged to show pedunculate oœcia (*oc.*). × 50.

Fig. 72.—*Stirparia occidentalis* sp. nov. Habit sketch, natural size.

Fig. 73.—*S. occidentalis.* Upper portion of the stalk and a few of the lower zoœcia, showing a specialization of the segments (*seg.*) of the stalk, their articulation (*art.*), and the sudden transition into zoœcia where the zoœcial tufts begin (*fst. zœ.*). × 50.

Fig. 74.—*S. occidentalis.* Portion of a branch to show character of zoœcia (*zœ.*), of avicularia (*av.*), spines (*sp.*), and oœcia (*oc.*). × 50.

Fig. 75.—*Stirparia californica* sp. nov. Habit sketch, natural size.

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PLATE XIV.

Fig. 76.—*Stirparia occidentalis,* sp. nov. One of the lower segments of the stalk drawn to the same scale as fig. 73, Pl. XIII, to show difference in length of segments in the upper and lower parts of the stalk. × 50.

Fig. 77.—*Stirparia californica* sp. nov. Portion of the stalk enlarged to show mode of attachment of single stalk to substratum by means of a foot disk. × 50.

Fig. 78.—*S. californica.* One of the longer segments of the stalk enlarged to the same scale as fig. 76. × 50.

Fig. 79.—*S. californica.* One of the shorter segments of the stalk enlarged to the same scale as the preceding figure. × 50.

Fig. 80.—*S. californica.* Portion of a branch enlarged showing Bugulan character of the zoœcia, position of avicularia (*av.*), and the Bicellarian like oœcia (*oc.*). × 50.

Fig. 81.—*Corynoporella spinosa,* sp. nov. Habit sketch.

Fig. 82.—*C. spinosa.* A few zoœcia enlarged showing method of branching, position of avicularia (*av.*), of spines (*sp.*), and rootlets (*r.*). × 50.

Fig. 83.—*C. spinosa.* A single zoœcium with oœcium (*oc.*). × 50.

Fig. 84.—*Synnotum aviculare* Pieper. Habit sketch.

Fig. 85.—*S. aviculare.* Portion of branch enlarged showing character of zoœcia, root fibres (*r.*), of sessile (*s. av.*), and pedunculate avicularia (*ped. av.*). × 50.

Fig. 86.—*Cellaria borealis* Busk. A few zoœcia enlarged to show their arrangement, the avicularia (*av.*) just above the operculum (*op.*) surrounded by the crenulate border (*cr. bor.*) similar to that separating the lines of zoœcia. × 50.

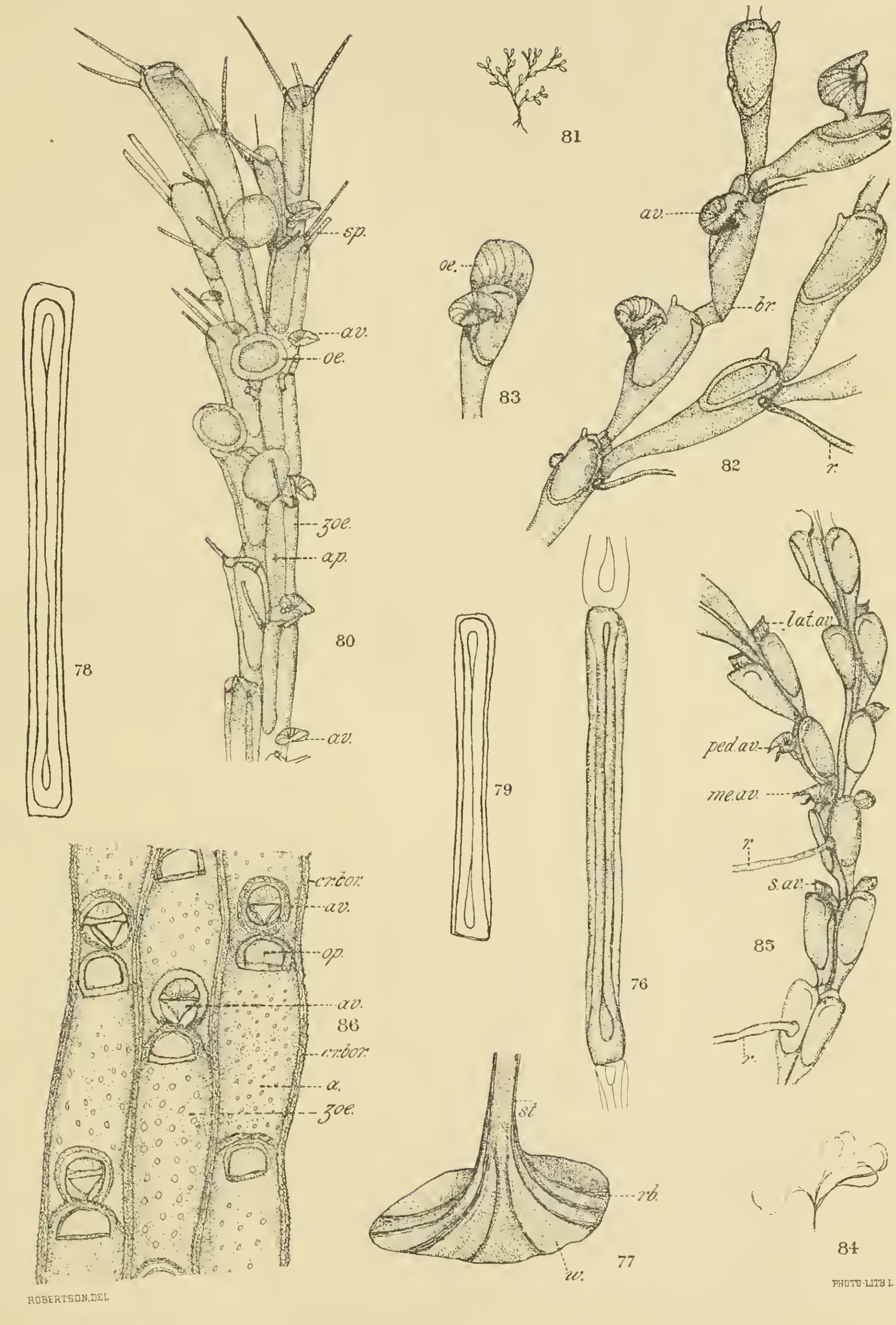

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PLATE XV.

Fig. 87.—*Cellaria mandibulata* Hincks. Two zoœcia, young stage showing lateral crenulated border (*cr. bd.*).

Fig. 88.—*C. mandibulata.* Several zoœcia at an older stage, showing operculum (*op.*) with its four denticles (*d.*), the immersed oœcia above, their orifices (*oc. or.*) only visible, and an avicularium with its large mandible (*man.*). The crenulated border (*cr. bor.*) has formed above and below the zoœcia, thus surrounding them. × 50.

Fig. 89.—*C. mandibulata.* Three zoœcia at a still older stage to show increase of calcareous wall and final form of oœcial orifice (*oe. or.*) resembling a small avicularium. × 50.

Fig. 90.—*Cellaria diffusa* sp. nov. A few zoœcia (*zœ.*) to show shape, oœcial orifice (*oc. or.*) with the lower margin developed into a mucro (*m.*), and the avicularia (*av.*). × 50.

Fig. 91.—*Flustra lichenoides* Robertson. A few zoœcia enlarged to show erect spines (*e. sp.*), operculum (*op.*), and oœcia (*oc.*). × 50.

Fig. 92.—*F. lichenoides.* The dorsal surface of a few zoœcia showing root fibres springing from the distal angle of each zoœcium.

Fig. 93.—*Flustra membranaceo-truncata* Smitt. Habit sketch.

Fig. 94.—*F. membranaceo-truncata.* A few zoœcia showing arrangement, immersed oœcia (*oc.*), and avicularium of simple structure in place of zoœcium (*av.*). × 50.

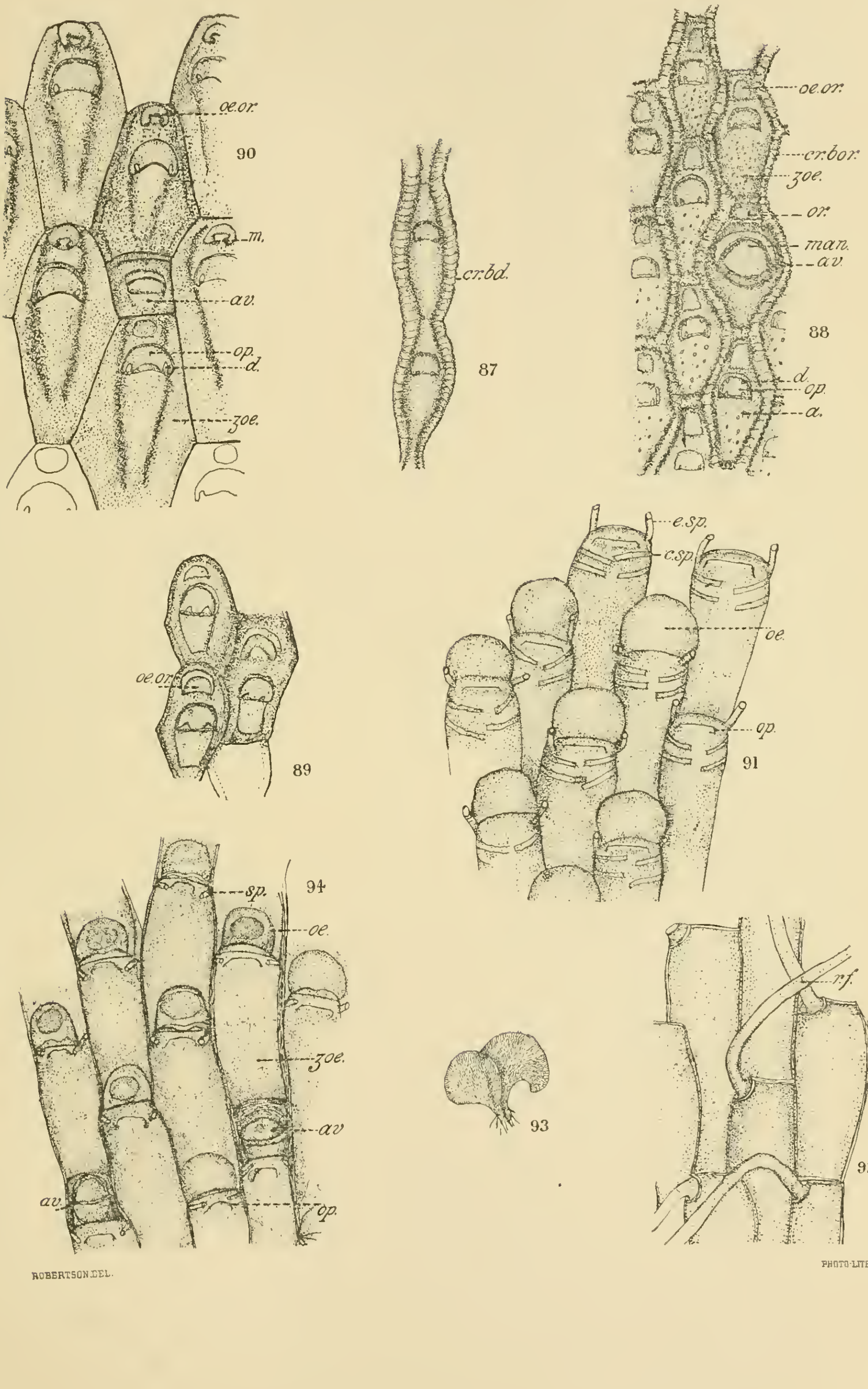

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PLATE XVI.

Photographs to show habit of growth.

Fig. 95.—*Scrupocellaria varians* Hincks.

Fig. 96.—*Scrupocellaria diegensis* Robertson.

Fig. 97.—*Bugula neritina* (Linnæus) Oken.

Fig. 98.—*Bugula murrayana* Johnston. Specimen from Orca, Alaska.

Fig. 99.—*Bugula murrayana* Johnston. Specimen from Puget Sound.

Fig. 100.—*Bugula californica* Robertson.

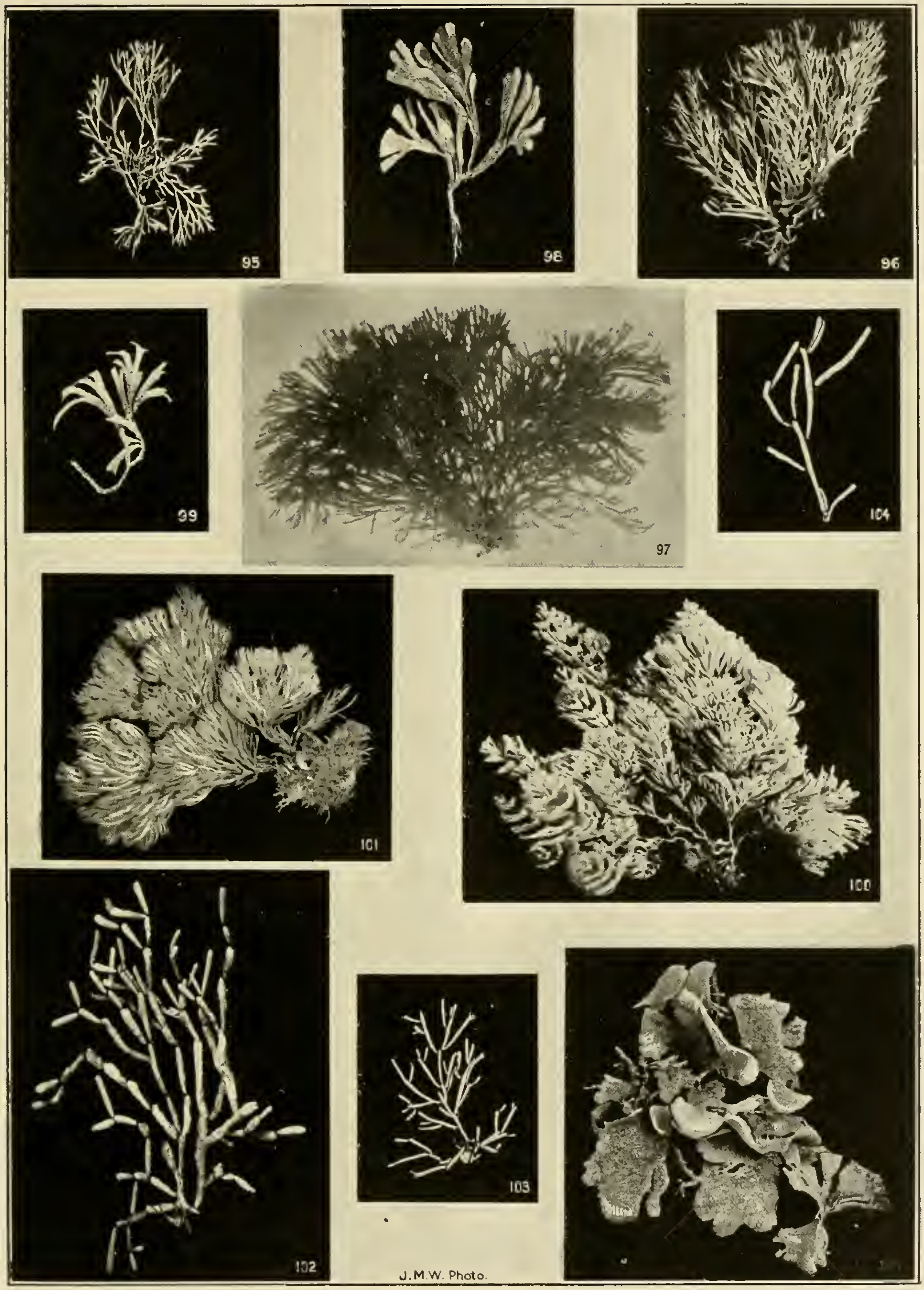
Fig. 101.—*Bugula pacifica* Robertson.

Fig. 102.—*Cellaria borealis* (Busk) Hincks.

Fig. 103.—*Cellaria mandibulata* Hincks.

Fig. 104.—*Cellaria diffusa* Robertson.

Fig. 105.—*Flustra lichenoides* Robertson.



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Vol. 2, Nos. 6 and 7, pp. 323-340 December 13, 1905

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VI

DIFFERENTIATION IN HYDROID COLONIES AND THE PROBLEM OF SENESCENCE

VII

THE BEHAVIOR OF CORYMORPHA

BY

HARRY BEAL TORREY

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VI.

DIFFERENTIATION IN HYDROID COLONIES AND THE PROBLEM OF SENESCENCE.

BY

HARRY BEAL TORREY.

An examination of Pacific Coast hydroids during the past few years (*vid.* Torrey, :02, :04) has convinced me that many if not all species change their structural type with age. Stems straight proximally may become sinuous distally. Branches which alternate during the early stages of colonial development may later originate in pairs. Length and annulation of hydrothecal pedicels, size, proportions and ornamentation of hydrothecae may similarly vary with the distance from the base of stem or branch. One hydroid in particular exhibited marked changes in structure with the growth of the colony and appeared to be especially favorable material for the investigation of certain questions of differentiation.

This species was described some months ago as *Clytia bakeri*[1] (Torrey, :04, p. 16). The stems, usually unbranched, rise from a creeping hydrorhiza to the height of 20 or 30 mm. For a few millimeters (2 to 5) each stem is free of polyps and is completely annulated. The annuli, short at the base, increase gradually in length until they become, at the first hydranth pedicel,

[1] The Hydroids of the San Diego Region. Univ. Cal. Publ. Zoology, II, No. 1, 1904.

two to four times as long as broad. They ultimately grade into the internodal segments of the stem, each giving rise at its distal end to one hydrothecal pedicel. The pedicels themselves vary in length and annulation from the base of the stem toward the tip. The first pedicel may exhibit 4 to 7 annuli. The last hydrotheca may possess no pedicel at all, or one of but a single annulus. The number to a pedicel varies with much general uniformity from one of these extremes to the other.

From base to tip, then, each stem presents two main serial changes. (1) Below the hydranth region, the cauline annuli grow progressively longer. (2) Within the hydranth region, the number of annuli to a pedicel progressively decreases. There is a strong suggestion in these facts that they depend on changes in the internal physiological conditions of growth. Since polyps are readily regenerated where stems are sectioned, a method at once presents itself for determining the differentiation at a given level of the stem at a given time.

The question to answer which the investigation was first undertaken was: Will the stem at a given level tend to regenerate the structural type which it originally produced there; or will it produce instead, a structural type characteristic of another region? For example, will a cut through the portion of the stem where each hydrothecal pedicel has five annuli initiate the regeneration of a pedicel with five or with one annulus, the number characteristic of the distal region?

The facts obtained from the experiments fall into three categories, according as the regeneration followed (1) a cut through the distal portion of the stem, (2) a cut through the middle portion, (3) heteromorphically from the cut basal end.

In all, 16 operations were performed. Of these, 7 were unsuccessful. Among the remaining 9, the cut in 5 had been made through the distal region, 3 through the middle region, and 6 had regenerated heteromorphic stalks. The small number of cases involved is offset by the clearness of the results.

The record of experiments in the first category is as follows:

I.—July 26, No. 2. Stem with 24 hydranths and terminal bud. Enumerating from base to tip,

Pedicels 1, 2 with 3 annuli
Pedicels 3–8 with 4 annuli
Pedicels 9–11 with 3 annuli
Pedicels 13–17 with 1 annulus
Pedicel 18 with 0 annuli
Pedicel 23 with 0 annuli
Pedicel 24 with 1 annulus

10 a.m. Cut off terminal bud, 24, 23, and part of 22.

July 28, 10 a.m. New hydranth No. 22 regenerated within old cup, on a short stalk from which hydrotheca is separated by a single constriction and is therefore sessile.

Result: regeneration is according to the local, not the basal structural type.

II.—July 26, No. 3. Stem with 17 hydranths and terminal bud.

Pedicel 1 with 3 annuli
Pedicel 2 with 3 annuli
Pedicel 3 with 4 annuli
Pedicel 7 with 1 annulus
Pedicel 9 with 1 annulus
Pedicel 11 with 0 annuli
Pedicel 13 with 0 annuli
Pedicel 15 with 0 annuli
Pedicel 17 with not even nodal constriction

12 m. Removed terminal bud, 17, 16, and part of 15.

July 27, 9:15 a.m. No. 16 has regenerated as a bud on short stalk; no constriction whatever between latter and hydrotheca (fig. 1). Though there are two cut surfaces, but one bud has been formed, in place of the originally proximal individual. No. 16 developed later into a hydranth, the skeleton remaining in the same condition except for a slight general thickening.

Result: regeneration is according to the local, not the basal structural type.

III.—August 5, No. 4. Stem with 15 hydranths and terminal bud.

Pedicels 1–4 with 2 annuli
Pedicels 5–11 with 1 annulus
Pedicel 12 with 0 annuli
Pedicel 13 with 3 annuli
Pedicels 14–15 with 1 annulus
Pedicel 16 with 0 annuli

8:45 a.m. Removed terminal bud, 15, 14, and 13.

August 7, 9:45 a.m. Nos. 13 and 14 have regenerated, each with a single annulus in the pedicel.

August 8, 2 p.m. Stem segment with bud of 15 has appeared; single annulus below hydrotheca.

Result: all the regenerated parts accord with the structural type characteristic of the distal region (fig. 2).

IV.—August 5, No. 5. Stem with 17 hydranths.

Pedicel 1 with 8 annuli
Pedicel 2 with 6 annuli
Pedicel 3 with 4 annuli
Pedicel 4 with 3 annuli
Pedicel 5 with 2 annuli
Pedicel 6 with 4 annuli
Pedicel 7 with 3 annuli
Pedicels 8–9 with 2 annuli
Pedicels 10–11 with 3 annuli
Pedicels 12–15 with 2 annuli
Pedicel 16 with 1 annulus
Pedicel 17 with 0 annuli

8:50 a.m. Removed 17 and 16.

August 11. No. 16 has regenerated. Pedicel with 1 (possibly 2) annulus and 16–18 tentacles.

Result: this stem was somewhat irregular with regard to the number of annuli in successive pedicels. The regenerated pedicel, however, corresponds with the local structural type.

V.—August 5. No. 6. Stem with 13 hydranths and terminal bud.

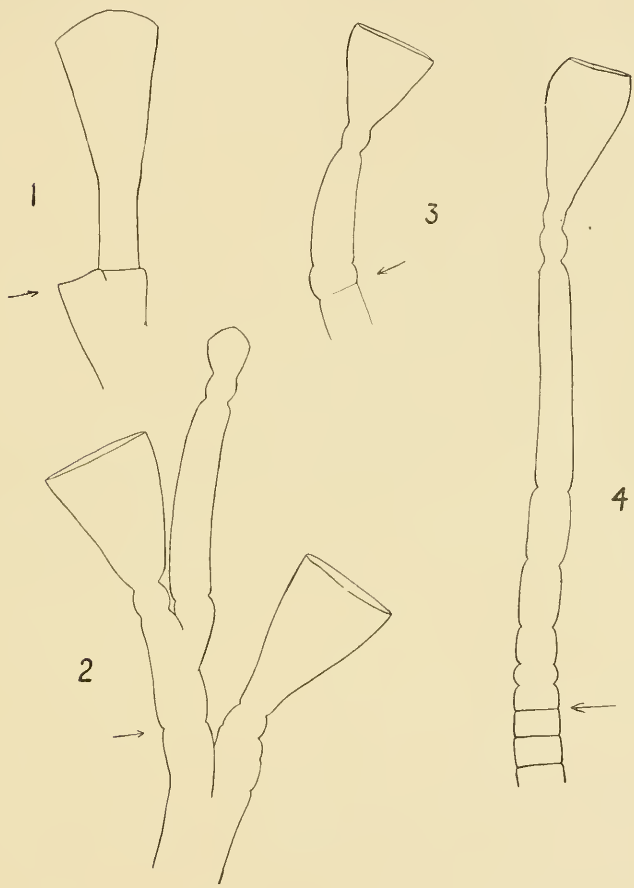
Pedicel 1 with 6 annuli
Pedicel 2 with 4 annuli
Pedicel 3 with 5 annuli
Pedicel 4 with 4 annuli
Pedicel 5 with 3 annuli
Pedicel 6 with 4 annuli
Pedicel 7 with 3 annuli
Pedicel 8 with 1 annulus
Pedicel 9 with 3 annuli
Pedicel 10 with 2 annuli
Pedicels 11–14 with 1 annulus

8:55 a.m. Removed terminal bud, 13 and 12.

August 8. Nos. 12 and 13 regenerated, each with 1 annulus in pedicel.

Result: regeneration according to the local, not the basal structural type.

Further experiments of this sort are unnecessary to show con-



Figs. 1, 2. Normal regeneration from distal wound.

Fig. 3. Normal regeneration from middle region of stem.

Fig. 4. Heteromorphic regeneration from base of stem.

The arrow indicates in each case the level of the cut.

clusively that, under the conditions of the experiments[1] regeneration from cuts through the distal region of the stem produces structures of the local, *i.e.*, *distal* type.

Experiments belonging to the second category; cuts made through the middle region of the stem.

I.—August 5, No. 8. Stem with 17 hydranths and terminal bud.

Pedicel 1 with 5 annuli
Pedicels 2–5 with 4 annuli
Pedicel 6 with 6 annuli
Pedicel 7 with 3 annuli
Pedicel 8 with 5 annuli
Pedicel 9 with 2 annuli
Pedicel 10 with 4 annuli
Pedicel 11 with 1 annulus
Pedicel 12 with 2 annuli
Pedicel 13 with 1 annulus
Pedicel 14 with 3 annuli
Pedicel 15 with 1 annulus
Pedicel 16 with 2 annuli
Pedicel 17 with 1 annulus
Pedicel 18 with 1 annulus

10 a.m. Cut stem between 6 and 7.

August 8, 3:30 p.m. No. 7 has regenerated without annuli immediately below the hydrotheca.

Result: regeneration according to the *distal, not the local* type.

II.—August 5, No. 9. Stem with 17 hydranths.

Pedicel 1 with 5 annuli
Pedicels 2–3 with 4 annuli
Pedicel 4 with 7 annuli
Pedicels 5–6 with 4 annuli
Pedicels 7–9 with 3 annuli
Pedicels 10–11 with 2 annuli
Pedicel 12 with 3 annuli
Pedicel 13–17 with 1 annulus

11 a.m. Cut stem between 4 and 5.

[1] The stems under observation were removed from the hydrorhiza and rested on the bottom of flat glass dishes containing about 300 c.c. of sea-water. None of the colonies took food during the course of the experiment beyond what they could get from the original supply of water, which was not changed. There is no reason to suppose that the results depend upon the conditions to which the stems were subjected, for several observations of regeneration in nature indicated that results are essentially similar in the two cases.

August 8, 9:45 a.m. Hydrotheca of No. 5 with 1 annulus immediately below it, supported on a segment of stem with an annulus next the cut (fig. 3).

Result: regeneration according to the *distal, not the local* type.

III.—August 5, No. 10. Stem with 20 hydranths and terminal bud.

Pedicel 1 with 5 annuli
Pedicel 2 with 0 annuli
Pedicel 3 with 0 annuli
Pedicel 4 with 7 annuli
Pedicel 5 with 5 annuli
Pedicel 6 with 7 annuli
Pedicels 7–9 with 3 annuli
Pedicels 10–21 with 1 annulus

11:10 a.m. Cut stem between 6 and 7.

August 7, 10:30 a.m. No. 7 has regenerated in a manner practically identical with that of the preceding experiment.

Result: regeneration according to the distal, not the local type.

The three cases in the second category seem to show that the mid regions of the stems no longer possess the capacity to produce the type of structure originally arising there, but that they do produce a type of structure peculiar to the *latest formed* portion of the stem. During their growth, the stems appear to have changed their character throughout their length.

The facts belonging to the third category concern the cases of heteromorphosis from the proximal cut end of the stem.

I.—August 5, No. 4 (see above).

August 8, 10 a.m. Heteromorphic stem.

August 11. Heteromorphic stem with terminal hydranth. Immediately below the hydrotheca are 3 annuli. The rest of the stem is similar in all respects to the heteromorphic stem in fig. 4.

II.—August 5, No. 8 (see above).

August 11. Heteromorphic stem similar in all respects to preceding (I), with the exception that development had stopped before a hydranth had appeared.

III.—August 5, No. 7. Stem with 11 hydranths and terminal bud.

Pedicels 1–2 with 6 annuli
Pedicel 3 with 2 annuli
Pedicel 4 with 5 annuli
Pedicel 5 with 3 annuli
Pedicel 6 with 1 annulus
Pedicel 7 with 2 annuli
Pedicels 8–11 with 1 annulus

August 8, 3:30 p.m. Heteromorphic stem with three annular basal segments, a long intermediate segment and one annulus immediately below the terminal bud.

IV.—August 5, No. 10 (see above).

August 8, 4:30 p.m. Heteromorphic stem differing but slightly from preceding (III), surmounted by a hydrotheca (fig. 4).

Latter small, and diaphragm not apparent. Hydranth attached to wall by a number of amoeboid strands which are common along the stem but are seldom met with in hydrotheca.

V.—August 5, No. 9 (see above).

August 8, 4:15 p.m. Heteromorphic stem with 3 basal annuli, a long stem segment and a poorly defined annulus immediately below the hydrotheca. Shoulder process on side of long stem segment carrying growing stalk of normal type.

VI.—August 5, No. 5 (see above).

August 11. Heteromorphic shoot with terminal hydrotheca. Three basal annuli and a very long non-annulated stem segment which passes directly into the hydrotheca, without an intervening constriction or annulus.

Disregarding for a moment the stalk, the number of annuli occurring immediately below the hydrotheca is typical of the latest formed (distal) region of the normal stem in 4 of the above 6 cases. In the other 2 cases, the number is larger than the typical distal number on the same stem but is smaller than the proximal number on one of the stems (II). It exceeds the proximal number on the other stem which, however, is exceptionally small (I). The tendency to develop according to the distal type is therefore conspicuous so far as the pedicels are concerned.

With respect to the stalks, it may be said that they begin always with one or two short segments characteristic of the earliest formed portion of the normal stem. These segments may even be shorter than the parent segment next the wound. It would seem that in this particular the regenerating stem develops according to the embryonic type. But the duration of this type of development is so short, lasting through the formation of one or two segments only, that it closely resembles what has already been seen in the figures of regular regenerations in the lower regions of the hydranth-bearing zone, *viz.,* that the new structures are almost invariably initiated by the formation of an annulus or part of one.

General considerations. In seeking an explanation which shall simplify as well as summarize the results presented in the foregoing paragraphs, I think we must pass by any hypothesis which rests solely upon a basis of morphological determinants. That regeneration at a given level may not reproduce the structural type characteristic of that level, while it does reproduce the type characteristic of a later level of the stem is a fact that is hardly simplified by the assumption of a residual germ plasm.

So, too, does it seem improbable that the structural type is the result of a functional balance between an organism possessing an unmodified regenerative capacity and the conditions surrounding it. This view would necessitate a change in the environment between the time a polyp first appears and the time it is regenerated in a somewhat different form. But no such change is evident. The polyps half way up a stem were subjected during their development to external conditions essentially identical with those which surrounded the developing individuals distal to yet differing from them.

The facts, however, appear to give strong support to the view that the stem, instead of retaining unmodified its regenerative capacity, actually loses with age its ability to produce structures which formerly characterized it; and that this is owing to a modification of conditions *within* the organism, which govern its behavior without being necessarily a part of it. These conditions are probably chemical in nature, intimately concerned with the metabolism. A destruction or addition of substance or substances in the course of the development is readily conceivable as the efficient cause of the structural modification. The relation between internal and external conditions is under consideration.

The resemblance of the phenomena of colonial differentiation in *C. bakeri* to the phenomena of senescence is so strong as to suggest a similar interpretation for both.

The experiments will be continued.

September 1, 1905.

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CONTRIBUTIONS FROM THE LABORATORY

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MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO.

VII.

THE BEHAVIOR OF CORYMORPHA.

BY

HARRY BEAL TORREY.

In a former paper (:04),[1] it was shown that *Corymorpha* possesses an unusually wide range of activities for a hydroid. It responds to mechanical and thermal stimuli, to chemical stimuli that produce their effect as mechanical irritants, not as odorous substances, and to gravity. In the movements of the stem, it resembles such naked forms as *Hydra, Clava* and *Hydractinia.* The stem is everywhere sensitive to mechanical stimuli, bending from side to side or shortening under their influence. Such reactions are due to the contractions of longitudinal muscle fibers which are situated in the usual fashion deep in the ectoderm. A lengthening of the stem may be caused wholly or in part by the circular endodermal musculature.

The long proximal tentacles, about twenty-four in number, may respond singly to direct mechanical stimulation or to a stimulus applied either to another tentacle or a distant portion of the stem. In all cases of effective stimulation, direct or indirect, they bend invariably toward, never away from the mouth. The reaction is rapid; the recovery, which ends in the resumption of the expanded condition, is slow.

The initial reaction of the distal tentacles to all effective stimuli is, on the other hand, always away from the mouth;

[1] Biological Studies on Corymorpha. I. C. palma and Environment. Jour. Exp. Zoology. I, No. 3, 1904.

after which, strong irregular movements toward and away from the mouth appear. The proboscis, which carries the distal tentacles to the number of about fifty in a crown around its summit, may react to mechanical stimuli, directly or indirectly applied, by bending in the direction of the stimulus.

These reactions of tentacles and proboscis constitute an efficient prehensile mechanism. A small object which happens to stimulate a proximal tentacle on its oral side is at once swept toward the mouth. The distal tentacles, which may be carried toward it by the bending of the proboscis, then move outward, meeting and transporting it by a subsequent inward movement to the mouth.

All the motions thus far described are due to muscular contractions. Locomotion is produced, as in *Hydra*, by the activities of amoeboid cells at the base of the stem. And the circulation of fluids in the coenosarcal canals is accomplished by the usual ciliary action, supplemented by the expansions and contractions of the proboscis and stem.

Aside from these types of motion, the stem exhibits a marked geotropism assuming when at rest a vertical position. This orientation does not appear to be dependent in any way upon muscular activity. The behavior not only of the stem as a whole but of pieces of one-eighth or one-tenth its length from the base or various other regions, indicates that the stem is everywhere sensitive to the stimulus of gravity and furnished with an efficient mechanism for bringing about a response. This mechanism is expressed, I believe, in the large, highly vacuolated cells of the endodermic axis which forms the core of the stem. Changes of orientation, according to this view, are produced by relative changes in the turgidity of such cells on opposites sides of the stem. Whether the orientation is to be reckoned as a contraction phenomenon, though this is probable, cannot be said definitely at this time. It is indeed a fact that the axial cells may not only decrease in size, as when the stem is shortened, but also increase in size, as when the stem is lengthened without loss in diameter.

Two conclusions which were formerly held, later experiments have shown to have been founded on data which were misleading owing to the conditions of experimentation. The first was that a change in the polarity of a region is accompanied by a change in the reactions of the axial cells in this region. The second was that, regardless of the point at which it is supported, whether proximally or distally, the stem would orient itself vertically, distal end uppermost. These results were obtained on individuals which had been kept in the laboratory during the warm days of summer for a week or ten days, and did not behave with the constancy or the precision which characterize the actions of the individuals observed last March. The latter were used for experimentation immediately upon their capture, and were kept under conditions which permitted a vigorous, healthy existence.

With regard to the first conclusion, it may be said that while such a change of polarity as heteromorphosis of the proximal end of a stem segment would be accompanied by an upturning of this end, the result would not be achieved by a change in the reactions of the axial cells in this region. The essential factor lies rather in the relation of the region in question to the substratum. In studying the regeneration of *Corymorpha,* the observation was frequently made that from pieces resting on the floor of the aquarium, cut from the distal half of a stem, U-shaped figures would be formed, fastened to the floor by the loop, the two arms extending vertically upward, each crowned with sets of developing tentacles. By the side of these heteromorphic pieces were many others fastened to the substrate by one end, which possessed an incipient holdfast, the other end developing tentacles. In both cases, the behavior of the axial cells was constant; the cells nearer the center of the earth were relatively larger than those on the other side of the stem. The proximal ends of the pieces which developed holdfasts remained lowermost merely because they were adhesive and clung to the substrate, which the distal ends could not do.

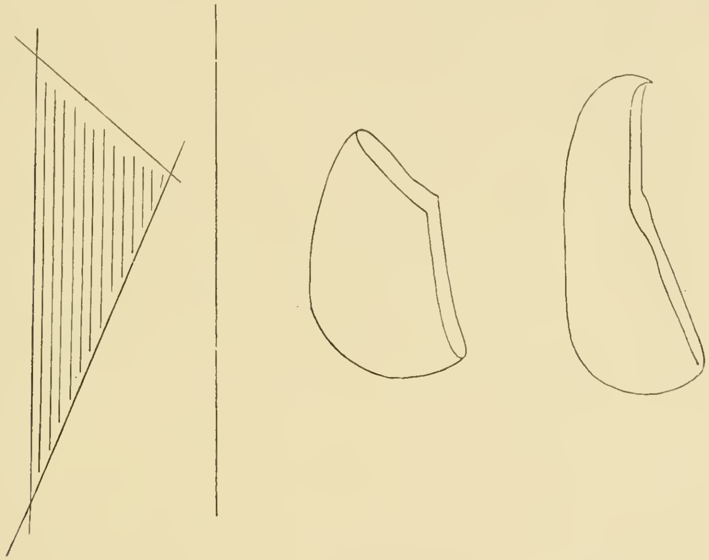
This fact appeared distinctly in the results of my recent experiments bearing directly upon the second conclusion stated above. I had found previously that when stems relieved of hydranths and the weight of sand grains adhering to the holdfasts were supported at their distal ends, they would assume the normal vertical orientation, proximal end down. Last March, the experiment was repeated many times, with special precautions against errors. Fresh animals were used, and their distal ends were fastened by a single loop to a rigid thread. The support thus afforded was secure and ample for various movements. In every case, without regard for the amount of holdfast present, the unsupported proximal end travelled *upward* and came to rest only when the stem had reached a position approximately vertical, but *upside down*.

Comparing this result with the movements of stems attached by the proximal end, either resting on or hanging from the substrate, it is obvious that no reversal of behavior in the axial cells need be assumed. The variable factor is connected with the point of support.

By the foregoing observations, *Corymorpha* seems to be removed from the category of animals for the elucidation of whose behavior none of the familiar mechanical explanations of geotropism seem to apply. Its geotropic reactions appear now to accord with the theory which Davenport formulated with reference to the geotropism of free-swimming organisms. There is a difference between the resistance encountered by the stem as it moves upward (friction plus weight) and the resistance it encounters when it moves downward (friction less weight). This difference is expressed in the stem by a tension on its upper side when it is inclined in any degree from the vertical. There is no tension on the lower side of the stem unless it be hanging downward at some angle; in which case it never equals the tension on the upper side except when the stem is vertical, its position of rest.

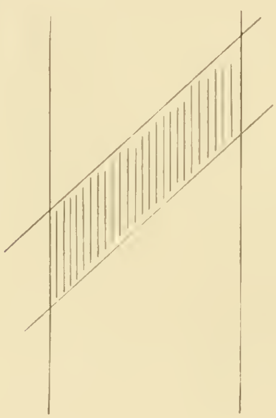
The evidence formerly presented in favor of the view that the axial endoderm cells, and not muscles, govern the geotropic orientation of the stem, has been strengthened to some extent by a further experiment. In my original experiments, cuts were made at frequent intervals half way through the stem on one side, or alternately on both sides. The stem was then laid on the floor of the aquarium, a cut side uppermost. In one to two hours, the stem had assumed an erect position. The cuts were intended to destroy the effectiveness of the muscles of the stem, leaving the column of axial endoderm cells intact. The muscles as a whole were weakened by the cuts. And the slowness of the reaction, coupled with the fact that the orientation was accomplished before the wounds closed, strengthened the view that muscles were not concerned in the reaction.

Other facts supporting the same conclusion have since been obtained. A piece was removed from a stem by two cuts which



1 *2* *3*

formed with each other an obtuse angle (fig. 1). On the cut faces, the axial endoderm was exposed. The rounded surface representing the original stem wall was still covered with ectoderm, provided with longitudinal muscles. Figs. 2 and 3 were drawn from this piece when it was in contraction and expansion respectively. It will be noticed that in the contracted condition (fig. 2), the course of the longitudinal muscle fibers is no longer straight: the angle made by the cut surfaces is greater than it was at first: there is a tension factor on the side of the stem opposite the layer of muscles which tends to draw the remotest edges of the muscle layer toward each other against the pull of the muscles themselves. In the expanded condition (fig. 3), though the piece lengthens, it bends strongly toward the cut surfaces. The latter now form an angle greater than 200 degrees. At the upper end of the figure, the tip of the piece has curled sharply over toward the wound. The tension is still more apparent here than in fig. 2. On the assumption that the axial endoderm cells have lessened their volume on the side toward the wound relatively to the volume of the axial cells on the side away from the wound, the configurations shown in figs. 2 and 3 are intelligible. The axial cells themselves did not push out between the edges of the wound but gave every indication of being under restraint.



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5

When long, thin, oblique slices are cut from a stem as in fig. 4, it follows inevitably that the narrow wedge-shaped ends curl toward the cut surface, as in fig. 5. The relatively decreased turgidity of the axial cells next the wound appears to account for this condition also.

In the light of these facts, it becomes clear that the axial endoderm cells under certain conditions are capable, by changing their turgidity, of producing movements in the stem comparable with those which are due to stimulation by gravity, though the evidence does not demonstrate that gravity itself affects them, directly or indirectly. But they are active, not passive elements, which increases the probability that they may be concerned in the geotropic response.

If it be true, as seems probable, that the axial cells do govern the geotropic response, *Corymorpha* stands alone among the metazoa in possessing a tropic mechanism distinct from the body musculature. In a recent paper, Holmes (:05) has shown that *Ranatra* exhibits uncommonly clear cut reactions to light. Here the tropic mechanism involves the same sense organ, the same musculature and to some extent at least the same nervous elements which serve in responses to other classes of stimuli, internal and external. Though *Ranatra* is an unusually favorable object for the analysis of the tropic mechanism, the confusion of various factors operating over the same lines renders an adequate analysis impossible at present. The presence of a geotropic mechanism distinct from the musculature in *Corymorpha* simplifies the problem. And I am led to believe, further, that the simply organized nervous system of the hydroid need play no part in the geotropic reaction. The axial endoderm cells probably change their volume under a given tension which is applied directly to them. Each cell may be considered a unit, not necessarily dependent in its actions upon its neighbors, acting with them only in so far as they may be subjected simultaneously to similar stimulation.

The response of *Corymorpha* to gravity is strikingly similar to the negative geotropism of the caulicles of plant seedlings, which is unquestionably dependent upon volume changes in the stem cells. The latter are again strikingly similar in structure to the axial cells of *Corymorpha*. There appears to be in the hydroid mechanism no more opportunity for a pleasure-pain type of reaction than among the plants; and there is no sign of it in the geotropic movements of the stem. Neither are there signs of trials and errors. The movement of the stem is very gradual, very definite, very direct. I know of no animal which more closely approximates the plant in structure and tropic response. If the behavior of the one be explicable on the basis of direct reactions to stimuli, of the reflex type, I do not see how the behavior of the other can be excluded from a similar interpretation.

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CONTRIBUTIONS FROM THE LABORATORY
OF THE
MARINE BIOLOGICAL ASSOCIATION OF SAN DIEGO

VIII

DINOFLAGELLATA OF THE SAN DIEGO REGION.—I. ON HETERODINIUM, A NEW GENUS OF THE PERIDINIDAE

BY

CHARLES ATWOOD KOFOID

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VIII.

DINOFLAGELLATA OF THE SAN DIEGO REGION.—I. ON HETERODINIUM, A NEW GENUS OF THE PERIDINIDAE

BY

CHARLES ATWOOD KOFOID.

The investigations of the plankton of the Pacific at the San Diego Station during the past three years has brought to light a number of species belonging to the family Peridinidae which do not conform to any known genus. They all present in common a number of characters which call for the establishment of a new genus for the reception of the several species represented.

To this genus also belong seven species described by Murray and Whitting ('99) from the tropical Atlantic as members of the genus *Peridinum* to wit: *Peridinium hindmarchii*, *P. milneri*, *P. blackmani*, *P. leiorhynchum*, *P. trirostre*, *P. tripos*, *and P. doma*. *Gonyaulax triacantha* Jörg. is also to be referred to this genus. All of these species except *P. trirostre* and *Gonyaulax triacantha* have been seen by me and a fuller discussion of their structure will appear elsewhere. In the following pages the brief discussion of each is based upon Murray and Whitting's figures.

I am indebted to Miss E. J. Rigden, assistant in the summer of 1904 at the San Diego Marine Biological Station, for some of the sketches utilized in the plates accompanying this paper and also for the skill and thoroughness of her examination of the plankton which brought to light the most of the species here discussed. The types and cotypes of the species here described for the first time are in the collections of the University of California.

Heterodinium gen. nov.

The form of the theca resembles that of *Peridinium* in the presence of a median or somewhat postmedian girdle which encircles the theca at its greatest diameter and in two antapical horns, always directed posteriorly or nearly so. The posterior margin or list of the transverse furrow is suppressed or feebly developed in comparison with the anterior one, especially at its distal end, while the anterior one, as if in compensation, is often excessively developed. The suture lines are demonstrated with great difficulty and some uncertainty in most of the species. The plates are as follows: three apicals, one left intercalary, six premedians, seven postmedians, one furrow plate, and three (?) antapicals, as shown in the accompanying text figures.

On the ventral face about midway between the apical and flagellar pores is a small pit or pore-like area in the mid ventral suture. An actual opening in this area has not been demonstrated. In the suppression of the posterior border of the girdle, in the number and arrangement of the plates and in the presence of the ventral pit on the epitheca *Heterodinium* differs from *Peridinium*, although in form and general appearance species of the two genera strongly resemble each other.

In some species and possibly generally in the genus there is a decided asymmetry to the theca brought about by a torsion of the body on the main axis in clockwise direction, looking from the posterior toward the anterior end. This is especially noticeable in the scoop-shaped forms such as *H. scrippsi.*

DETAILED DESCRIPTION.

The following is a more detailed description of the characters found in the genus. The theca is expanded in the equatorial region, with more or less well marked dorso-ventral flattening and ventral excavation near the flagellar pore. It is spheroidal, ellipsoidal, elongated, rotund, flattened, or even scoop-shaped. The length always exceeds either diameter, and the transdiameter at the girdle equals and more often exceeds the dorso-ventral one. The greatest transdiameter is usually at the girdle but in some species the epitheca or hypotheca may exhibit a slightly greater diameter. The greatest dorso-ventral diameter is at the left of the flagellar pore.

The epitheca is usually not contracted to an apical horn though in some species a short horn is present, and in others the elongated epitheca tapers gradually from the girdle to the apical pore with more or less concavity of the lateral margins. The anterior end of the epitheca is more often broadly rounded, being dome-shaped in the rotund species and like the end of an ellipsoid or even scoop-shaped in the flattened species. In some instances, as in *H. blackmani*, the epitheca is rotund at the girdle but flattened distally. The altitude of the epitheca is usually less than the transdiameter and exceeds it in only a few cases as in *H. blackmani* and *H. hindmarchi*.

The ventral face of the epitheca is flattened and somewhat excavated, slightly in rotund species, more deeply and extensively even to the lateral margins in the dorso-ventrally compressed forms. The mid ventral face is marked by the slightly sinuous suture ridge which runs from the flagellar pore to the apex and bears midway a pit or pore-like area, a characteristic structure in the genus. This varies greatly in distinctness and in the breadth of the widened smooth suture ridge in which it is placed. The apical pore is inclined, even as much as 10° in some species, to the right and is usually well defined though rarely protuberant.

The hypotheca is usually subequal to the epitheca, being longer in *H. milneri* and *H. sphaeroideum*, and shorter in *H. blackmani*. The posterior end may or may not show a bifurcation into antapical horns. It may be broadly rounded, dome-shaped and without any antapical differentiations as in *H. sphaeroideum* and *H. doma*, with mere spinules with or without lists as in *H. milneri* and *H. murrayi*, with slight median bifurcation as in *H. whittingae* or with typical elongated antapicals as in *H. blackmani.* In the form of hypotheca *Heterodinium* thus exhibits a development parallel to that found in the allied genus *Peridinium.* The ventral face of the hypotheca is channeled by the longitudinal furrow plate which in many species extends anteriorly so that it indents the epitheca above the flagellar pore.

The girdle is usually submedian in position, though premedian in some species as for example in *H. milneri,* or postmedian in others as in *H. scrippsi.* The girdle is much more oblique in the flattened than in the rotund forms. In *H. whittingae* its plane is inclined ventro-posteriorly at an angle of 45° to the axis. The girdle in all species thus far observed forms a descending right spiral with a displacement accelerated distally and amounting to 1–3 times the width of the furrow. The most characteristic feature of the girdle is its incompleteness distally and the absence or slight development of the posterior ridge. The furrow is bounded anteriorly by a heavy overhanging ridge which in species thus far observed is not a ribbed fin or list but a heavy projection of the thecal wall. The posterior border is formed by a less salient ridge which becomes less prominent distally and often diverges more widely from the anterior ridge towards its distal end . The feature of a more or less deficient posterior margin of the girdle is a constant character in all species thus far observed save the imperfectly known *H. sphaeroideum* which has, however, the ventral plates at least (the dorsal ones are not known) of the genus.

The transverse furrow is indented in the thecal wall and the flagellar pore is found at its proximal end.

The thecal wall is made up of discrete plates, which, however, are much less easily separated and much less clearly defined than they are in other genera of the family, as for example in *Peridinium.* The sutures are marked by flattened ridges or bands or smooth tracts in which the cleavage line may be traced in some cases in young individuals. The suture bands often have a secondary reticulation of minute polygons on their surface and are best seen on a deep focus. They are differentiated on the inner as well as the outer thecal surface. The epitheca consists of ten plates (figs. A and B) arranged as follows: three apicals about the apical pore, of which one (1) is a wide dorsal plate covering the dorsal half of the anterior end, and the other two (2, 3) are ventral and are separated from each other by the mid-ventral suture which runs from the apical to the flagellar pore. Between the dorsal and the two ventral plates are lateral sutures which in subgenera *Platydinium* and *Euheterodinium* become very heavy and much more prominent than any other sutures

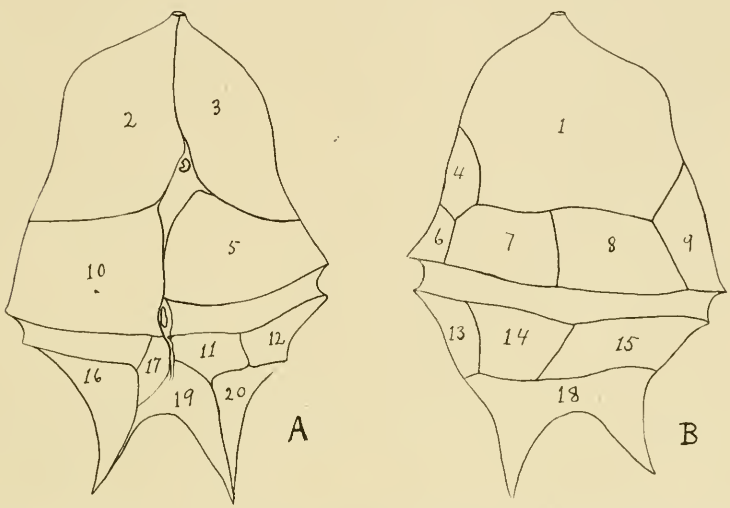

Fig. A.—Ventral view of *Heterodinium scrippsi* showing thecal plates; apicals, 1-3; premedians, 5-10; left intercalary, 4; postmedians, 11-17; antapicals, 18-20. × 450.

Fig. B.—Dorsal view of same. × 450.

of the theca. In some cases as in *H. scrippsi* and *H. blackmani* these lateral ridges are doubled, suggesting a narrow compressed plate, but in the more rotund species they are not doubled and there is no suggestion of the presence of such a plate. I therefore conclude that they are merely doubled margins and are not to be regarded as the margins of degenerate plates.

Anterior to the girdle is a premedian series (figs. A, B, 5–10) of 6 plates of which two are ventral (5, 10), two dorsal (7, 8), and one each right (9) and left (6). They are not as a rule symmetrically placed because of the considerable irregularity in their size and especially because of the disturbing effect of the left intercalary plate (4) which is found between premedians 5, 6, 7 (or 6 and 7) and apicals 1 and 3. This intercalary plate is often small and in compressed species is not easily found. It is shown clearly in *H. blackmani*, but is merely suggested or not shown at all in the rest of Murray and Whitting's ('99) species. Its demonstration in all species carefully examined by me leads me to expect it in others especially since they usually show the tilting of the apical pore to the right, the slight shoulder on the left marginal outline and the asymmetrical arrangement of the premedians which attend its presence in species in which it has been demonstrated. It is greatly reduced in size in flattened species such as *H. whittingae*, and it is certainly possible that this plate may be entirely suppressed in some of the flattened species of the subgenus *Platydinium*, though no conclusive evidence to that effect is at hand.

The ventral face of the epitheca of the flattened species is formed by the two ventral-apical plates (2, 3) and the two ventral-premedians (5, 10) but in the more rotund forms the lateral-premedians (6, 9) are partially exposed in a ventral view. The left intercalary in the flattened species is dorsal in position, but in the rotund forms as *H. murrayi* and *H. doma* it appears on the left shoulder in the ventral view, and may be shifted dorsalwards so that it does not touch the ventral premedian 5.

The girdle plate has the form of a trough-like band as in *Peridinium* and appears to be variously subdivided by reticular ridges some of which may be suture lines.

The plates of the hypotheca are less clearly defined than those of the epitheca, especially on the ventral face. There are seven postmedians (11–17) adjacent to the girdle, 3 dorsal (13–15) and 4 ventral (11, 12, 16, 17) one of which (16) appears to extend to the tip of the right antapical without subdivision into anterior postmedian and posterior antapical moieties, except possibly in *H. sphaeroideum*. The separation of the adjacent postmedian (17) from the ventral median antapical is often feebly expressed. The antapical series includes 3 plates, a single dorsal (18), a median ventral (19), and a left ventral (20). The distal end of the posterior list of the girdle usually descends on the suture between the right ventral and right latero-ventral postmedians and continues to the tip of the right antapical horn.

The boundaries of the plates on the right ventral face of the hypotheca are subject to much obscurity and considerable variation in location. The relations of the midventral plate (19) to the adjacent postmedian (17) and to the longitudinal furrow are subject to considerable variation in connection with the varying degrees of development of the posterior list of the girdle.

The longitudinal furrow is subject to considerable variation in length. It is relatively short in some species as in *H. rigdenae*, *H. sphaeroideum*, and *H. hindmarchi* where it is less than two-thirds the length of the hypotheca. In other forms as *H. trirostre* and *H. murrayi* it reaches the antapical border. It is without high membranous lists as a rule though one appears in *H. murrayi*.

The thecal wall is thin and hyaline and universally, except in apparently young individuals, reticulate with more or less irregular polygons formed by thickened ridges on the outer surface. In some species, as in *H. scrippsi*, and perhaps in certain stages of growth of other species these polygonal boundaries become so prominent as to obscure suture lines, as may be seen in Murray and Whitting's ('99) figures of *H. trirostre*, *H. murrayi*, and *H. hindmarchi*.

These reticulations are often quite regular as in *H. blackmani* and along the lateral margins of the epitheca of *H. scrippsi*, or very irregular as on the ventral and dorsal faces of *H. scrippsi* and in *H. trirostre;* they may be relatively large as in *H. murrayi* or small as in *H. sphaeroideum*, with very heavy ridges as in *H. trirostre* or but faintly outlined as in *H. milneri*, or forming but a delicate network as in *H. blackmani*. In young individuals they may be entirely lacking and the presumption is that in general, individuals with partially or feebly developed reticulations have not as yet reached the stage of completed formation of the theca. The reticulations are found also on the girdle plate and on the girdle lists and along suture lines there are frequently rows of smaller polygons. In but a few cases as in *H. murrayi* and *H. doma* are enclosing ridges so thickened by the filling in of the angles as to leave a subcircular central area. Each reticulation has typically one centrally located pore. In some species with coarse reticulations there are several pores in a single area, and frequently in all species there are minor irregularities in the number and position of the pores. Small polygons frequently lack the pores. The reticulation is evidently formed on the outer surface of the thecal wall by plasma which is extruded through the pores, for the polygons bear a definite relation to the arrangements and distribution of the pores.

The protoplasmic contents of the theca are usually hyaline and colorless, and often only partially fill the interior of the theca. The nucleus has the usual ellipsoidal form with beaded chromatin reticulum and lies near the center of the protoplasmic mass not far from the flagellar pore. It is small and is found with difficulty. No instances of diffuse reddish coloration often seen in *Peridinium* and *Pyrophacus* have been noted as yet in *Heterodinium*. Chromatophores are entirely absent in some instances, in others they are massed in spheroidal chromospheres of pale greenish yellow or deep cadmium orange color. In some cases the chromatophores are peripheral in location and of various forms. Vacuoles and pusules of varying form and distribution have been observed in the cell contents.

The dimensions of observed species are like those of *Peridinium*. The largest species thus far recorded appears to be *H. blackmani* which has a length of 225μ, and transverse and dorsoventral diameters of 135μ and 160μ respectively; the smallest appears to be *H. sphaeroideum* with a length of only 42μ, and transdiameter of 39μ.

The distribution of this genus from species thus far published appears to be limited, in the main, to warmer seas as shown in the following table:

Species	Latitude	Temperature C.
H. blackmani	7°–30° N.	25°–27°
H. doma	34°–39° N.	16.1°–18.9°
H. hindmarchi	19°–39° N.	15.6°–27.2°
H. trirostre	26° N.	27.2°
H. leiorhynchum	19°–39° N.	15.5°–24.5°
H. murrayi	14°–28° N.	20°–25.5°
H. milneri	29°–31° N.	26.9°–27.2°
H. sphaeroideum, H. rigdenae, H. scrippsi, H. whittingae, H. inaequale	San Diego 32.7° N.	14.6°–22.5°
H. triacantha	55°–81° N.	

Their vertical distribution is not known. At San Diego no individuals have been taken in the many surface catches of the tow nets made during the past few years. They have been found only in the vertical catches in from 165 to 40 fathoms to the surface. Murray and Whitting's ('99) species were all apparently from plankton collected by filtering water from ship's pumps and therefore taken some 2–3 fathoms below the surface. The absence of chromatophores or their aggregation in chromospheres observed in individuals taken at San Diego is suggestive of occurrence in deep water with diminished light. The extreme hyalinity of some species is also indicative of a deeper habitat. The excessive development of the reticulum on the theca, and the asymmetry are evidently adaptations for flotation, on the one hand by increase of friction surface, which is at least doubled in the more rugose forms, and on the other by giving a spiral course to any passive descent of the organism due to gravity, and thus prolonging its existence in the upper strata.

This is a genus of somewhat aberrant structure and is represented by relatively very few individuals in comparison with those of *Ceratium* and *Peridinium*. I regard it as a degenerate form unable to maintain itself at the surface and for some reason deficient in reproductive vigor. In comparison with the number of individuals observed the number of species is large. The known species are all well defined and observations on different individuals do not indicate as yet any noticeable intergradation.

The nearest allies of this genus are plainly in the family *Peridinidae*, though it shows no marked structural affinities to any particular genus. The form cycle found in its species resembles that of *Peridinium* but its thecal plates are entirely different. The midventral diamond-shaped plate of the epitheca so characteristic of *Peridinium* is entirely lacking in *Heterodinium*, unless indeed the slight midventral expansion on the suture line be taken to represent a degenerate midventral which seems improbable. The excessive development of reticulations on the surface of the theca approaches that in *Protoceratium* but this genus appears to lack the midventral pit on the epitheca, and has a narrow transverse furrow which is complete distally. Its plates (see Schutt ('96)) are not known and it may prove to have a closer relationship to *Heterodinium* when these are definitely determined.

The midventral pit on the epitheca of Heterodinium resembles the so-called "pore" in *Poroceratium gravidum* (Gourret) but bears a different relation to the thecal plates and is probably not a homologous structure. In Poroceratium the "pore" lies near the middorso-ventral line in the middle of the dorsal and ventral apical plates, whereas in *Heterodinium* it lies in the suture between the two ventral apicals.

The generic distinctness of *Heterodinium* is thus beyond question and it belongs with *Ceratium*, *Peridinium* and *Protoceratium* in the sub-family Ceratiinae.

SYNOPTIC KEY TO THE SPECIES OF HETERODINIUM.

Sphaerodinium subgen. nov.

Body spheroidal, antapical horns not present or only slightly developed as spines. Epitheca rotund without stout lateral sutures.

1. With no antapical horns or spines 2
1. With antapical spines 3
2. Outline smooth, sutures faint, reticulations minute..*H. sphaeroideum*
2. Outline subangular, sutures prominent, reticulations coarse..*H. doma*
3. No apical horn, thecal markings faint ....*H. milneri*
3. Short apical horn, thecal reticulation prominent ....*H. murrayi*
3. Long apical horn ....*H. triacantha*

Euheterodinium subgen. nov.

Epitheca dorso-ventrally compressed, with straight, convex or concave sloping lateral margins which are usually thickened and have doubled ridges between the lateral margins of the apical plates. Antapical horns well developed. Girdle not very oblique.

1. Epitheca with strongly convex sides, apex broadly rounded .... *H. inaequale*
1. Epitheca with straight or concave sides, apex not broadly rounded.... 2
2. Epitheca low, its altitude about one-half the transdiameter .... *H. rigdenae*
2. Epitheca high, tapering, nearly equal to the transdiameter 3
3. Left antapical bifurcated ....*H. trirostre*
3. Left antapical not bifurcated 4
4. Reticulations very coarse, scantily developed ....*H. leiorhynchum*
4. Reticulations subregular, very delicate ....*H. blackmani*
4. Reticulations medium sized, very heavy ....*H. hindmarchi*

Platydinium subgen. nov.

Epitheca dorso-ventrally compressed and hollowed out ventrally, scoop-shaped. Lateral margins convex, not contracted to an apical horn. Girdle very oblique dorso-ventrally. Antapical horns present.

1. Antapical horns divergent ....*H. scrippsi*
1. Antapical horns convergent ....*H. whittingae*

Heterodinium sphaeroideum sp. nov.

Pl. 3, fig. 15.

A minute symmetrical species of spheroidal form without apical or antapical horns. The body is spheroidal or broadly ellipsoidal, the length 1.1 transdiameters. Dorso-ventral diameter equal to transdiameter. Epitheca a low dome, its altitude 0.4 transdiameters. Hypotheca exceeding the epitheca, elongated hemispherical, its altitude 0.6 transdiameters, with broadly rounded symmetrical antapex. Girdle premedian, transverse furrow indented, posterodexiotropic with very slight displacement scarcely 0.2 its width, its anterior and posterior lists equal and the latter not deflected distally, both formed by sharp projecting ridges of the thecal wall. Longitudinal furrow short, its length less than 0.5 distance to the postmargin, broad and shallow, its distal two-thirds enlarged.

Thecal plates imperfectly known. Ventral plates of typical number and arrangement except that the right ventral postmedian (16) is not continued to the postmargin but appears to be divided into postmedian and antapical moieties. Suture lines faint, bordered by smooth structureless zones. No prominent lateral ridges. No lists or spines. Thecal wall minutely and faintly reticulate with subregular polygons with centrally located pores. Polygons relatively very numerous.

Plasma dense, heavily vacuolated, chromatophores irregular, peripherally located, greenish yellow; nucleus near flagellar pore, ellipsoidal.

Dimensions:—length, 42μ; transdiameter, 39μ; width of furrow, 4–5μ; diameter of polygons, 2–3μ.

Taken once in vertical haul from 165 fathoms off San Diego in June.

Although this organism does not have the deficient girdle found in other species of the genus its thecal plates, in so far as they are known, are those of *Heterodinium*.

Heterodinium doma (Murr. et Whitt.).

Peridinium doma Murray and Whitting ('99), p. 327, Pl. 30, fig. 3.

Plainly belongs to *Heterodinium* because of the clearly shown ventral pit in the central expansion of the median ventral suture. The plates are only partially shown but in the one view (ventral) given they conform to *Heterodinium* so far as shown. The girdle and furrows are also typical.

The species is characterized by the spheroidal form, submedian girdle, broadly rounded apex, entire absence of antapicals, median reticulations of subregular polygons and somewhat salient suture ridges.

Reported from the warm temperate Atlantic between 34°–39° N.

Heterodinium milneri (Murr. et Whitt.).

Peridinium Milneri Murray and Whitting ('99), p. 327, Pl. 29, figs. 3*a*, *b*.

The characteristic *Heterodinium* structures are not clearly shown in Murray and Whitting's figures. There is only a suggestion of the midventral suture of the epitheca and a markedly deficient posterior list of the transverse furrow. The ventral pit is lacking and the plates are incompletely shown.

The species is characterized by its spheroidal rotund body, premedian girdle with wide displacement and considerable overlap of the ends of the transverse furrow, wide zones along suture lines free from reticulations, and coarsely reticulated plates. It is closely related to *H. murrayi*.

Reported from tropical Atlantic in 29°–31° N.

Heterodinium murrayi nom. nov.

Peridinium tripos Murray and Whitting ('99), p. 327, Pl. 30, figs. 4*a*, *b*.
non *P. tripos* (Müller), Ehrenberg ('33), p. 272 = (*Ceratium tripos*).

The specific name *tripos* must be rejected as it was previously introduced into the genus *Peridinium* by Ehrenberg's ('33) transfer of *Cercaria tripos* of O. F. Müller (1786) to the genus *Peridinium*. As figured by Murray and Whitting ('99) this species shows almost none of the generic characters except the very deficient posterior list of the transverse furrow. The ventral pit is questionably figured and no trace of the plates is shown. The only evidence of the presence of the left intercalary is the shifting of the apex to the right.

The species is characterized by its small size, rotund body, large and few subregular polygonal reticulations with a coarse mesh which hide the sutures and cover the whole theca. The girdle is premedian and the transverse furrow is much displaced and has considerable overhang. The apex is somewhat contracted and the antapicals bear two short finned spinules on the left and one on the right. The anterior list of the transverse furrow is membranous. There are no antapical horns.

Reported from the tropical Atlantic in 14°–31° N.

Heterodinium triacantha (Jörg).

Gonyaulax (?) *triacantha* Jörgensen ('99), p. 35.
Ceratium hyperboreum Cleve ('00), pp. 14-15, Pl. 8, fig. 5.
Gonyaulax triacantha, Paulsen ('04), pp. 21-22, fig. 5.

This form appears to belong to *Heterodinium* by reason of the reticulated thecal wall, the midventral suture of the epitheca deflected to the left, the widened distal end of the transverse furrow, and the longer right antapical spine. There is also some indication that the distal end of the posterior list of the girdle is continued in the suture on the right side of the hypotheca. None of the figures shows the ventral area or pit, or the thecal plates in full. In so far as they are indicated in Paulsen's ('04) figures, they conform to those of the genus *Heterodinium*. There are difficulties in reconciling Cleve's ('00) figures with each other, and with those of Paulsen ('04) as well as with Jörgensen's description, probably due to the fact, that, as Paulsen suggests; Cleve's figure is reversed, *i.e.*, it is a view of the ventral face as viewed through the body from the dorsal face.

This species probably belongs in the subgenus *Sphaerodinium*, though it does not possess a spheroidal body. It is characterized by the absence of antapical horns and post indentation, concave sides of the epitheca, the developed apical horn, and the three antapical spines.

Dimensions:—length, 72–84μ; transdiameter, about 50μ; dorsal-ventral, about 45μ.

Reported from coasts of Norway and Iceland.

Heterodinium inaequale sp. nov.

Pl. 18, figs. 9, 10.

This is a small subpentagonal species with rotund epitheca and unequal widely separated antapicals.

The body in face view is subpentagonal, the two anterior margins are quite convex, the left posterior nearly straight, the right slightly convex and the postmargin between bases of the antapicals is concave. The length is 1.2 and the dorso-ventral diameter 0.75 times the transdiameter. The epitheca is low dome-shaped, compressed dorso-ventrally, its altitude (ventral) is 0.7 transdiameter. No apical horn is differentiated and though compressed dorso-ventrally it is not thinned down to a sharp edge at the doubled lateral sutures. The ventral face is scarcely excavated. The broad midventral suture runs from the longitudinal furrow to the apical pore swerving towards the left at the ventral pit.

The hypotheca is rotund, its altitude (mid-dorsal) 0.6 transdiameter. The antapicals are very unequal, the right is about one-half the length of the left and is abruptly incurved to an acute tip. The left is not incurved and is somewhat tapering. Its length is 0.3 transdiameter. The postmargin between the antapicals is slighly concave and is 0.4 transdiameter in length.

The plates are typical in number, the left intercalary being confined to the dorsal face. The dorsal premedians are very low, scarcely exceeding the girdle in width. The dorsal postmedians on the other hand are unusually long, and the posterior angle of the right one projects slightly beyond the margin.

The girdle is narrow and slightly oblique (15° postero-ventrally) to the equatorial plane. The transverse furrow is postero-dexiotropic with a displacement of its own width. It is scarcely indented, the thecal wall forming a slight anterior ridge, and a small posterior one which fades into the right antapieal suture distally. The longitudinal furrow is narrow and short, 0.6 distance to postmargin.

The thecal wall is structureless save for scattered pores in the two individuals thus far observed. These may both be young stages and the older ones may be reticulate as are other species in the genus, but there is not the slightest evidence of reticulations on the thecal walls of these two individuals. The suture lines are light and faint. The midventral one on the epitheca is broad in the posterior half between the ventral pit and the flagellar pore, and the lateral sutures of the epitheca and hypotheca are doubled and prominent. The right dorsal premedian suture is very oblique. No fins or lists were noted.

The plasma is coarsely granular, chromatophores few, large, spheroidal, clustered near the center.

Dimensions:—length, 116–120μ; transdiameter, 100μ; dorso-ventral, 75μ; furrow, 8μ in width.

Taken in vertical hauls from 40–95 fathoms to surface off San Diego in May and June.

This species is not closely related to any described species. Its asymmetry is noticeable but no other adaptations to flotation in the theca were found in the individuals examined.

Heterodinium rigdenae sp. nov.

Pl. 18, figs. 6-8.

A small pentagonal Peridinium-like species with a coarse polygonal reticulum and slight obliquity of the girdle, resembling *P. acutangulum* Lemm.

Body pentagonal in face view with straight or nearly straight subequal sides, broadly bifurcated posteriorly with short stout conical antapicals. Length 1.3 and dorso-ventral diameter 0.6 times the transdiameter. Epitheca without apical horn, the sides sloping in a straight line from the apical pore to the girdle, compressed dorso-ventrally and somewhat excavated in the mid-ventral region, lateral sutures prominent and doubled. Hypotheca also compressed, the right margin concave, the left with projecting angle at the junction of postmedian and antapical plates. Ventral face excavated. The antapical horns are short, 0.2 transdiameter in length, which is nearly equal to the slightly curved margin which separates their bases. Their ends blunt with short terminal spinule. The girdle is inclined about 15° postero-ventrally from the equatorial plane. The transverse furrow is deeply indented, more so towards its anterior than its posterior margin. It forms a descending right spiral with displacement slightly exceeding its width. Its distal end is feebly developed, the posterior ridge vanishing on the ventral face. The anterior ridge is a heavy projection of the body wall, nearly twice the height of the posterior. The longitudinal furrow is narrow and shallow, dilated posteriorly and extends from the flagellar pore little more than 0.5 of the distance to the post-margin.

Thecal plates of the normal type. Left intercalary confined to dorsal face. Suture lines heavy, deficient on right ventral area. Thecal wall covered with irregular polygons, mostly pentagonal, larger ones each with single central pore. Polygons relatively few, 41 on dorsal apical. In young individuals faint suture lines but no polygons are found. The ventral area is found as usual at the junction of the sutures on the ventral face of the epitheca. It is unusually large and contains the anteriorly located reniform pit-like structure.

Individuals thus far observed have been very hyaline and colorless or with pale greenish yellow chromatophores, reniform or irregular in shape.

Dimensions:—length, 120–125μ; transdiameter, 90–92μ; dorso-ventral, 155μ; girdle width, 10μ; polygons, 2–10μ.

Taken in vertical hauls from 90–100 fathoms to surface in June off San Diego.

This species resembles *H. hindmarchi* (Murr. et Whitt.) in the type of reticulations, but differs from it in its more robust form, shorter epitheca and antapicals.

Heterodinium trirostre (Murr. et Whitt.).

Peridinium trirostre Murray and Whitting ('99), p. 327, Pl. 29, fig. 5.

This species is shown to have the typical ventral plates of *Heterodinium*, the ventral pit and the deficient posterior list of the transverse furrow which is deflected posteriorly on the right antapical horn.

The species is characterized by the presence of pointed antapical horns, the left showing a bifurcation into two apices. The epitheca is high, broadly cuneate with doubled lateral sutures. The girdle is median, the transverse furrow being displaced only its own width. The reticulations are very coarse and heavy and exhibit more than the usual irregularity in form.

Reported from 26° N. in the Atlantic.

Heterodinium leiorhynchum (Murr. et Whitt.).

Peridinium leiorhynchum Murray and Whitting ('99), pp. 326-327, Pl. 29, figs. 2*a*, *b*.

This is unquestionably a *Heterodinium* as it shows a mid-ventral pit upon the epitheca, the doubled lateral sutures and diminishing posterior list of the transverse furrow. The plates are very imperfectly shown though there is a suggestion of the left intercalary of the epitheca in the slight shoulder on the left epithecal margin, and in the incomplete suture lines of the lateral view.

The species is characterized by the somewhat differentiated apical horn, the unequal, pointed, divergent antapicals terminating in spines, the rotundity at the girdle, prominent suture ridges (incomplete in figure), smooth or coarsely reticulate thecal wall, and fenestrated lists of the girdle.

Reported from the warm temperate Atlantic from 20°–40° N.

Heterodinium blackmani (Murr et. Whitt.).

Peridinium Blackmani Murray and Whitting ('99), pp. 327-328, Pl. 29, figs. 6*a*, *b*, *c*.

This superb and clearly marked species is the only one in which the left intercalary plate is shown by Murray and Whitting ('99). It is unquestionably a typical *Heterodinium* though these authors fail to show the ventral plates of the epitheca and the ventral pit characteristic of the genus. The remainder of the plates is almost completely shown. The prominent doubled lateral sutures, the short longitudinal furrow, and the posteriorly deflected posterior list of the transverse furrow stamp this species as a typical *Heterodinium*.

The species is characterized by the curved epitheca flaring to the greatly expanded equator, submedian girdle, divergent pointed antapicals. The suture lines are marked by prominent lists and the plates are reticulate with delicate subregular hexagonal polygons, which exhibit a tendency to horizontal elongation on the epitheca.

Reported from the Caribbean Sea and tropical Atlantic from 9°–25° N.

Heterodinium hindmarchi (Murr. et. Whitt.).

Peridinium Hindmarchii Murray and Whitting ('99), p. 326, Pl. 29, figs. 1*a*, *b*.

This is plainly a *Heterodinium* as it has the characteristic ventral pit in the central expansion of the median ventral suture of the epitheca, a short longitudinal furrow and the deficient distal posterior list of the transverse furrow. The plates are not shown but the presence of the left intercalary plate is suggested in the figure.

The species is characterized by the long stout widely separated antapicals, elongated epitheca, and coarse reticulations.

Reported from tropical Atlantic from Panama to 34° N.

Heterodinium scrippsi sp. nov.

Pl. 17, figs. 1-5.

A large species with short antapicals, scoop-shaped epitheca and coarse irregular reticulations. The body is subheptangular in face view, swollen at the girdle, and with shallow posterior bifurcation. The length is 1.5 and the dorso-ventral diameter 0.7 times the transdiameter. The epitheca is long, and its altitude is about 0.8 transdiameters. The ventral face is flattened and hollowed out anteriorly and thins out laterally to the doubled suture lines on the angular margin between the apical plates. Posteriorly the epitheca flares out to meet the girdle. The lateral margins have rounded shoulders about two-thirds of the distance from the girdle to the apical pore which rises from the anterior end in a fully developed apical horn. A short ventral slot-like extension of the apical pore such as is found in *Peridinium*, follows the midventral suture for a short distance.

The hypotheca is shorter than the epitheca and in the midventral line has scarcely 0.6 its altitude. To the tip of the long left antapical is 0.75 transdiameters. It is somewhat angular, is flattened ventrally and excavated in the midventral region between the antapicals. The dorsal side has considerably more flare toward the girdle. The antapicals are short and divergent, the right being more oblique than the left. The tips are acute.

The postmargin is not set off from the inner margins of the antapicals with which it forms a fairly regular arc. The distance between the tips of the antapicals is 0.4 transdiameters.

The girdle is postmedian, reniform in cross section, though somewhat thicker on the left side, and nearly perpendicular to the main axis. The transverse furrow is deeply indented with heavy overhanging anterior list and less strongly developed posterior one which vanishes distally on the ventral suture of the right antapical horn. The furrow is wide, postero-dexiotropic with a displacement equalling its width. The longitudinal furrow is about 0.6 distance to postmargin in length and is wide and shallow.

The plates of the theca are typical, the left intercalary being almost wholly confined to the dorsal face and of small size. Both pre- and postmedians are irregular in size and arrangement. There is an unusually large ventral area in the midventral suture of the epitheca which is deflected to the left and contains the reniform ventral pit. The suture lines are well developed and are laticed in places. Hyaline lists are found on the lateral and postmargins of the hypotheca. The thecal wall including the girdle is coarsely and irregularly reticulate with well developed polygons of 3–5 sides, each with a single central pore. Near the lateral margins of the epitheca these polygons are somewhat regular and often quadrangular. There are 108 in the dorsal apical plate.

The plasma and indeed the whole organism is beautifully hyaline. There are a few subspherical greenish chromatophores and an ellipsoidal nucleus near the flagellar foramen.

Dimensions:—length, 140–155μ; transdiameter, 100–105μ; dorso-ventral diameter, 60μ; width of transverse furrow, 10–12μ; polygons 4–8μ, rarely 12μ.

Taken in vertical hauls from 95 fathoms off San Diego in June.

I regard *H. scrippsi* as the type species of the genus.

Heterodinium whittingae sp. nov.

Pl. 19, figs. 11-13.

A large species with very oblique girdle, elliptical outline, and shallow rounded bifurcation. Body elliptical in face view with broadly rounded apical end and short incurved antapical horns which preserve the elliptical outline. The posterior bifurcation extends but one-fourth of the distance to the girdle and is broadly rounded anteriorly. The body is very much compressed dorso-ventrally, forming a sharp edge at the lateral margins. The girdle is very oblique being inclined at an angle of 45° to the main axis in an antero-dorsal to postero-ventral direction.

The length is 1.4 transdiameters and 3 times the distance between the greatest dorsal and ventral extensions which is found in the left half of the epitheca. The whole body is slightly twisted in a right spiral.

The epitheca is very much flattened anteriorly and somewhat excavated on the ventral face, forming in fact a thin sheet which expands posteriorly as it meets the oblique girdle. The hypotheca is likewise flattened and excavated ventrally about the longitudinal furrow. The lateral postmedian plates form a posteriorly projecting tooth on the left margin.

The girdle forms a descending right spiral with slight displacement equalling its width. Its distal end is much widened, the posterior border becoming low and deflected posteriorly into the ventral suture of the right antapical horn. The longitudinal furrow is short and narrow. The flagellar pore is found as an elliptical opening at its proximal end.

The thecal wall is thin, delicate and hyaline with light suture ridges except in the case of the lateral sutures between the apicals which are doubled and heavy, as are also the lateral sutures on the hypotheca. The plates are normal, the left intercalary being restricted to the dorsal face. The surface, including that of the girdle plate, is everywhere covered with a reticulum of irregular polygons, each with a single central pore. In the several specimens thus far observed the reticulum has been very light and delicate. The polygons are relatively numerous, 97 having been recorded on the dorsal apical plate.

The plasma is exceedingly hyaline and coarsely vacuolated and its total amount is relatively very small. The nucleus is minute (12μ), spheroidal and centrally located, and there is one pale chromosphere of similar size and form adjacent to it. This is a large species, 180μ in length, 140μ in transdiameter and 60μ in greatest dorso-ventral extension. Polygons 5–12μ in diameter.

Taken in vertical catch from 85 fathoms to the surface off San Diego in July.

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EXPLANATION OF PLATES.

PLATE 17.

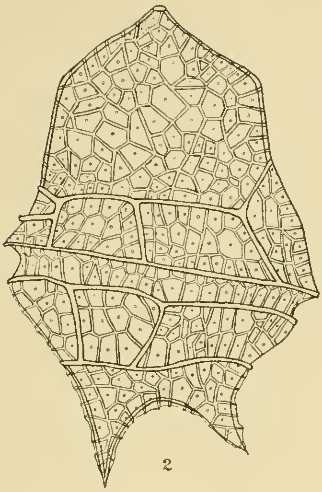
Fig. 1.—*Heterodinium scrippsi* ventral view. × 725. *ap. p.*, apical pore; *fl. p.*, flagellar pore; *l. f.*, longitudinal furrow; *v. a.*, ventral area; *v. p.*, ventral pit.

Fig. 2.—Dorsal view of same. × 420.

Fig. 3.—Oblique view of left side of same. × 420.

Fig. 4.—Diagrammatic apical view of same. × 420.

Fig. 5.—Reticulations adjacent to posterior list of transverse furrow. × 2725.



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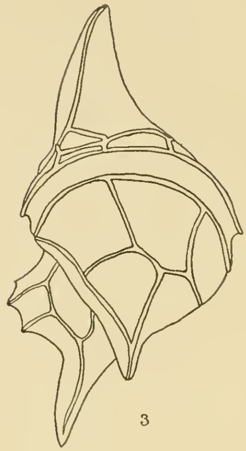

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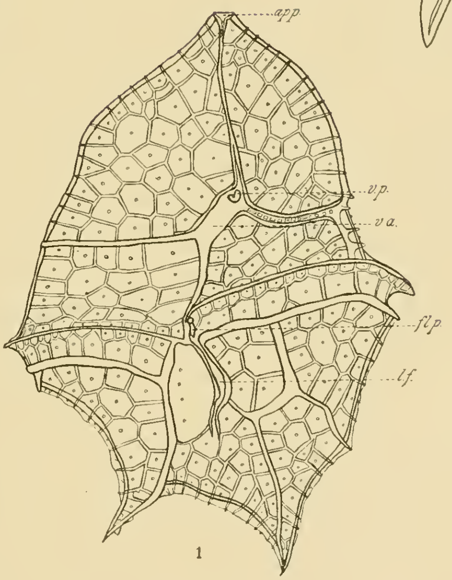

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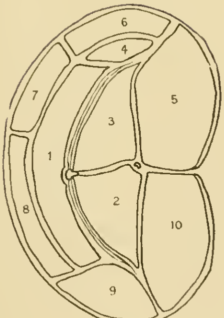

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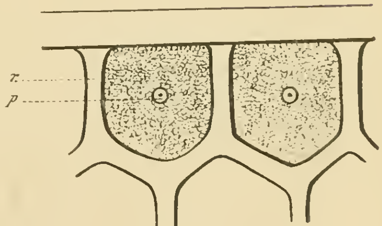

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PLATE 18.

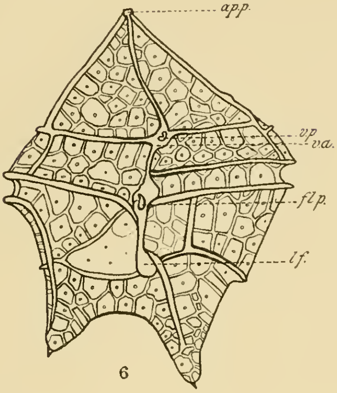
Fig. 6.—*Heterodinium rigdenae*, ventral view. × 410. *ap. p.*, apical pore; *fl. p.*, flagellar pore; *l. f.*, longitudinal furrow; *v. a.*, ventral area; *v. p.*, ventral pit.

Fig. 7.—Dorsal view of the same. × 410.

Fig. 8.—View of left side of same. × 410.

Fig. 9.—Ventral view *H. inaequale*. × 420. Abbreviations as in fig. 6.

Fig. 10.—Oblique view of right side of same. × 420.



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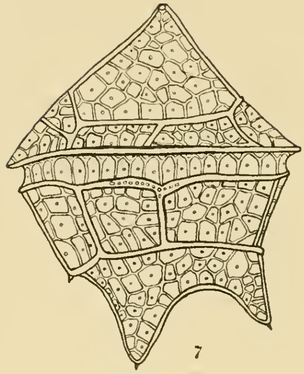

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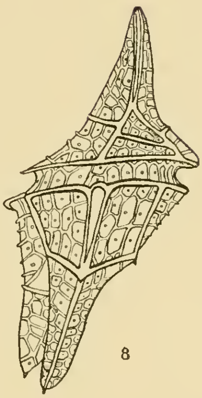

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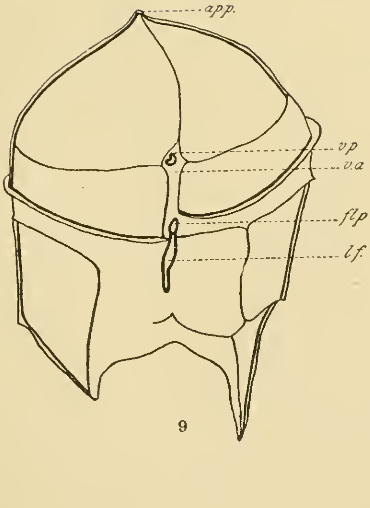

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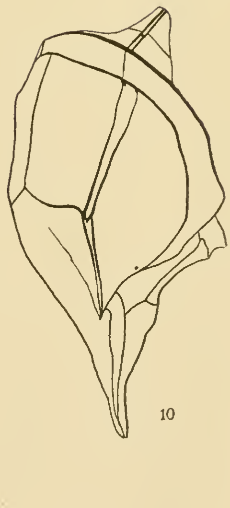

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PLATE 19.

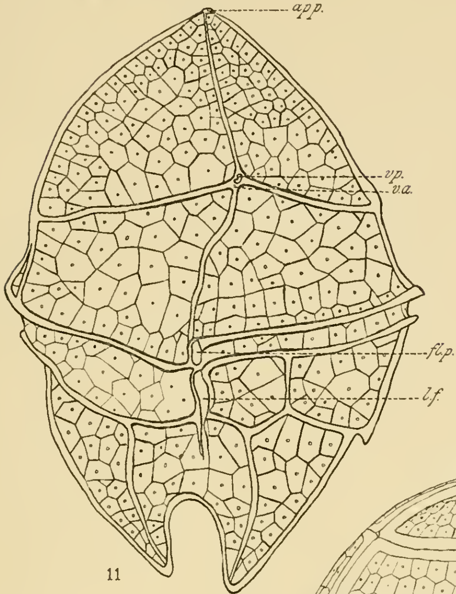
Fig. 11.—Ventral view of *Heterodinium whittingae*. × 420. *ap. p.*, apical pore; *fl. p.*, flagellar pore; *l. f.*, longitudinal furrow; *v. a.*, ventral area; *v. p.*, ventral pit.

Fig. 12.—Dorsal view of same. × 420.

Fig. 13.—View of right side of same. × 420.

Fig. 14.—Optical section at girdle of same. × 420.

Fig. 15.—Ventral view of *H. sphaeroideum*. × 1500.



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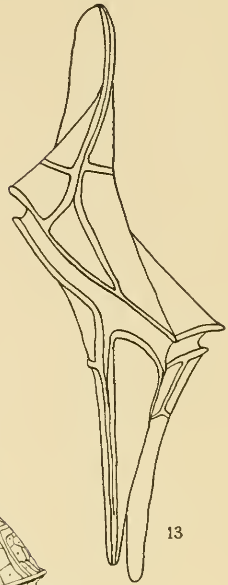

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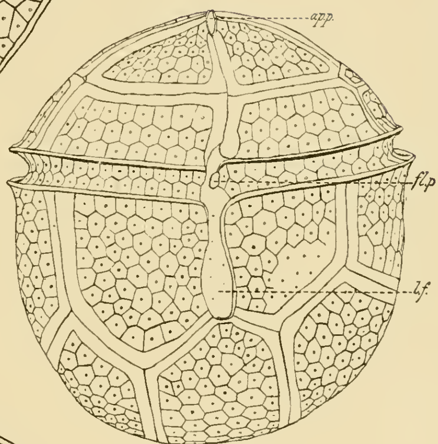

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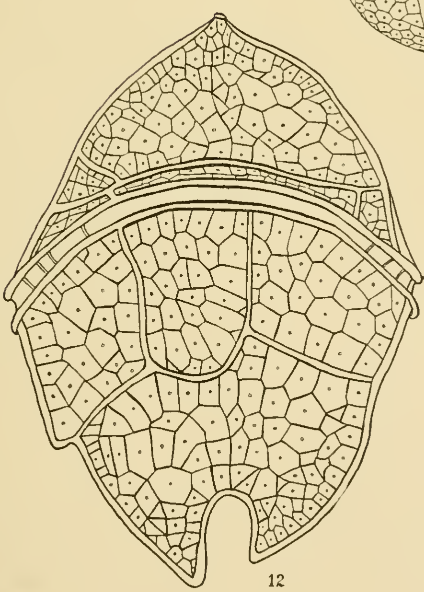

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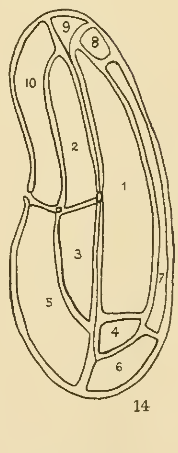

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