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THE HYDROIDA

OF THE

PACIFIC COAST OF NORTH AMERICA,

WITH ESPECIAL REFERENCE TO THE SPECIES IN THE COLLECTIÓN OF THE UNIVERSITY OF CALIFORNIA.

BY

HARRY BEAL TORREY.

CONTENTS.

*Two species should be added, though found too late to be given their proper places in text or tables. One, a Bougainvillia, was growing with *T. crocea*, in Oakland Creek. It is probably the *B. mertensi* of A. Agassiz, ('65), which for reasons stated below (p. 29) I had identified with *Bimeria franciscana*. The size and habit of the two species are similar. There are many medusae attached to the stem of the Bougainvillia, each of the larger ones having four pairs of tentacles and eight eye spots. The other newly found species is *Clytia bicophora Ag.* It was growing on stems of *T. crocea*, where it has been found on the eastern coast. It has not been recorded previously from the Pacific Coast. Blastostyles with medusae. Both species were collected September 26.

The following species are briefly discussed, in connection with the species concerned:

Relation of Form and Habit to Environment (*Syncoryne mirabilis*, p. 31; *Tubularia crocea*, p. 44; *Campanularia urceolata*, p. 54; *Obelia commissuralis*, p. 57).

Development and Regeneration of Tentacles; Taxonomic Significance (*Clava leptostyla*, p. 30; *Hydractinia milleri*, p. 35; *Corymorpha palma*, p. 41; *Tubularia crocea*, p. 45).

Orientation (*Corymorpha palma*, p. 39; *Sertularia furcata*, p. 66; *S. argentea*, p. 68).

Response to Tactual Stimulation (*Corymorpha palma*, p. 41).

Origin of Branches and Gonothecae within Hydrothecae (*Sertularella dentifera*, p. 61; *S. halecina*, p. 62; *Plumularia goodei*, p. 76).

Haleciid with Free Medusa (*Campalecium medusiferum*, p. 48).

THE HYDROIDA

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PACIFIC COAST OF NORTH AMERICA,

WITH ESPECIAL REFERENCE TO THE SPECIES IN THE COLLECTION OF THE UNIVERSITY OF CALIFORNIA.

The scope of this paper has broadened since its preparation was begun. It was intended at first to embody the species of hydroids collected off the southern coast of California during the summer of 1901 by the University of California. To obtain a proper view of these species, however, especially from the standpoint of their distribution, not only was it found necessary to consider all the known species of the western coast of North America, but all the previous collections of the University were overhauled and a number of new species brought to light. As a consequence, 140 western species have been distinguished. Of these, 102 are represented in the University of California collections, 55 (39%) are restricted to this region, and 20 (14%) are new.

While the lack of collections from the deeper waters along our shore would make any attempt to monograph the West Coast Hydroida premature on my part even were it not unnecessary in view of the enormous task of monographing the Hydroida of North America which is now engaging the energies of Professor C. C. Nutting, I have thought that a key to the known species would be at least a convenience at this time, the more so because there are not likely to be any considerable additions in the near future to the list of littoral species, which are the most accessible and for that reason form the great majority of the total number. In the body of the paper all the species in the University of California collection are treated, with the exception of those from the Alaska coast, an account of which Professor Nutting ('01), has recently published.

If there is one thing more than another which the preparation of this paper has brought emphatically to my attention, it is the great necessity for long-continued observations on the growth and development of hydroids under natural and artificial conditions. Unfortunately the systematist is forced to rely for his determinations almost exclusively upon skeletal characters, which are peculiarly variable. Size, habit, branching, length of branches and internodes, thickness of perisarc, shape and ornamentation of hydrothecæ, kind and amount of annulation, number of tentacles on the hydranth and on the medusa at the time of liberation—all these are subject to often perplexing variations. This leaves little doubt that when proper measures are taken for the observation of living animals the number of species will be materially decreased.

It is mainly through experimentation that the natural conditions of life will be analyzed, and it is only by a thorough investigation of the latter that true affinities can be established. Some of the many causes which affect the lives of hydroids directly have been suggested in the course of the paper. In the cases of *Sertularia furcata* and *S. argentea*, gravity seems to be a factor of importance in determining the direction of growth and the position of the hydrothecæ on the stem. In *Gonothyræa clarki* and *Campanularia pacifica*, malnutrition, or some other unfavorable condition not yet known, produces a peculiar attenuation of branches and perisarc, possibly by directly stimulating the coenosarcal cells to division while inhibiting the action of those with a glandular function. It is equally desirable to know the factors which determine the position of the gonosome in such forms as *Obelia commissuralis*, *Plumularia goodei*, and *Sertularella halecina*, in which species the gonangia take the place of hydranths.

There are other sorts of questions which can receive as yet but doubtful answers, such as the causes of the seasonal distribution of some species, *e.g.*, *Tubularia crocea*, which dies out in San Francisco Bay during the winter months, though it flourishes the year round at San Pedro; here the result is probably referable to changes in temperature.

It is important to discover the relative variability of species, their plasticity or adaptability, what characters are affected directly by the conditions of the environment, what are more stable or not affected at all. So I have tried to bring into this paper as much pertinent ecological material as possible. Most of the western species have been described from preserved specimens, and in many cases there are no records of environmental features, such as depth, temperature, character of the bottom, etc. The depth and temperature, whenever known, are given in the table of distribution. The records are necessarily incomplete, and form a rather insecure basis for generalizations at present.

The development of some species, especially with reference to the appearance of the tentacles, has been briefly considered, being of much taxonomic importance. In connection with some species, especially *Corymorpha palma*, I have described certain activities, phenomena of orientation, and processes of regeneration, some of the points which have appeared to me to be of general interest.

Distribution. Of the 140 species on the western coast of North America, 54 (39%) are restricted to this region. Of the remaining 85 species, 24 (17%)* are found on the eastern coast of North America, 11 (8%) in Greenland, 36 (25.7%) in Asia, 5 (3.6%) in South Africa, and 6 (4.3%) in New Zealand and Australia. The presence of 11 of the foreign species is recorded for the first time.

The great center of distribution is northern. *Halicornaria producta* is a single exception to the rule, having been collected in Australia and San Diego, California, only. The South African species are circumboreal. Three of the New Zealand species are circumboreal, the other two probably so, since they are found also in Great Britain. Of the foreign species, 4 do not pass the Aleutian Islands from the north; 14 do not pass Sitka, Alaska; 15 reach, but do not pass Puget Sound; 13 are found in Southern California, 4 being peculiar to that region. The northern character of the hydroid fauna is shown by the tables,

* The percentages are based on the total number.

according to which 69 species (49%) occur north of Sitka, 96 (68.5%) north of Puget Sound.

The only geographical barrier of any magnitude is Alaska Peninsula. The fauna of Alaska north of the peninsula is distinguished from that south of it by the absence of any representatives of the *Haleciidae*, *Lafœidae* and all the families of the *Gymnoblastea* except three species of *Pennariidae*, which are restricted to that region; also by the small number of species (2) of *Campanulariidae*, in representatives of which family the fauna of Alaska south of the peninsula is so rich. The fauna of the Aleutian Islands belongs essentially to that of Alaska south of the peninsula. Of the nine species distributed between Kyska Island and Akutan Pass, none occurs north of the islands, although five occur in the Southern Alaska region.

From Alaska Peninsula to San Diego there are no abrupt transitions in the fauna. It is possible, however, for purposes of comparison, to divide this great region into four sub-regions. The first extends from Alaska Peninsula south to Sitka. It possesses a large number of species (59, 18 of which are peculiar to it) belonging mainly to the *Campanulariidae* and *Sertulariidae;* there are relatively large numbers of *Haleciidae* (7) and *Lafœidae* (6). The second sub-region includes the fauna of Puget Sound, Vancouver Island and vicinity. There are 50 species, of which 10 are peculiar to the region; 22 are *Campanulariidae*, of which 10 are found in the first sub-region; 14 are *Sertulariidae*, 9 of which are found in the first sub-region; 5 are *Haleciidae*, of which but one is found in Alaska and one south of Puget Sound. The two species of *Lafœidae* are Alaskan; the four species of *Plumulariidae* includes the single Alaskan species. Both first and second sub-regions contain families of *Gymnoblastea*, though no species are common to the two. The third sub-region comprises San Francisco Bay and vicinity, including Monterey Bay. There are here no representatives of the *Lafœidae* and *Haleciidae*. Six species are peculiar to it, all of which are *Gymnoblastea*, including a *Clava* and a new *Hydractinia*. The fourth sub-region comprises Southern California, south of Point Conception. The fauna contains a relatively large number of *Plumulariidae* (12, of which 8 are local) and *Sertulariidae* (14, of which 7 are local); three of the four species of *Haleciidae* are local; the *Clavidae* and *Hydractiniidae* are without representatives.

The differences in the fauna which have just been outlined are correlated with certain geographical differences. The Japan Current, striking the shore of Alaska, parts into two streams. The larger turns down along the coast of the United States; the smaller turns upward and runs along the southeast shore of the Alaska Peninsula. The shore of this part of the Alaska coast drops precipitously away, so that the current comes close in toward the land. North of the peninsula is the great one hundred fathom plateau, extending many hundreds of miles out from the shore line. On this plateau the hydroids from Northern Alaska have been collected. It is covered by waters much colder than those south of the peninsula. If the warmer waters of the Japan Current reach it, they flow, so far as known, only along its edge.

North of the peninsula, then, is a region whose waters are largely covered with ice for more than half of each year. South of the peninsula begins a vast stretch of coast which is washed by the comparatively warm waters of the Japan Current. This current is probably accountable for the absence of abrupt transitions between the faunal areas which I have tried to schematize above, and the exceedingly long distances to which some of the northern species have been distributed southward. The temperature of the current varies gradually with the latitude, however, and that offers some explanation for the small faunal differences that exist.

Future exploration will doubtless reduce these differences. While the Alaska coast from Unalaska to Sitka has been rather thoroughly explored, practically no collections have been made between Sitka and Vancouver Island. From Puget Sound to San Pedro little is known of the off-shore fauna, though much dredging and shore collecting have been done in Puget Sound and San Francisco and Monterey bays. Little is known of the hydroid fauna on each side of Point Conception, a natural barrier which has decidedly affected the distribution of some groups of animals, notably the molluscs.

Table of Distribution.

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature. ° C.
Gymnoblastea																			
Bougainvilliidae																			
Atractyloides formosus Fewkes																			
*Bimeria annulata (Nutt.)			+			+				+								0, 42	
formosa (Fewkes)							+												
* franciscana						+												0—1	
gracilis Clark										+								0—1	
* nutans Wright			+										B					0—1	
* robusta									+									0—1	
*Perigonimus repens Wright				+		+							B					0—1	
Clavidae																			
*Clava leptostyla Ag.						+					M							0—1	
Corynidae																			
*Coryne brachiata Nutt.			+																
*Syncoryne eximia Allman			+				+						N						
* mirabilis Ag.				+		+		+				Sp						0—1	
Eudendriidae																			
*Eudendrium californicum						+	+											0—1	
* rameum Pallas									+				+	N				0—D	—1.0
* ramosum Linn.							+						+					1—50	
* vaginatum Allman			+										B						

Table of Distribution—*Continued.*

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range in fathoms.	Temperature. ° C.
Hydractiniidae																			
*Hydractinia milleri.						+												0—1	
Pennariidae																			
Corymorpha carnea (Clark)	+																		
* palma									+									0—1	
Tubularia borealis Clark	+																		
* crocea (Ag.)						+			+	+	+								
indivisa Linn.	+												N						
larynx E. & S.				+							N		+						
harrimani Nutt.			+																
marina					+	+	+											0—1	
tubularoides (A. Ag.)						+													
Calyptoblastea																			
Haleciidae																			
*Campalecium medusiferum									+									6	
*Halecium annulatum										+								9	10
corrugatum Nutt.																			
densum Calk.				+															
* halecinum Linn.			+								+	Sp.G	+						
* kofoidi										C+								5—42	to 12

TABLE OF DISTRIBUTION—*Continued.*

	West Coast America.				California.						East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range in fathoms.	Temperature. ° C.
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.									
*Halecium muricatum Johnston			+								+								
* nuttingi nom. nov.				+						+								15—25	
* ornatum Nutt.			+																
* reversum Nutt.			+																
* robustum Nutt.			+																
* scutum Clark			+																
* speciosum Nutt.			+																
wilsoni Calk.				+															
Campanulariidae																			
Campanularia attenuata Calk.				+															
circula Clark			+	+														12—18	
* denticulata Clark			+						+									0—18	
* everta Clark							+											0—42	
exigua Sars				+									+						
* fascia				+					+									1—5	12
* fusiformis Clark				+		+												0—1	
* hincksi Alder										+			B					1—D	to 12
integra Macgill.			+	+															
kinkaidi Nutt.				+															
* lineata Nutt.			+	+															
* pacifica A. Ag.				+		+												0—1	

Table of Distribution—*Continued.*

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature. C
*Campanularia regia Nutt.			+																
rigida (A. Ag.)						+													
* ritteri Nutt.			+															20	
* speciosa Clark			+															6—20	
* urceolata Clark			+	+		+												0—18	
* verticillata (Linn.)			+								+		+					20—50	
* volubilis Linn.				+		+			+		N		N					0—100	—0 to 13
Gonothyraea gracilis Sars				+															
* clarki nom. nov.	+		+	+		+					M		N					0—30	
* inornata Nutt.			+																
*Obelia borealis Nutt.			+																
* commissuralis McCr.						+					M							0—1	
* dichotoma Linn.			+	+					+	+	M		B	N				0—24	—1.0 to 13
* dubia Nutt.			+																
fragilis Calk.				+															
gelatinosa (Pallas)				+							M								
* geniculata (Linn.)						+				C	SMN		+			+		0—42	
gracilis Calk.				+															
griffini Calk.																			
longissima Hincks											M			N				5—80	
* plicata Hincks			+	+									B						

TABLE OF DISTRIBUTION—*Continued.*

	West Coast America.				California.						East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature, ° C.
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.									
Obelia surcularis Calk.				+															
*Clytia caliculata (Hincks)			+	+							N		B					0—15	
* compressa (Clark)			+							+								3—20	13
?johnstoui (Alder)			+	+							+		+			+		0—D	
*Calycella syringa (Linn.)			+	+		+				+		1G	B	N				1—100	to 12
*Campanulina rugosa Nutt.			+																
*Hebella pocillum (Hincks)	+		+								N		B					15	
Incerta sedis: Thaumantias inconspicua Forbes				+									B						
Lafoeidae																			
*Filellum serpens Nutt.			+									1	B	N				12—100	—0.8
*Grammaria immersa Nutt.			+																
*Lafoea adhaerens Nutt.			+																
* dumosa (Fleming)		+	+	+							+	Sp	N					12—450	
* fruticosa M. Sars		+	+								+	1G	N	N				6—35	1.6
* gracillima (Alder)			+	+					+		+	Sp	+					15	
Sertulariidae																			
Dynamena group																			
*Sertularia desmoidis									+	+								1—40	13
* furcata Trask						+	+	+	+	+								0—25	9.5 to 13
? pumila (Linn.)											+		+		+	+		0—2	

Table of Distribution—*Continued.*

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature. ° C.
Hydrallmania group																			
*Hydrallmania distans Nutting				+					+										
falcata (Linn.)				+							+		+	N	+			—35	
franciscana Tr.						+													
Selaginopsis group																			
*Selaginopsis cylindrica (Cl.)			+	+														0—15	
* mirabilis (Verr.)			+	+										E					
Sertularella group																			
Sertularella clarki Meresch.	+	+																	
* conica Allman									+		S							10—60	
* dentifera									+										
* fusiformis Hincks						+							B					0—1	
* halecina										+								5—12	12
* hesperia										+								1—9	10 to 12
nana Hartlaub				+															
pinnata Clark		+	+									J						0—112	
* polyzonias (Linn.)	+		+										+		+			0—30	
* saccata Nutting			+																
* tenella (Alder)										+			B			+		0—D	10
* tricuspidata (Alder)			+									GI		N				4—40	—0.8
* turgida (Trask)						+												0—42	13

Table of Distribution—*Continued.*

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature. ° C.
Thuiaria group																			
Sertularella albida K.	+		+											E					
*Sertularia argentea E. & S.			+	+	+	+		+			N	G	N					0–50	
* cupressoides Cl.	+		+															6–13	
* fabricii Lev.			+	+															
* filicula E. & S.	+		+	+		+	+		+	+	N		B					0–25	to 12
* greenei Murray				+	+	+	+	+											
* incongrua									+										
* similis Cl.	+		+	+														8–15	
tenera Sars	+											I	N	N				4–40	—1.6
* thuiaroides Cl.	+		+															11–24	
* traski									+										
* variabilis Cl.	+		+	+				+						N				0–112	—1.0
*Thuiaria coei Nutting		+																	
* costata Nutting			+																
* elegans Nutting		+	+																
* gigantea Clark	+		+															0–10	
plumosa Clark	+													N				10–30	
robusta Clark	+													N				0–33	—1.0
* turgida Clark		+	+											N				0–28	0.0

Table of Distribution—*Continued.*

	West Coast America.				California.														
	Alaska N. of Peninsula.	Aleutian Islands.	Alaska S. of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Reg.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast America.	Greenland, Iceland, Jan Mayen, and Spitzbergen.	Europe.	Asia.	South Africa.	New Zealand.	Australia.	Bathymetrical Range, in fathoms.	Temperature. ° C.
Plumulariidae																			
*Aglaophenia diegensis										+								1—7	12
* inconspicua										+								5	12
* pluma (Linn.)										+			+		+			1—40	12
* struthionides (Murray)				+		+	+	+	+	+								0—32	13
*Antenella avalonia										C									
*Halicornaria producta (Bale)										+							+	1—2	12
Nuditheca dalli (Clark)		+																	
*Plumularia alicia									+	+								5—25	10—13
echinulata, var., Calk.				+									B						
* goodei Nutt.							+	+										1—D	
* lagenifera Nutt.			+	+			+		+									1—20	
* [lagenifera septifera]										[+]									
* plumularoides Clark	+									+								8—25	
* setacea (Ellis)				+		+	+	+	+	+			+					0—25	12
virginiae Nutt.								+											
Totals	20	9	59	50	3	28	14	9	23	29	24	11	36	15	5	5	1		

The letters in the table have the following significance: B, Great Britain; C, Catalina Island; D, deep water; E, eastern; G, Greenland; I, Iceland; J, Jan Mayen; M, middle; N, northern; S, southern; Sp, Spitzbergen. The species preceded by an asterisk are represented in the collection of the University of California; those which are not followed by a proper name are new.

Condensed Table Showing the Numerical Distribution of Species Occurring on the West Coast of North America.	West Coast North America.											General Distribution.						
	Species peculiar to locality.	Alaska North of Peninsula.	Aleutian Islands.	Alaska South of Peninsula.	Puget Sound Region.	Humboldt Region.	San Francisco Region.	Monterey Bay.	Santa Barbara.	San Pedro Region.	San Diego Region.	East Coast North America.	Greenland, Iceland, Spitzbergen, and Jan Mayen.	Europe.	Asia, North and East.	South Africa.	New Zealand.	Australia.
Alaska North of Peninsula	2	20	...	13	6		2	1	1	1	2	6	2	6	8	1	...	...
Aleutian Islands	3	...	9	5	1	...	...	...	...	...	...	2	3	2	3	...	...	...
Alaska South of Peninsula	18	13	5	59	22	1	6	3	2	4	4	12	9	18	9	2	1	...
Puget Sound Region.	10	6	1	22	50	2	14	6	6	8	7	13	7	19	6	1	2	...
Humboldt Region		...	...	1	2	3	3	2	2	...	...	1	1	1	...	1	...	...
San Francisco Region	5	2		6	14	3	28	8	6	7	8	9	3	9	1	1	2	.
Monterey Bay	1	1	...	3	6	2	8	14	4	6	6	1	...	4	...	...	...	...
Santa Barbara	1	1	...	2	6	2	6	4	9	3	3	2	1	2	2	1	...	...
San Pedro Region	7	1	...	5	9	...	7	6	3	23	8	5	...	5	...	...	...	...
San Diego Region	8	2	.	5	8	...	9	6	3	9	29	2	...	7	1	1	2	1

Table Showing the Distribution by Families of the West Coast Hydroids.	Bougainvilliidae, incl. Bimeriidae.	Clavidae.	Corynidae.	Eudendriidae.	Hydractiniidae.	Pennariidae, including Tubdae and Corymdae.	Haleciidae.	Campanulariidae, including Campanulinidae.	Lafoeidae.	Sertulariidae.	Plumulariidae.
Alaska North of Peninsula	...	...	...	...	...	3	...	2	...	14	1
Aleutian Islands	...	...	...	...	...	...	...	1	2	5	1
Alaska South of Peninsula	2	...	2	1	...	1	7	21	6	18	1
Puget Sound Region	1	...	1	...	...	1	5	22	2	14	4
Humboldt Region	...	...	...	...	...	1	...	...	...	2	...
San Francisco Region	3	1	1	1	1	3	...	9	...	7	2
Monterey Bay	1	...	1	2	...	1	...	1	...	4	4
Santa Barbara	...	...	1	...	...	...	...	...	...	4	4
San Pedro Region	1	...	...	1	...	2	1	4	1	9	4
San Diego Region	2	...	...	...	...	1	3	5	...	7	9

KEY TO THE HYDROIDA OF THE WESTERN COAST OF NORTH AMERICA.*

1. No true hydrothecae or gonangia ... Gymnoblastea 2
1. True hydrothecae and gonangia present ... Calyptoblastea 25
2. Tentacles in proximal and distal sets ... Pennariidae 3
2. Filiform tentacles in one whorl ... 8
2. Tentacles scattered ... 20
3. A single nutritive polyp, rooted in the sand; perisarc rudimentary ... Corymorpha 4
3. Several nutritive polyps from a common hydrorhiza ... Tubularia 5
4. About 40 prox. tentacles; body a coral red C. (Rhizonema) carnea[1]
4. Not more than 30 prox. tentacles; stem colorless ... C. palma (p. 37)
5. Gonophores with laterally compressed processes ... 6
5. Gonophores with conical or tentaculate processes ... 7
5. Gonophores with conspicuous radial canals; no processes ... T. indivisa[1]
6. With 4 processes, 32-34 proximal and 50-60 distal tentacles ... T. borealis[1]
6. With 6-10 processes and 25 proximal tentacles ... T. crocea (p. 43)
7. 4 tentaculiform processes on female gonophore, as long as gonophore; proximal tents. 22-25 ... T. marina (p. 46)
7. 3-5 tentaculiform processes on gonophores, half as long as gonophores; proximal tents. 40-50 ... T. harrimani[2]
7. Processes conical; proximal tents. 18-20 ... T. larynx[3]
7. Proximal tents. 30-40 ... T. tubularoides[4]
8. Hydranths of two sorts: large sterile and small fertile, each with clavate proboscis; spiral zooids; hydrorhiza encrusting, with tubular spines ... Hydractiniidae
Hydractinia milleri (p. 34)
8. Hydranths of one sort ... 9
9. Proboscis trumpet-shaped ... Eudendriidae
Eudendrium 10
9. Proboscis conical ... Bougainvilliidae 13
10. Hydrocaulus annulated throughout ... 11
10. Hydrocaulus not annuluated throughout ... 12
11. Height of colony 2 inches or less; female gonophores usually without tentacles ... E. vaginatum[2]
11. Height of colony 4-5 inches; female gonophores with tentacles ... E. californicum (p. 32)
12. Stem and principal branches polysiphonic ... E. rameum (p. 33)

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*Some of the species in the key are described in this paper, others in papers mentioned in their several synonymies; descriptions of the rest may be found in the papers to which the indices after the specific names refer, which have been selected with especial reference to their accessibility.

12. Stem polysiphonic at base only; principal branches simple .... E. ramosum (p. 34)
13. Unbranched .... Atractyloides formosa[5]
13. Branched 14
14. Gonophores fixed sporosacs .... Bimeria 15
14. Gonophores free medusae .... Perigonimus 19
15. Stem polysiphonic 16
15. Stem simple 17
16. Stems several inches long, robust .... B. robusta (p. 29)
16. Stem less than an inch long .... B. nutans[8]
17. Stems annulated throughout .... B. annulata (p. 28)
17. Stems not annulated throughout 18
18. Hydranth with 10-12 tentacles .... B. gracilis[6]
18. Hydranth with 14-16 tentacles; hydrorhiza creeping over base of stem .... B. franciscana (p. 28)
19. Branches not annulated; tentacles 4-12 .... P. repens (p. 29)
19. Branches slightly annulated; tentacles 10-16 .... P. (?) formosus[5]
20. Tentacles filiform; fixed sporosacs .... Clavidae
Hydrocaulus rudimental; hydranths claviform; gonophores proximal to tentacles .... Clava 21
20. Tentacles capitate .... Corynidae 22
21. More than 20 tents.; color red .... Clava leptostyla (p. 30)
22. Gonophores free medusae .... Syncoryne 23
22. Gonophores fixed sporosacs; tents. of one sort .... Coryne 24
23. Tentacles 20-30; colony 2 or more inches high .... S. eximia (p. 31)
23. Tentacles 16; colony ½ in. to 1½ in. high .... S. mirabilis (p. 31)
24. Branches regularly annulated throughout .... C. brachiata[2]
25. Hydrothecae saucer-shaped; hydranth with conical proboscis .... Haleciidae 26
25. Hydrothecae campanulate, pedunculate, with partial septum at base .... Campanulariidae 33
25. Hydrothecae tubular, without basal septum, margin smooth, no operculum .... Lafoeidae 60
25. Hydrothecae well developed, sessile; nematophores absent .... Sertulariidae 66
25. Hydrothecae well developed, sessile, borne on one side of stem or branch only; nematophores present .... Plumulariidae 92
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26. Gonophores fixed sporosacs .... Halecium 28
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28. Fascicled 32
29. Annulated 30
29. Not annulated 31
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30. Sparsely and irregularly annulated; irregularly branched; parasitic; 23-30 tentacles .... H. ornatum[2]

30. Stem geniculate, pedicels taking the place of stem joints; gonothecae annulated, with annulated pedicels .... H. speciosum[2]
31. Branched, 1½ inches high; hydrothecae on internodes sessile, not reaching beyond distal node; rim not everted .. H. kofoidi (p. 49)
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32. Bushy, principal branches pinnate; rim of hydrothecae not everted; gonothecea ovate, female surmounted by two hydranths.. .... H. halecinum[8]
32. Stem and branches polysiphonic, stiff; hydrothecae everted; gonothecae compressed, spiny .... H. muricatum[5]
32. Each internode of branches with one or two proximal annulae, with distal hydrothecae reaching beyond end of internode; ultimate branches geniculate .... H. nuttingi (p. 50)
32. Flabellate colony; hydrauth small, 20 tentacles, pedicels from proximal part of internode .... H. reversum[2]
32. Thick stem and branches fascicled with many tubes, branching profusely; hydranths numerous, crowded, in whorls and clusters, with 10 tentacles; rim of hydrotheca non-everted......H. robustum[2]
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43. Hydrotheca large, cylindrical, delicate; long slender pedicel with 1 distal and 2 or 3 proximal annulae only .... C. ritteri[2]
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71. Hydrothecae smooth, tubular, aduate at base only, opening outward and upward................................. S. tricuspidata[8]
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1. Clark ('76, 1).
2. Nutting (''01, 1).
3. Calkins ('99).
4. A. Agassiz ('65).
5. Fewkes ('89).
6. Clark ('76, 2).
7. Nutting ('99).
8. Hincks ('68).
9. Trask ('54).
10. L. Agassiz ('65).
11. Kirchenpauer ('84).
12. Nutting (''00).
13. Mereschkowsky ('78).

Systematic Discussion.

GYMNOBLASTEA.

Hydroida without true hydrothecae or gonothecae. Gonophores when free, usually furnished with eye-spots, gonads on wall of manubrium.

Fam. Bougainvilliidae.

Atractylidæ, Hincks, Brit. Hydr. Zooph., 1868, p. 87.

Trophosome. Hydranth with a single verticil of filiform tentacles around the base of a conical or dome-shaped proboscis.

Gonosome. Gonophores in the form of fixed sporosacs or free medusæ.

There is, it appears to me, as little advantage in separating this family into two (*Bimeriidæ*, *Bougainvilliidæ*) on the basis of the free or fixed character of the gonophores, as there is in dividing the *Corynidæ* into two families on the same grounds. I have ventured, therefore, to restore the family *Atractylidæ*, as Hincks understood it, changing the name, however, for reasons which Allman has fully set forth ('71, p. 299). The oldest genus in the family thus constituted is *Bougainvillia*, for which reason I have given its name to the family.

Bimeria. Wright.

Bimeria. T. S. Wright, Edin. N. Phil. Jour., 1859, n. s., X., p. 109. Hincks, Brit. Hydr. Zooph., 1868, p. 103. Allman, Gymnobl. Hydr., 1871, p. 297.

Garveia. T. S. Wright, Edin. N. P. Jour. 1859, p. 109. Hincks, Brit. Hydr. Zooph., 1868, p. 101. Allman, Gymnobl. Hydr., 1871, p. 294. Nutting, Proc. Wash. Ac. Sc., 1901, III., p. 166.

Trophosome. Colony branching, hydranth fusiform with conical proboscis, and invested with perisarc which may cover the tentacles and proboscis proximally.

Gonosome. Gonophores sporosacs, never borne on body of hydranth.

The original diagnosis of *Bimeria* was based upon specimens of *B. vestita* Wright, which up to the present time has been the only species definitely referred to the genus, with the exception of a species from San Diego, Cal., described by Clark ('76), under the provisional name of *Bimeria* (?) *gracilis*.

The character which distinguishes the trophosome of *Bimeria* from that of *Garveia* in the diagnosis of Hincks ('68) and Allman ('71) is the continuation of the perisarc so as to invest the proximal portion of each tentacle. Allman adds that the perisarc also covers the hypostome to within a short distance of the mouth.

I have examined specimens of *Garveia annulata* Nutting from the collection which contained the type of his species, and find that they are similar in all respects to a hydroid from the entrance of San Francisco Bay. These San Francisco specimens were carefully examined to determine the presence or absence of perisarc on the tentacles. It was extremely difficult to make out the distal limit of the perisarc. It is certainly attached to the cœnosarc, thinning away distally very gradually. Soaking in caustic potash destroyed more than the distal half of each tentacle, and demonstrated that the basal portion of each was sheathed in delicate perisarc, as shown in Fig. 1, Pl. I. Repeatedly have I seen the perisarc continue upon the bases of the tentacles in the expanded living hydranth. It is by no means an "opake brown" (Hincks, '68, p. 103) nor is it so conspicuous and its distal limit so clearly marked as in Allman's figure of *B. vestita* ('71, Pl. XII). But these cannot be considered differences of generic importance. Neither do I think that the extent of the perisarc offers any longer a proper criterion for the separation of the two genera. The tentacles of *B. vestita* are alternately elevated and depressed; those of *G. nutans* and the present species are not. This character by itself, however, is not even of specific importance.

While the trophosomes do not offer distinguishing characters, the gonosomes of these genera are held to be distinct for two reasons: first, the gonophore is "borne on the summit of a true branchlet, where it takes the place of the hydranth on an ordinary branchlet" (Allman); second, the perisarc of this branchlet expands below the gonophore into a sort of cup (Nutting). The Alaska and San Francisco specimens agree in possessing gonophores, some of which are completely covered with perisarc, as in the typical *Bimeria*, and lack the proximal cup-like expansion, while others are left half naked by the rupture and retraction of their perisarcal covering, and still others possess what approximates the cup-like expansion that Nutting describes.

The "branchlets" on which the gonophores are borne are no less like peduncles than those of the *B. vestita* which Allman figures. They are similar to hydranth-bearing branches in color, diameter and the transverse wrinkling of the perisarc characteristic of the species.*

In the gonosome, then, as in the trophosome, *G. annulata* is intermediate between the types of *Bimeria* and *Garveia*, possessing and combining the essential characters of each. It seems no longer desirable, therefore, to retain both generic names. Originally both appeared on the same page of one of T. S. Wright's papers (1859, p. 109), with *Bimeria* first. This name will consequently take precedence.

Bimeria annulata Nutting.

Pl. I. Figs. 1, 2, 3.

Garveia annulata, Nutting, Proc. Wash. Ac. Sc., 1901, III, p. 165.

Distribution. Santa Catalina I., Cal., 42 fathoms; San Francisco Entrance, Cal., between tides. Yakutat and Sitka, Al. (Nutting).

Bimeria franciscana, sp. nov.

Plate I. Fig. 4.

Trophosome. Stems rising to the height of about 70 mm. in dense clusters from a tangled hydrorhiza which creeps over the bases of the stems for a few millimeters. Branches arise at short intervals in all planes; some may be more than half as long as the main stem. On these are borne secondary branches, which have hydranths. All secondaries borne on the *distal side* of the branches, alternately to right and left. Hydranths fusiform with 14–16 tentacles; conical hypostome.

Perisarc of the main stem moderately thick, smooth, without annulæ. On the branches it is much thinner and roughened by irregular wrinkles which extend to hydranths. A few more or less definite annulæ at the origin of the branches and branchlets. Body of each hydranth invested with perisarc. Color brown throughout.

Gonosome. Sporosacs with very short peduncles borne irregularly on secondaries and ultimates in the proximal half of the colony in abundance. Female with prominent spadix and one or two ova. Invested with a layer of perisarc.

Distribution. San Francisco Bay, between tides.

* The annulation of the stem is by no means so regular and prominent as the figure in Nutting's paper (1901, Pl. XVI, fig. 1) would lead one to suppose, nor are the gonophore stalks there shown typical for all colonies.

This is in all probability the hydroid that A. Agassiz ('65, p. 152) suggests may be the hydrarium of *Bougainvillia (Hippocrene) mertensii*. There is nothing in his notice to indicate that he saw the gonosome on the hydroid, and that would account for a mistake in referring a free medusa to a form with fixed sporosacs. His brief description, so far as it goes, answers well for the present species. So far as I know, there is no *Bougainvillia* in San Francisco Bay.

Bimeria robusta, sp. nov.

Pl. 1. Figs. 5, 6, 7.

Trophosome. Hydrorhiza encrusting. Stems and larger branches stout, polysiphonic. Colony may be 13 cm. long, longest branches 4 cm. or even 6 cm. long. The latter arise irregularly. Hydranth pedicels from these, or from secondaries which are always short (6–8 mm.) and may bear 2-4 hydranths. All branches rather closely associated. Perisarc wrinkled throughout, investing the hydranth body and possibly bases of the tentacles.

Hydranths fusiform, with conical proboscis, the largest with 11 tentacles, rarely 12, in one case 16. Five tentacles are longer and often stouter than the others, subequal, suberect, and belong to the first whorl. The tentacles of the second whorl, alternate with these, are shorter, subequal, and bend downward.

Gonosome. Absent.

Distribution. San Pedro, Cal. Covered with diatoms and Tentaculifera. Growing in company with *Eudendrium rameum* and *Tubularia crocea*, on the float at the ferry landing.

This species is placed provisionally in the genus *Bimeria* until the character of the gonosome shall have been determined.

Perigonimus Sars.

Trophosome. Hydrocaulus branched or simple, rooted by a filiform hydrorhiza. Hydranth fusiform with conical hypostome.

Gonosome. Free medusæ, with either two or four marginal tentacles with bulbous bases but without ocelli.

Perigonimus repens (Wright), Hincks.

Atractylis repens, Wright, Proc. Roy. Phys. Soc. Ed., I, p. 450.

Perigonimus repens, Hincks, Brit. Hyd. Zooph., 1868, p. 90.

Perigonimus repens, Calkins, Proc. Bot. Soc. N. H., 1899, XXVIII, No. 3, p. 339.

Distribution. Sausalito, Cal., between tides. Townsend Harbor, Wash. (Calkins). Great Britain (Allman).

A single colony covering the shell of *Nassa mendica*. Some of the medusæ were about ready for liberation (March 25, 1895).

Fam. CLAVIDÆ.

Trophosome. Hydranths clavate or fusiform, with scattered filiform tentacles.

Gonosome. Gonophores fixed sporosacs.

Clava, Gmelin.

"*Trophosome.* Hydrocaulus rudimental and consisting of very short tubular processes from the free surface of a hydrorhiza which is composed of creeping tubes, either distinct or adnate to one another by their sides, and invested, as well as the rudimental hydrocaulus, by an obvious perisarc. Hydranths claviform.

"*Gonosome.* Sporosacs springing from the body of the hydranths at the proximal side of the tentacles." Allman, '71.

Clava leptostyla Ag.

Pl. I. Figs. 5, 8, 9, 10, 11, 12.

Clava leptostyla, Ag., Contr. N. H. U. S., 1862, IV, p. 218.

Distribution. San Francisco Bay, Cal. Massachusetts Bay (Agassiz). Great Britain (?) (Hincks). Between tides.

Found the year round, with sporosacs, in Oakland Harbor, (brackish water). The sexes of this species are ordinarily separate, but occasionally a colony will be found with individuals of both sexes, one predominating greatly, however; instances of hermaphroditic gonophores have been met with also.

Regeneration. This species regenerates readily. Pieces cut from a hydranth may produce hydranths at each end. (Figs. 8,9). The basal portion of the hydranth, if left attached to the stolon, will produce tentacles and a mouth. The development of the tentacles on one such piece was followed. During the night after the animal was sectioned four tentacles appeared at the same level (Fig. 10), and, to judge by their equal length, simultaneously. The next four appeared simultaneously just proximal to and alternating with these (Fig. 11). The third four appeared simultaneously, proximal to these directly in line with those of the first quartette (Fig. 12). The scattering of the tentacles evidently takes place later.

According to Allman's observations on *C. squamata*, the tentacles appear on the fixed planula in the same way; so that there is in *Clava* a certain correspondence of methods of regeneration and normal development. This correspondence is not necessarily true for all hydroids, (*e.g.*, *Tubularia*, *p.* 46), which makes it important to determine the factors which lie behind the differences wherever they exist.

Fam. Corynidæ.

Trophosome. Hydranths spindle shaped, with scattered capitate tentacles, and a conical proboscis.

Gonosome. "Fixed sporosacs, or medusæ with a very long manubrium, four marginal tentacles and four sense bulbs with eye-spots." Nutting, 1901, p. 164.

Syncoryne.

Trophosome. Characters of the family.

Gonosome. "Free medusæ with a very long manubrium, four margina tentacles and four sense bulbs with eye-spots." Nutting, 1901, p. 164.

Syncoryne eximia Allman.

Coryne eximia, Allman, Ann. N. H., 1859 (3), IV, p. 141.

Syncoryne eximia, Allman, Ann. N. H., 1864, (3), XIII, p. 357. Nutting, Proc. Wash. Ac. Sc., 1901, III, p. 166.

Distribution. Pacific Grove, Cal. Juneau, Al. (Nutting). Gt. Britain (Allman). Lofoten Is., Norway (Sars).

Fragment of stem. No gonophores. Dec. 19, 1896.

Syncoryne mirabilis Ag.

Coryne mirabilis, Ag., Contra N. H. U. S., 1862, IV, p. 185.

Coryne rosaria, A. Ag., Ill. Cat., 1865, II, p. 176.

Distribution. San Francisco Bay, between tides, Atl. U. S. (Ag. and Clark). Spitzbergen (Marktanner—Turn.).

It does not seem to me that a separation of the western representative of this species from the eastern is advisable. The trophosomes agree in all points, and it is doubtful whether the medusæ are distinguishable.

As Agassiz has said concerning *S. mirabilis*, it lives either in the open sea or in brackish water in equal abundance. Corresponding with these extremes of habitat it lives in San Francisco Bay under two forms. The one grows at the entrance of the bay, upon rocks which are exposed to the breakers of the open ocean; the other has been found upon wharf piling on the eastern shore of the bay, where the water is comparatively quiet, usually muddy and brackish. The former has the more vigorous appearance; the perisarcal tube is firm and is filled by the coenosarc; the stems reach the height of an inch, and may branch three or four times. The latter has a more delicate perisarc, from which the attenuated coenosarc has shrunk away. The branching is not profuse, but the branches are longer and are matted together in tangled masses not characteristic of the other form. The colonies from the Bay entrance possessed numerous medusæ Dec. 14, 1895. There were a few medusæ on colonies collected at West Berkeley (bay form) August, 1894.

FAM. EUDENDRIIDÆ.

Trophosome. Branching hydrocaulus, invested with perisarc. Hydranths more or less ovate with a single whorl of filiform tentacles; proboscis abruptly differentiated from the body.

Gonosome. Gonophores fixed sporosacs.

The integrity of this family can no longer rest solely upon the shape of the proboscis. In *Hydractinia milleri* the proboscis represents a condition transitional between the conical and trumpet shaped types. In combination, however, with the non-fusiform hydranth and the branching hydrocaulus, the limits of the family are still sufficiently well marked.

Eudendrium.

Trophosome. Same as for family.

Gonosome. Male gonophores polythalamic, borne on body of hydranth in a whorl proximal to tentacles. Female gonophores monothalamic, less regularly distributed on hydranth body or stalk.

Eudendrium californicum, sp. nov.

Pl. II. Figs. 13, 14.

Trophosome. Stem stout, simple, reaching 140 mm. or more in length, in clusters of 6 or 8 from an encrusting platelike hydrorhiza. Each ascends in a very loose spiral, giving rise to branches at moderately frequent intervals in all planes. These branches first bend away from the stem at a wide angle, turning upward near the tip. The branches are usually less than 20 mm. long, of nearly the diameter of the stem and branching similarly, though their branches (secondaries) tend to bend toward the distal end of the colony. Hydranths, with 20–22 tentacles, borne on secondaries, though one fertile hydranth may appear at times near the base of a primary. Color of hydranths flesh pink.

Gonosome. Perisarc annulated regularly in narrow annulæ on stem and branches, extending as a thin expansion upon the bodies of the hydranths to the bases of the tentacles. Very dark brown, may be almost black. Female gonophores monothalamic, crowded on the body of the hydranth immediately proximal to the tentacles; each gonophore usually with one ovum to which its orange color is due. Male gonophores dithalamic, in two or three whorls just proximal to tentacles; a delicate pink with small green spadix. Gonophores of both sexes invested with perisarc.

Distribution. Entrance of San Francisco Bay; Tomales Bay, Cal.; Pacific Grove, Cal., between tides.

This species resembles *E. vaginatum* closely, but differs in the distinctly narrower annulation of the perisarc, and the habit, which is much freer and more graceful, though the branches are quite rigid. The annulation agrees perfectly with that figured by Clark ('76) for a hydroid from Santa Cruz; this, with his description and the fact that *E. californicum* occurs both north and south of Santa Cruz, removes any doubt in my mind that his species is identical with the latter, rather than with *E. vaginatum*. It is probable that *E. pygmæum* Clark ('76) is a synonym of *E. vaginatum*, as Nutting suggests.

Colonies with female gonophores were collected during November, December, January; male gonophores were seen in January, 1902.

It is clear from Fig. 14 that the gonophores are borne on young but fully formed hydranths which may not lose their tentacles as the gonophores develop. Often the gonophores become so numerous as to crowd the tentacles, which are then usually more or less concealed; but in no case that I have examined are they wanting.

Eudendrium rameum Pallas.

Tubularia ramea, Pallas, Elenchus Zoophytorum, p. 83.
Eudenrium rameum, Johnston, Brit. Zooph., 1847, p. 45.

Distribution. San Pedro, Cal. Mediterranean, Norway, Great Britain (Allman). Jan Mayen (Marktanner-Turneretscher).

The hydroid which I have referred to this species, hitherto unrecorded for the Pacific Coast, reaches a length of 11 cm. The stem is polysiphonic, the perisarc heavy and brown. Branches appear irregularly but tend to lie in one plane, more or less alternate. Secondary branches approximately alternate, in planes at an angle of 120°. Tertiaries arise similarly on secondaries and may branch. All branches with 2–5 rings at the base, though not always sharply marked. Hydranths usually on the distal side of the branches; tentacles 24–27, in one whorl; prominent nettle cells in a close spiral on each tentacle; hypostome trumpet shaped.

Gonosome absent (December, 1901).

Growing at the surface, on a float at the ferry landing.

Eudendrium ramosum Linn.

Tubularia ramosa, Linn., Syst. Nat., ed. X.

Eudendrium ramosum, Ehrenberg, Corallenth. des r. Meeres. Abh. Berl. Ac., 1832, p. 296. Allman, Gym. Hyd., 1871, p. 332.

Distribution. Pacific Grove, Cal. Great Britain (Allman). Adria, Rovigno, Jan Mayen (Mark. T.)

The gonosome is not present, but the trophosome agrees in all details, save size, with the description and figure in Allman's monograph. Length of tallest stem 35 mm.

Not previously reported from the Pacific Coast.

Fam. HYDRACTINIIDAE.

Trophosome. Two sorts of persons: clavate or cylindrical naked hydranths arising from the encrusting hydrorhiza, with a circlet of filiform tentacles and a conical or clavate proboscis; spiral zooids, usually at the edge of the colony. Hydrorhiza may be beset with spiny processes.

Gonosome. Sporosacs borne upon more or less specialized hydranths.

Hydractinia Van Ben.

With the characters of the family.

Hydractinia milleri, sp. nov.

Pl. II. Figs. 15, 16, 17, 18, 19, 20.

Trophosome. Sterile hydranths with 8-20 filiform tentacles, which in contraction may be seen to be arranged in closely approximated alternating series of four each around the base of a clavate (in contraction subconical) proboscis. Larger ones 3-5 mm. long (preserved specimens). Spiral zooids at the edges of the colony about as long as the sterile hydranths, but much more slender; end knobbed, the whole structure resembling a very long tentacle. Processes from the encrusting hydrophyton, tubular without spinules or coenosarcal investment, $\frac{1}{2}$-1 mm. in length.

Gonosome. Fertile hydranths, usually not more than one half as long as sterile ones and more slender, with 3-8 filiform tentacles around the base of a long clavate proboscis, with a terminal mouth. Sporosacs borne on hydranth about midway between base and tentacles. Male sporosacs spherical with small spadix; female smaller, slightly elongated, with distally extended spadix, and containing one, or at most, two eggs.

Distribution. San Francisco Entrance; Tomales Bay, Cal.

This hydroid grows commonly in patches sometimes several square inches in extent on rocks exposed to the breakers of the open sea, between tidal limits. The color of the hydranth and male gonophore is a very delicate pink; the female gonophores are of a faint orange due mainly to the yolk in the egg. The perisarc of the hydrophyton is of a dark horn color. Each gonophore has a separate origin from the fertile hydranth. I have never seen more than four on the same hydranth.

This species is readily distinguished from the eastern *H. polyclina* and European *H. echinata* by the tentacles on the fertile hydranths, the smooth tubular processes from the hydrorhiza, and the small number of eggs in the female gonophore. The sterile hydranths are much stouter than those of *H. polyclina*, with which I have compared them. The species is related closely to the *Stylactis fusicola* (Sars) of Allman. The latter has all the characters of *Hydractinia* save the spiral zooids and the coenosarcal covering of the hydrorhiza—both of which characters might have been easily overlooked. Sars originally described the species as a *Podocoryne*, from which genus it is excluded by the possession of fixed sporosacs. I feel, however, that Allman was hardly justified in removing it to his genus *Stylactis*.

The arrangement of tentacles in series of four each is of considerable interest. These series evidently represent successive generations of tentacles—though four do not appear simultaneously in all cases at least, since at the edge of a colony young hydranths often may be seen with three or five tentacles not of a uniform size.

This development in quartettes I have repeatedly observed in regenerating hydranths of *C. leptostyla*, and the same thing occurs in the egg development (Allman). In a recent paper Paul Morgenstern ('01, p. 567) shows that the first four tentacles in *Cordylophora*, a near relative of *Clava*, appear in twos at the same level. This is true also for *Syncoryne (Coryne) mirabilis* Ag. I have found that the regenerated distal tentacles in

Corymorpha palma appear similarly to those in *Clava* up to the number of twelve at least. In embryos of *Tubularia* the first tentacles to be developed are two in number and opposite. The distal tentacles develop in fours. In regenerating, however, both proximal and distal tentacles appear in considerable numbers simultaneously and in a peculiar manner. Possibly the conditions under which regeneration takes place have determined the method of regeneration in this case. There is a wide discrepancy here between this method and the one employed by the related *Corymorpha*, where the distal tentacles appear in fours and as buds, not ridges. The appearance of the tentacles in *Hydra* has been variously reported. In one case, in a *Hydra* bud two opposite tentacles appeared simultaneously, then a single dorsal one, followed by a ventral one, completing the quartette.

Another form is worthy of note in this connection — the *Bimeria robusta* of San Pedro. The tentacles of the budding hydranths in this species appear in *fives*, there being usually two complete whorls of five tentacles each, and another with from one to three. In the adult condition the whorls are almost indistinguishable except by the habit of carrying the tentacles alternately raised and depressed. I venture to suspect that the related *Perigonimus* may develop on this plan, a view supported by Allman's figure of *P. repens*. There may be here a criterion for the determination of larger groupings of far more moment than the fixed or free habit of the gonophores.

But it is quite impossible at present to establish certain phylogenies on this basis. I shall refer more in detail to the growth of tentacles in discussing the species concerned.

The exceptional shape of the proboscis of *H. milleri* should be emphasized, as it is of some taxonomic importance. It is usually long, and especially prominent in the fertile hydranths where it is set off from the body of the hydranth by a narrowed base and is swollen distally. Even in cases of extreme contraction, which are common among the sterile hydranths, this swollen extremity preserves its identity (Pl. II, Fig. 18). In no case have I seen what might be called a typically conical proboscis. The shape is clearly intermediate between the conical and the trumpet shaped types, the latter of which is so characteristic of the *Eudendriidæ*.

FAM. PENNARIIDÆ.

"Hydrocaulus branched or unbranched. Hydranths much enlarged proximally with one ring of large filiform tentacles about the base and with another set of capitate or filiform tentacles distributed irregulary or regularly. Proboscis conical, short, and not distinctly limited but passing gradually into the hydranth. Gonophores in the form of medusæ or of sporophores." (Calkins, '99, p. 335, translated from Schneider, '97.)

Corymorpha.

Trophosome. Hydranths solitary, rooted by filamentous processes; with several whorls of closely set distal and one whorl of larger proximal filiform tentacles. Cavity of stalk in the shape of a number of superficial longitudinal canals of equal size. Perisarc thin, non-supporting.

Gonosome. Gonophores borne between proximal and distal tentacles, medusiform, fixed or free, with four radial canals and one to four tentacles, all of which may be rudimental.

Corymorpha palma, sp. nov.

Pl. II. Fig. 21.

Trophosome. Stem 2–4 inches long, rooted in the sand by a dense tangle of filamentous processes and covered by perisarc proximally for $\frac{1}{8}$ or $\frac{1}{4}$ its length. Thickest near proximal end, tapering gradually into a narrow neck which supports the hydranth. Hydranth with 18–30 proximal tentacles in one whorl, with a span of an inch or less; 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 canal, four radial canals, and a manubrum at least twice as long as the bell, without a mouth; tentacles, wanting; velum may be present or absent.

Distribution. San Pedro, Cal., throughout the year; between tides.

This species resembles the eastern *C. pendula* closely, but differs in lacking all but the merest rudiments of tentacular processes on the medusa bell, which is much shorter, relatively to the manubrium, than in *C. pendula.* Nor is the color a "bright pink" (Agassiz), it being an extremely delicate pink, if it can be said to have any color at all in hydranth and stem. The endoderm of the gonophores is usually furnished with green color bodies.

I was long in doubt as to whether the gonophores ever became free. On individuals collected in summer and winter months, gonophores were always present in various stages of development ranging from the earliest appearance of buds to medusoids with long manubrium and pulsating bell. This pulsation seemed to indicate that the medusa was ready for liberation and was attempting to free itself. Yet these apparent struggles for liberty have continued, in aquaria, for more than ten days, without success. The bell finally shriveled away, leaving entirely naked the long mouthless manubrium. I have never seen a medusa detach itself nor were they seen to my knowledge in the tow taken daily in San Pedro Harbor during the latter part of May, and the entire months of June and July, 1901, although I have seen eggs on the manubrium of different attached medusæ during the same months.* The individuals examined in December had no sexual cells, which makes it probable that the breeding season is limited to the warmer months of the year.

The perisarc surrounding the lower part of the stem is thin and flexible; this invested portion of the stem is more transparent than the rest, and its ectoderm contains very few scattered nettle cells, compared with the many that appear at once as soon as the distal edge of the perisarc is passed and cover the rest of the stem.

C. palma inhabits sand and mud flats between tides, often thickly covering patches many square yards in extent. The filamentous rootlets by which it is anchored, arise as outpocketings on the proximal coenosarcal canals, under the perisarc. These small processes, or frustules (Allman), may occur regularly in pairs on each canal, or they may be more or less scattered or alternately arranged. There are usually not more than eight pairs on each canal, rather closely associated. The proximal ones are longest. Each process in elongating grows downward for some distance, closely applied to the stem in the manner of a stolon as though responding to a thigmotactic stimulus. The enlarged

* Since this paper was sent to press eggs of Corymorpha have been laid in the the laboratory (in May, June, and July, 1902). They drop from the manubrium of the attached medusa, and stick by their adhesive coat to whatever they first touch. There is no free swimming larva. Often the young are clustered on the root filaments of old hydroids. The new species of Tubularia recently described by Hargitt (Am. Nat., July, 1902) is undoubtedly based on such clusters of young individuals of Corymorpha. Buds of the peduncles which support the medusoids appear very early. I shall describe the development more fully in another paper.

free end is connected by a much attenuated stalk to the place of origin. It finally turns outward, investing itself with perisarc and may attain to the length of an inch, penetrating between and adhering to sand grains. The longest processes are usually nothing but perisarc, the attenuated coenosarc having disappeared.

The characteristic attitudes of the expanded hydroid are somewhat different from those of *C. pendula*. It is oftenest perfectly erect, in quiet water, the plane of the tentacles being slightly tilted from the horizontal. It may bend downward, however, in which case the arching includes the greater part of the stem. I have never seen it assume the pendulous attitude shown in Agassiz's figures of *C. pendula*.

Orientation. A few simple experiments demonstrated that the erect posture of the stem was assumed in response to a geotropic stimulus. To determine relatively the specific gravity of different parts of the polyp, the basal tufts of sand-incrusted filaments were cut from several polyps and the latter were placed in an aquarium. They sank directly to the bottom, distal (hydranth) end foremost. Then several other polyps, together with two polyps with proximal filaments removed, were put into a jar filled with water so that all but a small bubble of air was excluded when sealed. When the rooted polyps had assumed erect postures the jar was transferred to a dark closet and tilted at an angle of 45°, the polyps remaining parallel to the sides of the jar. In an hour all the polyps had become erect. The jar was righted, and within another hour the polyps had oriented themselves again in line with the pull of gravity. The polyps without basal filaments did not change their position materially during the whole experiment, without doubt because they lacked a proximal point of support.

There was no difference in the result when the experiment was performed in the light or in darkness. To determine whether light exercised a directive influence, several polyps were exposed before a window, so screened that the light came from one direction only. At the end of three hours, no effect on their attitudes was visible. Light thus appears to be without influence as an orienting factor, and the following experiment was performed in the day light.

Two individuals were suspended by a string so that the stems pointed directly downward. Within seven hours both had assumed horizontal positions. At the end of thirty hours one was bent sharply upon itself so that the distal four-fifths of the stem was vertical, the knot by which the animal was tied interfering with the assumption of a vertical position by the entire stem; the other polyp was extended upward at an angle of 45°. On the following day both were as nearly vertical as the knot would allow; and so they remained until released several days later.

To determine whether the sensitiveness to the stimulus of gravity was local or general, three polyps were transversely sectioned, the first just below the hydranth, the second half way down the stem, the third near the base. They were placed in the dark in an airtight jar, which was set at different angles as in the first experiment. Like results followed. Each piece responded, the shortest taking the longest time to become erect, the longest one the shortest time, but all finally arranging themselves in line with the pull of gravity.

To determine whether the muscles of the stem or the vacuolated endoderm cells (skeletal cells) respond to the stimulus of gravity, the following experiments were made. An individual was decapitated, and cuts were made on one side at three levels, half through the column, thus destroying the continuity of the muscle layer on that side in three places. The muscles contracted between the wounds, causing them to gape; the gaps were soon filled by skeletal cells. The column bent toward the side opposite the wounds showing the greater potency of the uncut muscle layer. When, however, it was laid upon the bottom of the aquarium, wounded side uppermost, it assumed an erect posture in about an hour—moving toward the muscularly weaker side.

Another individual was cut in a similar manner, though there were eight or ten cuts, alternately on one side and the other. These cuts interrupted the continuity of the muscle layer on the entire circumference except for very short distances. The column lay quite limp on the floor of the aquarium immediately after the operation. Within two hours, however, it had stiffened into an erect posture, though the wounds had not closed.

These experiments seem to demonstrate what was suggested by the slowness of the orientation of the normal individual and the method of lengthening the stem by increasing the turgescence of the skeletal cells (since the diameter may increase at the same time) viz., that the skeletal cells alone are susceptible to geotactic stimulation, the muscles producing only such comparatively rapid movements as the contraction of the tentacles and the proboscis, and the bending of the column away from the perpendicular against the stimulation of gravity.

Response to tactual stimulation. A vigorous stimulus, such as a pinch by forceps, results in a contraction of the stem within two seconds, whether the stimulus is applied to a tentacle or the proboscis or the proximal or distal portion of the stem itself. Only that part of the stem contracts that is not invested in perisarc, though the perisarc seems to be too thin to be an effective hindrance to contraction in the basal region. The fact may be formulated in this way: A vigorous stimulus applied in any region of the body produces a definite localized response. The phenomenon reminds one forcibly of the behavior of *Mimosa* under stimulation, and is due to the same immediate cause—a change in the turgescence of certain large vacuolated cells, which in *Corymorpha* form the axis of the stem.

A stimulus too slight to produce any reaction when applied to the stem, may be effective with a tentacle. The tentacle may respond at once and independently of all the others, by shortening slightly, and waving toward the proboscis. This reaction is the same, whether the stimulus be applied to the tip or base, upper or lower side. If the stimulus be increased, all the tentacles may contract, without any evidence of response in the stem.

These reflex movements indicate the presence of a co-ordinating mechanism which appears to have adaptive value for the prehension of food and for protection.

Regeneration. C. palma regenerates certain lost parts with great readiness. Pieces of the stem produce remarkable cases of hetermorphosis, which will be considered in another paper. A few of the facts connected with the regeneration of the hydranth may be mentioned here.

Proximal and distal tentacles appeared on several regenerating pieces of the stem in the following manner: The proximal tentacles, averaging about twenty-four in the adult, arose as buds, in two series. The tentacles of the first series appeared simultaneously to the number of seven to fourteen, the number being conditioned apparently by the diameter of the stem and the number of canals in it; a tentacle arose on each canal. The tentaeles of the second series appeared singly, between the tentacles of the first series, some time after the latter.

The distal tentacles are filiform in the adult, and are scattered and more numerous than the proximal ones; in small regenerating pieces they are somewhat capitate at first and arranged more or less regularly in whorls of four (quartettes), each whorl being proximal and alternating with the one immediately preceding it. The tentacles of the several whorls did not develop simultaneously. They may appear one at a time, in no order that I have yet determined; but their arrangement in quartettes in the first two or three whorls seems to be certain.

The bearing of these observations upon the question of the affinities of *Corymorpha* is important. The young regenerated hydranth of *C. palma* is essentially identical in form with young hydranths of *Pennaria* and *Tubularia*.* Each possesses a flask-shaped body, a whorl of filiform proximal tentacles and one or more quartettes of capitate distal tentacles. This agreement supports the view of Schneider, which has been adopted by Calkins ('99), and with which I am in accord, that the *Tubularidæ* and *Pennaridæ* should be united to form but a single family, since the capitate or filiform character of the distal tentacles offers hardly sufficient ground on which to base a distinction between families. The *Tubularidæ* as here used include both the *Corymorphidæ* and *Hybocodonidæ* of Allman ('71) and later authors. For the *Hybocodonidæ* have been distinguished from the *Tubularidæ* only by the possession of free swimming medusae, those of the latter family being permanently attached. The difference is of minor importance. Moreover, *Tubularia couthouyi* and *Corymorpha palma* should hardly be placed in distinct families on account of differenees in extent of perisarc, and character

*With the uncertain *Vorticlava* Alder and *Acharadria* Wright also, which lack the gonosome and are probably immature forms.

of root filaments, the only respects in which they differ conspicuously. It is because of the transitional condition of these filaments in such forms as *Tubularia couthouyi* that we are able confidently to interpret those of *Corymorpha* as homologous with the creeping hydrorhiza of other forms.

It may be mentioned that peripheral canals and a solid endodermal axis are present in *T. couthouyi* and *T. indivisa*, as well as in *Corymorpha*. This condition seems to be a direct adaptation to size, since all three species have exceptionally large diameters.

Tubularia Linn.

Trophosome. Hydrocaulus usually unbranched and rising from a creeping hydrorhiza; both completely invested with perisarc. Hydranth with two sets of filiform tentacles.

Gonosome. Gonophores fixed, more or less medusoid.

Tubularia crocea (Ag.).

Pl. II. Figs. 22, 23.

Parypha crocea, Agassiz, Contr. N. H. U. S., IV, 1862.
Parypha microcephala, A. Agassiz, Ill. Cat., II, 1865.
Tubularia crocea, (Ag.), Allman, Gymn. Hydr., 1871.

Distribution. San Francisco Bay, San Pedro Harbor, San Diego Bay, Cal. Eastern U. S. (Ag.).

This species is essentially a brackish water, harbor form. It has been recorded already for San Francisco, Cal., by Alex. Agassiz, in his Illustrated Catalogue ('65) under the name of *Parypha microcephala*. Agassiz distinguished it from *P. crocea* in the belief that it had a more slender stem and smaller head. Numerous observations on the living animals from Oakland Harbor, at different times of the year, have demonstrated to me that these characters are not constant; and I cannot find any others upon which to base a separation of the western from the eastern form. According to observations made at San Pedro during December, on living animals, the tentacular processes on the female gonophores are eight in number, though they may vary greatly in size and shape, appearing at times as little more than small welts about the bell mouth. L. Agassiz says of the male gonophores: "The male medusoids never have any tentacles, nor do they deviate from an almost perfectly spherical shape." Fig. 15, Pl. XXIII of his work, however, shows a raised welt at the edge of the bell mouth, divided by radial wrinkles into a number of rudimentary processes. Fig. 22 of the present paper represents a male gonophore drawn at San Pedro from life, on which there are eight unmistakable flattened tentacular processes. It does not represent the condition in all male gonophores, however, for these tentacular processes vary in size almost to the vanishing point. The shape of the bell is not constant, either, though varying far less than that of the female gonophores. All of these variations in size and shape are due either to different degrees of contraction—which applies especially to the tentacular processes; or to the nature of the contents—which applies especially to the shape of the gonophores. The female gonophores are less symmetrical than the male only when they become distorted by the growth of the contained embryos, which often number four or even more.

I have seen actinulæ liberated at Oakland in September and at San Pedro in July, August and December. Specimens dated May 10, 1898, in the University of California collection, have heavily loaded male gonophores.

In midwinter, headless stems only are found ordinarily in Oakland Harbor. At the same time of year the species is growing luxuriantly at San Pedro where it is found the year round. The difference is perhaps to be explained by a difference of habit. The headless stems in Oakland Harbor are attached to fixed supports, such as the piles of wharves and bridges, sometimes as many as three feet above mean low water mark. Consequently they are exposed to the air at least once a day, at ebb tide. On the other hand, the San Pedro colonies which grow so luxuriantly the year round are attached as a rule to floating timbers, unused barges and other floating supports; consequently they are never uncovered at ebb tide. It is possible that the severity of the diurnal change to which the Oakland colonies are subjected during the winter is the cause of the loss of the hydranths. Whether well formed colonies continue below mean low water through the winter I cannot say positively, but so far as I have been able to see from the surface at low tide, they do not. If they do not, then it is probable either that the temperature of water is too low for them, or that they do not grow during any season below mean low water mark. From their prevalence on floating supports, near the surface and hence near the oxygen supply—usually a position of great advantage in harbor water, so constantly fouled with sewage and other dirt—I suspect the latter to be the more probable alternative.*

A word might be added with reference to S. F. Clark's species, *Tubularia elegans*, collected on the piles of a wharf in San Diego Bay. Clark's description would suffice for *T. crocea*, with two exceptions: 1. There are "about thirty tentacles in the proximal set" in *T. elegans*, while I have never seen more than twenty-five by actual count in *T. crocea*. 2. Instead of several flattened tentacular processes around the mouth of the gonophore, there are four conical tubercles crowning the larger gonophores, which Clark has figured.

The first difference is of little consequence, since "about thirty" might mean twenty-five. The second is more important, and I would not have been led to doubt the validity of Clark's species, had I not found in the University of California collection several colonies of *T. crocea* from Coronado. In some of the female gonophores, the tentacular processes are much contracted and might be judged without careful observation to be conical and fewer in number than they really are. Clark's material was very poor, being in "the same delapidated condition" as a *Bimeria* (?) packed with it, whose "hydranths and sporosacs especially were in a very worn and mutilated state." These facts make it evident that Clark's figure is rather diagrammatic and that he did not have sufficiently well preserved material to be certain of the tentacular processes. For these reasons I am of the opinion that *T. elegans* will prove to be a synonym of *T. crocea* Ag.

Regeneration. Regeneration of pieces of the stem occur in the way already known for *T. mesembreanthemum*. Both distal and proximal sets of tentacles first appear as welts or ridges on

* Since every colony arises from a single actinula, its position must be determined by the influences that control the movements of the actinula during its free existence. It would be interesting to know whether these influences include any of the tropisms, for instance, geotropism and chemotropism (with respect to oxygen.)

the coenosarc. The proximal set has about one-half (12) its adult number; the distal approximating their final number quite closely (15–18). This regenerative process, interesting to the naturalist because among other reasons it occurs constantly in nature, is doubly so because it departs so widely from the method of development of the tentacles in the egg embryo. In the latter the tentacles arise as buds, not ridges. The distal tentacles appear in successive alternating whorls of four each (quartettes). The proximal arise in a less orderly fashion, one or two at a time; probably a secondary modification of the quartette type, since the first two tentacles are opposite, and the actinula has a symmetrical eight tentacle stage. Both proximal and distal tentacles are capitate for a time, which is true also for *Pennaria* and the regenerated distal tentacles of *Corymorpha*. The questions of relationship which these facts suggest have been considered in another place (p. 42).

There is at present no explanation for this difference between regeneration and embryonal development. Driesch ('01) has seen the tentacles appear as ridges on a small naked piece of Tubularia stem which seems to exclude the possibility that confinement within the perisarc might be the determining factor. The question needs further investigation however.

Tubularia marina, sp. nov.

Pl. III. Figs. 24, 25.

Trophosome. Stems rising in clusters, from a creeping hydrohiza to a height of 30–50 mm.; moderately stout, unbranched, increasing in diameter distally; more or less annulated; annulæ more frequent and regular in proximal half. Hydranths with 22–26 proximal and 18 distal tentacles.

Gonosome. Colonies dioecious. Gonophores in about ten pendulous racemose clusters which may be as long as the proximal tentacles, and contain more than twenty gonophores each, in well developed specimens. Male gonophores very broadly ovate with four small apical processes slightly flattened laterally. Female gonophores more narrowly ovate than male, with four stout, stiff tentacles with bulbous bases, sometimes forking near their ends and as long as the gonophore. Actinulæ (S. F.).

Distribution. Trinidad, (June), San Francisco, (Dec., Jan., Feb.) and Pacific Grove, (Dec.) Cal.

This species is easily recognized by the unusually long tentacles on the female gonophores. A. Agassiz, in his Illustrated

Catalogue ('65, p. 196), has mentioned a species of Tubularia which he calls *Thamnocnidia tubularoides*, and which is characterized by the "stoutness of the stem and size of the head, surrounded by as many as from thirty and even forty tentacles in large specimens. Found growing profusely on the bottom of the coal barges which bring coal from Benicia to the Pacific Mail Company's steamers at San Francisco." This description is very meagre, but is sufficient, I think, to show that it does not refer to the species I have just described. *T. marina* is in no sense a harbor species, but grows between tides on the lee side of rocks exposed to the breakers of the open sea. Its head is not noticeably large as compared with *T. crocea*, and the largest number of tentacles I have seen is twenty-six, on one occasion only. The female gonophores are so characteristic that I feel sure they would have been described in Agassiz's notes had he seen them. I have not seen any hydroid in the bay corresponding to his description.

The nearest relative of this species on this coast appears to be *T. harrimani* Nutting, from which it may be distinguished by the much smaller number of proximal tentacles, and the greater length of the tentacles of the female gonophores.

CALYPTOBLASTEA.

Hydroida with true hydrothecæ and gonothecæ. Gonophores when free usually with otocysts; gonads on radial canals.

Fam. Halecidæ.

Trophosome. Hydrothecæ arranged alternately on hydrocaulus, shallow, saucer-shaped, incapable of containing the large hydranths in contraction, margin smooth; hydranth with conical proboscis and one whorl of filiform tentacles.

Gonosome. Gonophores sporosacs or medusoid.

Whether the Haleciidae are primitive or highly modified Calyptoblastea is a problem that is at present without an altogether satisfactory solution. The hydranth-bearing blastostyles and reduced hydrothecae place them near the Gymnoblastea. The presence of sarcostyles (*Diplocyathus* Allman) and a row of bosses on the inner surface of the theca are characters of the highly specialized Plumulariidae (cf. *P. plumularoides*). Sessile hydrothecae are characteristic of both Plumulariidae and Sertulariidae. The mode of branching, while exhibiting at times a certain irregularity suggestive of the Gymnoblastea, most nearly approaches the type of branching in the Campanulariidae, which family the Haleciidae further resemble through such forms as *Diplocyathus dichotomous* Allman, in which the hydrothecae have rudimentary stalks, and *Campalecium medusiferum*, described below, in which the gonotheca contains a series of medusoid gonophores.

This union of the characters of the various families of the Calyptoblastea is strong support for the view, which I am disposed to adopt, that the Haleciidae stand nearest of them all to the ancestral Gymnoblastea.

Campalecium, gen. nov.

Trophosome. As in *Halecium.*

Gonosome. Gonothecae each with a blastostyle bearing several medusoid gonophores.

This genus bears a relation to *Halecium* similar to that between Gonothyraea and Campanularia. The distinction is not a sharp one, being based on the degree of degeneration of the gonophores, yet it is serviceable in the absence of intergrading forms.

Campalecium medusiferum, sp. nov.

Pl. III. Figs. 26, 27, 28, 29.

Halecium tenellum, Clark, Trans. Conn. Ac., 1876, III, p. 255.

Trophosome. Stems short (5-10 mm.), sparingly and irregularly branched, rooted by a creeping stolon. Hydrotheca with strongly everted rim. Hydranth large, with low conical proboscis and 24 to 28 tentacles in one whorl.

Gonosome. Gonotheca on short peduncle arising just below a hydrotheca; about three times as long as broad; broadest at distal end which is truncate, tapering gradually to the peduncle. Orifice not determined. Gonophores 2 to 5, in linear series, medusoid, with 4 tentacles developing in pairs which differ in size, and a conical manubrium.

Distribution. Long Beach, Cal., in 6 fathoms. Bottom covered with Nitophyllum. July 6, 1901.

The material consists of a few stems on a stolon which was tangled round the bases of stems of *P. setacea* and *S. halecina*. The skeletal characters agree closely with Hincks's description of

H. tenellum, but the medusoid gonophores constitute an important difference in the gonosome. Whether the gonophores are ever liberated as medusae I have no means of knowing at present. Their development to an advanced stage, however, before definitive sex cells appear (they are not present in any of the gonophores) and before the gonotheca containing them has obtained an external opening, is a condition of affairs usually associated with the formation of free medusae—as yet unknown among the Haleciidae.

The species which Clark ('76) identifies with *Halecium tenellum* Hincks is in all probability *Campalecium medusiferum*.

Halecium.

Trophosome. No sarcostyles. Other characters those of family.

Gonosome. Female blastostyles usually bear two distal hydranths. Gonophores sporosacs.

Halecium annulatum, sp. nov.

Pl. III. Figs. 30, 31.

Trophosome. Stems rising from a creeping stolon to a height of 7 mm.; the longer have two or three 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 gonothecae broadly ovate, excessively compressed, with terminal aperture. Single gonophore with numerous ova, surrounded by blastostylar processes reaching to gonothecal wall.

Distribution. South of Coronado, Cal.; 10-fathom line; eel grass. Growing on seaweed. July 6, 1901.

Halecium kofoidi, sp. nov.

Pl. III. Figs. 32, 33.

Trophosome. Colony with a thick trunk from which branches arise irregularly, forming a sparse tuft 1½ inches high. The branches may branch again; from these secondaries the ultimate branchlets grow, alternating regularly on either side of the branch. All branches are divided obliquely into internodes of approximately equal length. Each internode usually bears on a shoulder at its distal end a sessile hydrotheca which does not reach beyond the distal internode. Within this hydrotheca another may arise on a short stalk, and within the latter still another on a similar stalk. These stalks are somewhat constricted at the base, and bend away slightly from the stem. Occasionally a stalked hydrotheca arises directly from the internode without the interposition of a sessile hydrotheca. There may be one or two wavy annulations at its base. Secondary and ultimate branches arise from the bases of hydrothecae.

The wall of the hydrotheca is especially thickened, the interior contour in profile being convex while the outer one is straight. There is a circle of bosses of variable number and arrangement around the inner surface of the wall.

Gonosome. Male gonothecae present. When mature they are long, oval, smooth, three to four times as long as broad, each attached just below a hydrotheca by a short pedicel which may have one or two faint annulatious. The base of the gonotheca may have a wavy outline. Small terminal aperture.

Color of stem and base of branches brown. Coenosarc in poor condition.

Distribution. Off Point Loma, San Diego, Cal., bottom of sand and cobbles; harbor in 5 fathoms; Catalina I., in 42 fathoms.

Halecium nuttingi, nom. nov.

Halecium geniculatum, Nutting, Proc. U. S. Nat. Mus., XXI, p. 774.

Distribution. Dredged off Pt. Loma, San Diego, Cal., July, 1901; sandy, cobbly bottom. Puget Sound (Nutting).

The single colony of this species in the collection agrees with Nutting's description in every detail save the number of tentacles (18–24 instead of 16–20), and the fasciculation, which is prominent on the stem, larger branches and bases of the smaller branches; the gonosome is absent also. Several stems of varying lengths, the longest 40 mm., arise from a stolon creeping over a fragment of seaweed frond. On the longest stem two stemlike branches are borne. On each of these and the stem, secondary branches of irregular lengths—none more than 10 mm.—arise alternately on either side in approximately the same plane. These may branch again. The non-fascicled branches are more or less regularly annulated at their bases. Only the ultimates are geniculate. Occasionally they acquire annulations similarly to those of *H. annulatum*, from which they can be distinguished by the larger size of hydranth and diameter of branches.

The specific name given by Nutting had been used already by Norman for a British species of *Halecium* (Rep. Brit. Assn., 1866, p. 196), so I have taken the liberty of substituting Dr. Nutting's own name in its stead.

Fam. Campanulariidae.

Trophosome. Hydrothecae well developed, pedunculate, non-operculate, with septum at base.

Gonosome. Gonophores free medusae or fixed.

Campanularia.

Trophosome. Colony regularly branching or unbranched, simple or polysiphonic; hydrothecae campanulate.

Gonosome. Gonophores fixed sporosacs.

Campanularia denticulata Clark.

Pl. IV. Fig. 34.

C. denticulata, Clark, Proc. Ac. Sc. Phil., 1876, XXVIII, p. 213.

Distribution. San Pedro Harbor, on float at ferry landing. Port Etches, Al,, dredged 10–18 fathoms; clayey mud (Clark).

The San Pedro colonies agree with Clark's description with the one exception that they branch. The Alaska form lacks a gonosome and is probably immature.

The branches bearing hydrothecae are completely ringed, with 5–15 rings. They arise in all planes. Above each axil the main stem has 3–8 rings. Below and opposite the origin of the hydrotheca there is a definite knee. The stem is straight between knees; as a whole not flexuous. Hydranths with 22 tentacles. Hydrothecae .65 mm. x .36 mm.: .75 mm. x .47 mm.; 1.00 mm x .45 mm. Tallest stem 20 mm. Gonosome absent.

Campanularia everta Clark.

Pl. IV. Figs. 35, 36, 37.

C. everta, Clark, Trans. Conn. Ac., 1876, III, p. 253.

Distribution. Catalina I., 42 fathoms; San Diego, 1–24 fathoms, fine sand; Pacific Grove, Cal. San Diego (Clark). Growing on seaweed. July, 1901.

This is an exceedingly variable species. The rim of the hydrothecae may or may not be everted; it is usually, but not always crenate. The wall of the hydrotheca may be very thick or very thin, and is either straight or convex in profile. The stem may be long or short, smooth, wavy or irregularly jointed. A constant feature is the presence of a spherical annula immediately below the theca. The gonotheca is somewhat compressed, ovate, with a small round terminal orifice. The wall varies in thickness and may be slightly wavy. Acrocysts containing three or four embryos were found on female colonies from Catalina. Male gonothecae are smaller than female.

Transitions between all the forms of hydrothecae can be traced in the same colony. The typical form is different, however, in different localities. As a rule the Catalina specimens have thicker walls than those from Pacific Grove, whose walls are often quite thin; the San Diego material is intermediate in this respect.

C. everta may be distinguished from *Clytia compressa*, which it closely resembles, by the gonosome only. The gonothecae have a much narrower aperture and the gonophores are fixed sporosacs.

Campanularia fascia, sp. nov.

Pl. IV. Fig. 38.

Trophosome. Height of longest stem, 45 mm. Branching irregularly and profusely, forming a coarse, shrubby tuft. Stem and branches polysiphonic; ultimates alone monosiphonic. Perisarc thin throughout, wrinkling easily. Ultimates wavy or ringed, never with more than two hydranths. Shorter hydranth stalks with 8-10 rings; longer with 9-11 at base and 5-8 immediately below hydranth, with wavy interval. Hydrothecae less than twice as long as broad, cylindrical in distal half, tapering gradually to narrow base. Rim with 11-12 moderately sharp teeth. Hydranth with 20-24 tentacles.

Gonosome absent.

Distribution. Pt. Loma, San Diego, Cal.; hard sand bottom. Covered with *Calycella syringa.*

Campanularia fusiformis Clark.

C. fusiformis, Clark, Trans. Conn. Ac., 1876, III, p. 254.

Distribution. Point Reyes Peninsula, growing on *Bimeria annulata;* Dillon's, Cal., on *Sertularia anguina.* Vancouver I., on *S. anguina.* Between tides.

This species resembles *C. urceolata* closely. The hydrothecae are deeper, narrower, with fewer and blunter teeth. The gonotheca often has a long neck. It may be sessile or raised on a peduncle with five or six annulae. Gonophores present July 7, 1898, and August 10, 1892.

Campanularia hincksi Alder.

Campanularia hincksii, Alder, Trans. Tynes. F. Club, 1857, III, p. 127.
Hincks, Brit. Hydr. Zooph., 1868, p. 162.

Distribution. Mouth of San Diego, Cal.; shallow water, shelly bottom. British coasts (Hincks), from 10–20 fathoms to deep water.

In the San Diego specimens the diaphragm is not so heavy as in Hincks's figures. The gonothecae may have 15–18 rings. July 13, 1901.

Campularia pacifica (A. Ag.)

Pl. IV. Figs. 39, 40, 41.

Laomedea pacifica, Agassiz, Ill. Cat., 1865, II, p. 94.

Trophosome. Stems stout, frequently reaching a length of 200 mm.; branching profusely, forming an exceedingly dense and bushy colony. Stem and larger branches polysiphonic; 2-4 annulae above the origin of each branch. Hydrothecae borne on pedicels of moderate length, usually annulated throughout; 5-8 annulae; deep, gradually tapering to base, rim with ten teeth, each with two cusps. Hydranth with 26 tentacles.

Gonosome. Gonothecae elongated, clubshaped, female somewhat broader than male; bottle neck and moderate round aperture. Gonophores fixed sporosacs.

Distribution. San Francisco Bay. Gulf of Georgia, Wash., and San Francisco, Cal. (Agassiz). Bering Str., Avatska Bay, Kamtschatka (Stimpson).

This is a common species in Oakland Harbor the year round, where it flourishes in the brackish and dirty water, attached to the supports of wharves and bridges, between tides. The branches arise in all planes, and with the exception of occasional stem-like branches, are short. Two usually appear at the same point, one at right angles to and much smaller than the other. Both rebranch profusely.

Gonophores are produced from March to November at least. They show no traces of bell. The endoderm of the manubrium is lobed as in *Gonothyraea* and serves as a nutritive organ for the sex cells. There may be six, eight or even more ova in the larger gonophores, which vary in number from four to twelve or fifteen.

Campanularia urceolata, Clark.

Pl. V. Figs. 42, 43, 44, 45, 46, 47.

C. cylindrica, Clark, Trans. Conn. Ac., 1876, III, p. 254.
C. urceolata, Clark, Proc. Phil. Ac. Sc., 1876, XXVIII, p. 215,
C. turgida, Clark, *ibid.*
C. reduplicata, Nuttiug, Proc. Wash. Ac., 1901, III, p. 172.
C. urceolata, Nutting, *ibid.*

Distribution. San Francisco, Tomales Bay, Pacific Grove, Cal., between tides. Yakutat, Al. (Nutting). Lituya Bay (9 fathoms) and Port Etches (12–18 fathoms), Al.; California (Clark).

The hydrothecae of this species are quite variable, the gonothecae somewhat less so. On the stolon (Fig. 42) two hydrothecae, one typical of *C. urceolata*, the other of *C. reduplicata*, may be borne side by side. These are the extremes. There are various gradations between them, corresponding to the typical hydrotheeae of *C. cylindrica* and *C. turgida* as figured and described by Clark ('76). The gonothecae may be sessile or elevated on a pedicel of a few rings; always with small circular orifices. The walls are smooth or slightly wrinkled. There are numerous gonophores in each gonotheca.

A fact of some interest is the beautiful spiral annulation which appears on the hydrorhiza whenever it happens to grow for a space without touching the substratum. The hydrorhiza is smooth when in contact with the substratum (*Sertularia anguina* in the case of the San Francisco specimens). It is throughout its length twice the diameter of the stem. In one instance its free end had narrowed abruptly into a hydrotheca stalk with a hydrotheca at its extremity (Fig. 47). It seems clear that this striking heteromorphosis, and the change of form of the perisarc of the stolon are causally related to the presence or absence of a contact stimulus.

Campanularia volubilis (Linn.),

Pl. V. Fig. 48.

Sertularia volubilis, Linnaeus, Syst. Nat., XII ed., p. 1311.
Campanularia volubilis, Alder, Tr. Tynes. F. C., 1857, III, p. 125. Hincks, Brit. Hydr. Zoöph., 1868, p. 160. Hartlaub, Zoöl. Jahrb. Abth. Syst., Geogr. and Biol., 1901, XIV, p. 349. Nutting, Bull. U. S. F. C., 1901, XIX, p. 345.

Distribution. San Pedro and Tomales Bay, Cal. Bare I., near Vancouver, B. C. (Hartlaub). Gulf of St. Lawrence, 20–30 fathoms, (Packard). Massachusetts (Agassiz). "Off Reikiavik, Iceland, in 100 fathoms, amongst icebergs, on *Sertularia*" (Hincks). Norway (Sars). Mingan Is. (Hincks).

Dredged near San Pedro, Cal., from a sandy bottom covered with small stones and some kelp roots, in 9 fathoms. A single gonotheca, lost before it could be drawn, was much compressed. The margin of the hydrotheca is furnished with nine teeth and is frequently reduplicated. The colonies from Tomales Bay grew between the tides.

Gonothyraea clarki, nom. nov.

Gonothyraea hyalina, S. F. Clark, Proc. Phil. Ac., 1776, XXVIII, p. 215.

Distribution. Oakland, Cal. Alaska, 13–30 fathoms (Clark). Shetland (Hincks).

The form from Oakland Harbor agrees in all respects with Clark's description, save that the extracapsular medusoids are more nearly spherical than those of Clark's material. Male and female medusoids are of the same size and shape, the tentacles of the female being possibly a little longer. A feature which distinguishes this species from *G. loveni* is the absence of radial canals, though an endodermal lamella is present. The skeletal characters of the two are indistinguishable (Nutting). Hincks's *G. hyalina* was in all probability a form of *G. loveni*.

The ectoderm of the manubrium is very thin and may lie close to the subumbrella ectoderm so that the bell, lacking mesenchyme entirely, often appears in section to be composed of four extremely attenuated closely applied cell layers. The endoderm of the manubrium is a conspicuous layer of darkly staining columnar cells, showing signs of glandular activity and without doubt furnishing with yolk the ova which are pressed against it.

I have never seen a medusoid leave the gonotheca and do not know whether it actively aids itself or not. Certainly it does not move, so far as I have observed, after leaving the gonotheca. The blastostyle thins out as the medusoids leave, as though under a tension. But this tension could hardly be exerted by the medusoids, which are motionless on the free ends of narrow blastostylar processes with no perisarcal covering.

I have seen neither tentacles on, nor fertilized ova in, intracapsular medusoids, though a great many observations have been made. In rare instances, an extracapsular medusoid is found with unfertilized ova. On one occasion a dancing mass of sperm was crowded around the bell mouth of an extracapsular medusoid, apparently attracted to that spot. It is here that the sperm probably penetrate, after the medusoid has left the gonotheca.

There may be four embryos in each female medusoid, which are retained until the planula stage.

There are usually four medusoids to the blastostyle in female, and five to seven in male colonies. Occasionally blastostyles with sterile medusoids are met with, such as those described by Weismann ('83). The cause of this sterility has not been determined, so far as I know. It is the more obscure because a whole colony is not always affected, but only here and there a blastostyle. The general external conditions of temperature, oxygen, light, food, etc., would seem to be the same for all parts of the colony; so that the cause is probably local, possibly malnutrition from some mechanical defect in the circulatory canals. Colonies in the University of California collection with medusoids taken in January, March, April, May, September.

Obelia.

Trophosome. All known species branched; otherwise as in Campanularia.

Gonosome. Blastostyles in axils of branches, giving rise to free disk-shaped medusae with four radial and a ring canal, eight lithocysts and more than eight tentacles; mouth without tentacles.

Obelia commissuralis, McCr.

Obelia commissuralis, McCrady, Gymno. Charls. Harbor, p. 95.
Agassiz, Contr. N. H. U. S., 1862, IV, p. 315.

Distribution. San Francisco Bay, Cal., between tides. Eastern U. S. (Agassiz).

This species has not been recorded previously for the Pacific Coast. The San Francisco specimens are identical with Agassiz's description of the Eastern form.

It is not an unusual thing to see the branches of *O. commissuralis*—and the associated *C. pacifica* and *G. clarki*—grown out into tendril-like processes. These appear so constantly in colonies confined in aquaria, or growing in dirty water or under other unfavorable circumstances, that there can be no doubt of a causal relation between their appearance and external conditions, though the definite cause is as yet obscure. The processes are usually attenuated, with very thin perisarc, and grow rapidly: 2 to 3.5 mm. in 24 hours. They may be ringed at intervals or smooth, and may be terminated by hydranths of proportionate size. They often behave like stolons. When one comes in contact with a solid substratum, it may cling to it. So long as it is in contact with the substratum it does not develop rings or end in a hydranth. The stimulus of contact, however, is not necessary to the transformation of these processes. While free they may not only remain smooth but give rise to buds at right angles to their own axes, just as attached stolons do. The growing point of each develops rapidly, while the hydrocaulus behind thins out and may degenerate completely. In this way a given area may be quickly occupied by colonies which have arisen non-sexually from a single one sexually produced. Here is a function of possibly adaptive value, its activity dependent, however, on appropriate external conditions.

It is apparent that the attenuated branches of these species have no phylogenetic significance, being explicable on physiological grounds. I have little doubt that the "long filiform tendrils" described by Calkins in *O. surcularis*, which bear "in some cases, one or two hydrothecae" are in the same category and have no value as specific characters.

Obelia dichotoma (Linn.).

Sertularia dichotoma, Linnaeus, Syst. Nat., 1756, X ed, p. 812.
Obelia dichotoma, Schulze, Nordsee Exp., Hydr., 1872, p. 129.
Calkins, Proc. Bost. Soc. N. H., 1899, XXVIII, p. 356.

Distribution. San Pedro to Coronados Is., Cal. Puget Sound (Calkins). Sitka, Berg Inlet and Orca, Al. (Nutting). British coasts (Hincks). Heligoland (Schulze). Eastern U. S. (Nutting).

Colonies in San Pedro Harbor liberated medusae in December, 1901. The medusae possessed from 20–24 tentacles, this variation correlated with a variation in the number of tentacles in the several quadrants, and the spacing of the lithocysts. This is the only departure from the type described by Hincks.

All the colonies were growing on kelp when collected, save those in San Pedro Harbor, where they were fastened to the float at the ferry landing. In all cases they were near the surface except at the Coronados Is., where they came up in a haul at 18–24 fathoms.

Obelia geniculata (Linn.).

Sertularia geniculata, Linnaeus, Syst. Nat.
Eucope diaphana, Agassiz, Contr. N. H. U. S., 1862, IV, p. 322.
Obelia geniculata, Allman, Ann. Nat. Hist., 1864.

Distribution. San Francisco, Cal., between tides; Catalina I., Cal., in 42 fathoms. New Zealand (Hartlaub). Eastern U. S. (Agassiz). Europe (Hincks).

The length of internodes and the thickening of perisarc below the shoulder processes vary widely in the same stem. Near the bases of some stems there are no thickenings below the shoulders at all; they appear only near the tips.

The Catalina colonies were growing on a frond of *Macrocystis;* the gonothecae were loaded with medusae (June 28, 1901). The San Francisco colonies were found on boulders in the breakers at the entrance of the Bay, also with medusae in the gonothecae (Dec. 14, 1895).

Clytia.

Trophosome. Colony not regularly branched. Hydrothecae with long pedicels.

Gonosome. Gonophores liberated as medusae, with four tentacles.

Clytia compressa (Clark).

Pl. VI. Fig. 49.

Campanularia compressa, Clark, Proc. Ac. N. Sc. Phil., 1876, XXVIII, p. 214.
Clytia compressa, Nutting, Proc. Wash. Ac. Sc., 1901, III, p. 170.

Distribution. San Diego (5 fathoms) and San Pedro (3 fathoms), Cal. Orca, Al. (Nutting). Shumagin Islands (Clark), 6–20 fathoms, on Laminaria.

Colonies growing on seaweed. Trophosome resembles that of *C. everta*. The hydrothecae vary greatly. The margin is usually wavy, a character which is not mentioned in the original description. Gonosome present May 23 and July 13, 1901.

Calycella (Hincks).

Trophosome. Hydrotheca tubular, on short annulated pedicel from a creeping stolon; operculum of several triangular tooth-like pieces.

Gonosome. Gonothecae on stolon; with acrocysts at maturity.

Calycella syringa (Linn.).

Pl. VI. Fig. 50.

Sertularia syringa, Linnaeus, Syst. Nat., XII ed., 1767, I, p. 1311.

Calycella syringa, Hincks, Ann. Nat. Hist., (3), 1861–2, VIII, p. 293. Calkins, Proc. Bost. Soc. N. H., 1899, XXVIII, p. 358. Nutting, Proc. U. S. Nat. Mus., 1899, XXI, p. 741; Proc. Wash. Ac. Sc., 1901, III, p. 176. Clark, Proc. Ac. Nat. Sc. Phil., 1876, XXVIII, p. 217.

Distribution. Mouth of San Diego Bay, Cal., 1–5 fathoms. Puget Sound; Berg Inlet and Kadiak, Al. (Nutting). Coal Harbor and Shumagin Is., Al. (Clark). Beach, Kara Sea (Bergh). British coasts (Hincks). Iceland, 100 fathoms (Hincks). Greenland (Levinsen).

FAM. LAFOEIDAE.

Trophosome. "Hydrothecae tubular, margins without teeth or opercula, the hydrothecal cavity not divided from the stem cavity by a partial septum.

Gonosome. "Gonangia forming a 'Coppinia' mass." (Nutting, '01).

Lafoea.

Trophosome. "Colony with a fascicled stem, and with hydrothecae either free or partially immersed in the stem, the distal portion not being abruptly turned upward.

Gonosome. "A 'Coppinia' mass." (Nutting, '01.)

Lafoea dumosa (Fleming).

Sertularia dumosa, Fleming, Edin. Phil. Jour., 1828, II, p. 83.

Lafoea dumosa, Sars, Bidrag til Kundskaben om Norges Hydroider, 1873, p. 45. Clark, Proc. Ac. N. Sc. Phil., 1876, XXVIII, p. 216. Nutting, Proc. U. S. Nat. Mus., 1899, XXI, p. 741; Proc. Wash. Ac. Sc., 1901, III, p. 177.

Distribution. Port Orchard, Puget Sound. California coast (Clark). Port Etches, Al., 12–18 fathoms, clayey mud (Clark).

Dutch Harbor, Al. (Nutting). New England coast (Verrill). West Indies, 450 fathoms (Allman). British Coast (Hincks). North Cape, Norway (Sars). Spitzbergen (Mark.-T.).

Lafoea gracillima (Alder).

Campanularia gracillima, Alder, Tr. Tynes, N. F. C., 1857, p. 39.
Lafoea gracillima, Clark, Proc. Ac. N. Sc. Phil., 1876, p. 216. Nutting, Proc. U. S. Nat. Mus., 1899, XXI, p. 741; Proc. Wash. Ac. Sc., 1901, III, p. 177.

Distribution. San Pedro, Cal. Puget Sound; Juneau, Berg Inlet, Orca, Al. (Nutting). Shumagin Is., beach, and Sitka, Al., 15 fathoms, gravel and mud (Clark). New England coast (Verrill). British coast (Alder). Spitzbergen (Mark.-Turn.).

No gonosome. August 1, 1901.

FAM. SERTULARIIDAE.

Trophosome. Hydrothecae sessile, more or less adnate to stem, in two or more series, separated from stem by basal septum. Hydranth with a conical proboscis.

Gonosome. Gonothecae with fixed gonophores.

Owing to our insufficient knowledge of the natural affinities of the members of this family, I have adopted as a temporary method of classification the system of groups proposed by Schneider ('97). With very few exceptions the original generic names have been retained.

Sertularella group.

Hydrothecae alternate, one to each internode.

Sertularella conica Allman.

Sertularella conica, Allman, Mem. Harv. Mus. Comp. Zoöl., 1877, V, p. 21.

Distribution. San Pedro, Cal., S. W. of Tortugas, 60 fathoms (Allman).

The specimens at hand agree perfectly with Allman's figures and description, though the latter does not indicate the range of variation. The habit is nearly simple and the hydrothecae are always wrinkled transversely, though they may approximate in general form the hydrothecae of *S. polyzonias*. The internodes of the stem vary also, in length and thickness. There is one character, however, which seems to separate this species definitely from *S. polyzonias:* there are without exception three teeth and three pieces to the operculum on each hydrotheca.

The gonosome still remains unknown. (August 1, 1901.)

Sertularella dentifera, sp. nov.

Pl. VI. Figs. 51, 52.

Trophosome. Stems slender, flexuous, branched. Branches arising within or in place of hydrothecae; similar to stem. Hydrothecae free for three-quarters of their length, tubular, slightly enlarged at base; margin reduplicated, furnished with three moderate teeth forming a triangle with apex nearest stem.

Gonosome not present.

Distribution. San Pedro, Cal.

In size and habit this species resembles *S. conica* Allman, and was brought up in the same haul with specimens of the latter. It is represented in the collection by a single stem, with portions of two branches. The mode of origin of its branches—within hydrothecae—places it in Allman's genus *Thecocladium.* That genus, however, seems to me quite as unnecessary as *Synthecium*, whose validity is discussed below (p. 62.)

Sertularella fusiformis, Hincks.

Pl. VI. Figs. 53, 54.

Sertularia fusiformis, Hincks, Ann. N. H., 1861–2, (3), VIII, p. 253.
Sertularella fusiformis, Hincks, Brit. Hydr. Zoöph., 1868, p. 243.

Distribution. San Francisco, Cal., between tides. Great Britain, between tides (Hincks). New Zealand (var. *nana*, Hartlaub).

Female gonothecae with acrocysts, January 22, 1902.

Sertularella halecina, sp. nov.

Pl. VI. Fig. 55. Pl. VII. Fig. 56.

Trophosome. Stems rising from a creeping stolon, about an inch in length and may branch once or twice. Branches similar to the stem, with two or three annulae at the base of each, and a hydrotheca in the axil. Stem and branches divided by faint oblique nodes, which may often be wanting, into equal internodes. Hydrothecae alternate, one to each internode, adnate at base only; cylindrical, with a slight swelling on the lower side at base and a wide aperture with a smooth everted rim, which may be reduplicated; without operculum.

Gonosome. Gonothecae (male) arise from within hydrothecae; long, tubular, somewhat broader than hydrothecae and five to six times as long as broad. A single tubular gonophore.

Distribution. San Diego Bay, Cal., 5–12 fathoms.

The everted margin, with its frequent reduplication in old hydrothecae, suggests the Haleciidae. The remarkable position of the gonophores is characteristic of Allman's genus *Synthecium.* This genus is to my mind untenable, since it wrenches from their nearest allies such diverse species as *Sertularella alternans* and *Sertularia campylocarpum* and unites them on the basis of a feature which is chiefly interesting to the physiologist. It has doubtless arisen independently in several species, and cannot at most have more than specific value. It is significant that the species just named were taken in the same haul of the dredge and were thus presumably surrounded by similar conditions. To make manifest the importance of a physiological point of view in this connection, the fact might be recalled that in the genus *Obelia* an axillary bud may grow into either a blastostyle or a hydranth, the function being determined by physiological conditions operating *after* the bud has begun to grow.

The male gonosome develops, briefly, as follows: A hydranth degenerates. From its more or less disorganized tissue at the base of the theca a bud springs, with no sign of definitive sex cells in or near it. When this bud attains about twice the length of the hydrotheca, sex cells appear between the ectoderm and endoderm, in a region varying in length, extending from near the tip over the distal half of the bud. There is no sign of orifice in the covering of perisarc which has been secreted over the growing bud. The bud stalk does not behave as a blastostyle, since no secondary buds are produced; it alone functions as the gonophore. Full maturity has not been reached by any of these structures in the scant material at hand, but at this stage they bear a striking resemblance to the sporosacs among the Gymnoblastea. They may arise from any hydrotheca. The maturest may be distal or proximal to the others; the usual order of succession from base to tip of the colony is not observed.

The cause which determines the formation of a gonophore out of the substance of a degenerated hydranth in *S. halecina* is as mysterious as that which determines whether a certain bud in an

Obelia colony is to become a hydranth or a blastostyle. Hickson ('91) has described in *Millepora murrayi* the transformation of zooids into male medusae, brought about by the immigration of sex cells from the coenosarcal canals. This case differs from that of *S. halecina* in that in the latter no direct transformation of well formed hydranths into gonophores can be said to take place, much less through the agency of sex cells. Yet the two cases resemble each other in the substitution of one sort of individual for another. In *S. halecina* the degeneration of the hydranth does not appear to be due to the same cause which initiates a gonophore. It is possible, however, that the conditions which favor the degeneration of the one may determine the growth of the other. But the solution rests with the experimenter.

The following hydroids form a suggestive series with reference to the origin of the gonosome:

1. *Obelia*—in which the blastostyle is not preceded by any degeneration, does not take the place of another sort of individual, and is not determined by the presence of sex cells.

2. *Campanularia*—in which the blastostyle originates as in Obelia, accompanied, however, by sex cells which appear in the endoderm of the bud.

3. *Sertularella halecina*—in which the formation of the gonophore is preceded by the degeneration of a hydranth, though no causal nexus is apparent, and sex cells seem to be absent.

4. *Millepora murrayi*—in which the formation of the gonophore is preceded by the degeneration of a zooid, both being due to the same cause—the presence of sex cells in the wall of the zooid.

In each case the function of the buds which may form blastostyles or gonophores is determined by internal or external conditions. The problem is essentially physiological, and needs experimental analysis.

Sertularella hesperia, sp. nov.

Pl. VII. Figs. 57, 58.

Trophosome. Stems with a few branches and a rambling habit, rising from a creeping stolon to the height of 30 mm.; divided obliquely into internodes which vary in length in different branches. Hydrothecae alternate, one to each internode; immersed for about half its length; distal half bent away from the stem, usually narrowing slightly to the orifice, which is furnished with three moderate sub-equal teeth.

Gonosome absent.

Distribution. Mouth of San Diego Harbor, Cal., 1–9 fathoms.

This species grows commonly int angles of other hydroids and bryozoa, which may account for the variation in internodes and hydrothecae.

Clark found in his Alaska collection what he considered to be a robust variety of *S. tricuspidata* Alder. The San Diego species corresponds well to his figures, differing, however, in the greater immersion of the hydrothecae. The aspect of the colony is quite unlike Hincks' figures of *S. tricuspidata*. So I have thought it best, in the absence of any knowledge of the gonosome, to consider it a distinct species.

Sertularella tenella, Alder.

Sertularella tenella, Alder, Trans. Tynes. Nat. F. C., 1857, III, p. 113. Hincks, Brit. Hydr. Zoöph., 1868, p. 242. Hartlaub, Zoöl. Jahrb., Abth. Syst. Geogr. u. Biol., 1901, XIV, p, 349.

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

Gonosome absent, July 16, 1901. Creeping in profusion over Fucus. Immediately below each opercular piece is a short longitudinal ridge projecting into the cavity of the hydrotheca. Longest stem, 4 mm. long; length of hydrotheca, .4–.5 mm.; breadth, .25 mm.

Sertularella turgida (Trask).

Pl. VII, Figs. 59–62. Pl. VIII, Figs. 63–69.

Sertularia turgida, Trask, Proc. Cal. Ac. Sc., 1854, I, p. 113.

Sertularella turgida, Clark, Trans. Conn. Ac., 1876, III, p. 259.

Sertularella conica, Calkins, Proc. Bost. Soc. N. H., 1899, XXVIII, p. 359.

Sertularella nodulosa, Calkins, *ibid*, p. 360.

Sertularella turgida, Hartlaub, Zoöl. Jahrb., Abth. Syst. etc., 1901, XIV, p. 349.

Distribution. San Diego, 5 fathoms; Catalina I., 42 fathoms; San Pedro, 9 fathoms; Pacific Grove, and San Francisco, Cal., between tides. Monterey, San Francisco, and Tomales Pt. (Trask). San Diego, Santa Cruz, Cal., and Vancouver I (Clark). Bare I. (Hartlaub). Townsend Harbor, 15–20 fathoms (*S. conica* and *S. nodulosa* Calkins.)

The figures on Pls. VII and VIII show at a glance the unusual variability of this species. Trask's type came from San Francisco Bay, and it is from colonies from San Francisco Entrance that Figs. 59, 60, and 61 have been drawn. Figs. 59 and 60 represent the two types of gonothecae described by Clark, the first approaching the gonotheca of *S. polyzonias*. Figs. 62 and 63 were drawn from the same colony from San Pedro, and mark stages in the transition from the unringed spiny type through a ringed spiny condition to the form typical of *S. polyzonias*, reached in colonies from San Diego (Fig. 68). As a rule the hydrothecae on colonies with annulated gonothecae are transversely ridged or annulated, and somewhat narrowed distally. The length and diameter of the internodes and the degree of immersion of the hydrothecae in the stem vary considerably.

In spite of the wide range of variation, there are always three teeth on the margin of each hydrotheca, the proportions are in general constant, and the stems are stiff, flexuous and sparely branched.

The causes of the variation are not clear. Trask's type grows on the shore rocks, between tides, from Tomales Pt. to Pacific Grove. The synonymous *S. nodulosa* Calkins, dredged at 15–20 fathoms in Townsend Harbor, Wash., is also found in 9 fathoms near San Pedro, Cal. Only the dredged forms seem to be transeversely wrinkled. It is impossible to estimate the value of these and similar facts, however, without the aid of experimentation.

Dynamena group.

Hydrothecae opposite, a joint between each pair.

Sertularia desmoidis, sp. nov.

Pl. VIII. Figs. 70, 71, 72.

Trophosome. Stems rising from a creeping stolon to the height of one to two inches, branching sparely and irregularly, forming at times a matted tangle with bryozoa. Internodes vary somewhat in length; the portion distal to the hydrothecae is never longer than the rest of the internode. On the proximal portion of each internode is a pair of hydrothecae opposite and contiguous for half their length on one side of the stem. Each hydrotheca is well immersed, bending outward rather sharply in its distal half and narrowing slightly to a more or less bilabiate operculate aperture.

Gonosome. Gonothecae borne on stem; sessile, ovate, with a wavy outline and broad round aperture; half as broad as long. Single gonophore centrally placed, with coenosarcal processes connecting it on all sides with gonothecal wall.

Distribution. San Diego, (1–25 fathoms), San Clemente I., (42 fathoms), San Pedro, Cal., (13 fathoms); rocky and sandy bottom; growing usually on seaweed.

The portion of each internode distal to the hydrothecae is subject to considerable variation in length, so that the stems may have a rather stringy or a robust habit. The aperture of the hydrotheca is never conspicuously bilabiate; the greater diameter is transverse.

Sertularia furcata Trask.

Pl. VIII. Figs. 73, 74, 75.

Sertularia furcata, Trask, Proc. Cal. Ac., 1854, I, p. 112. Clark, Trans. Conn. Ac., 1876, III, p. 258.

Distribution. Near San Pedro, Cal., 9 fathoms; Coronados Is., 18–24 fathoms; San Diego, 5 fathoms; San Francisco, shore rocks. Farallone Is., Cal., (Trask). Santa Barbara and Santa Cruz, Cal., (Clark).

Gonothecae, hitherto unknown, were present in San Francisco (Nov. 24, 1897) and San Diego (July, 1901) colonies. Gonotheca broadly ovate, compressed, with moderate terminal aperture; blastostyle connected with gonothecal wall by numerous branching coenosarcal processes; two elongate ovate gonophores.

The San Francisco colonies were growing on erect stalks of *Phyllospadix.* The stems are short and project from all sides of the eel grass. Each stem leaves the eel grass at an angle of about thirty degrees, then bends quickly away so that for the most part it makes an angle of seventy degrees with the stalk. The hydrothecae of the first, and often of the second pair as well, are not in contact. Those of succeeding distal pairs are not only in contact for half their length but tend much more strongly toward the upper side of the stem than do the proximal hydrothecae. This would seem to be an instance of the effect of gravity upon the direction of hydranth buds. The farther the stems diverge from the vertical, the more closely do the hydrothecae of each pair crowd each other on the upper side of the stem.

These facts, together with those which relate to the habit of *S. argentea* (p. 68), render it probable that geotropism is to some extent an efficient cause of the habits of various *desmoscyphus* forms. It is possible that the same explanation may be applicable to the habits of other colonial coelenterata, especially those cords in which the mouth axis of each polyp lies in a plane passing through the axis of the colony.

Thuiaria group.

Hydrothecae more or less alternating, in two rows, closely placed, and many to an internode.

Sertularia argentea E. & S.

Pl. VIII. Figs. 76, 77. Pl. IX. Figs. 78, 79.

Sertularia argentea, Ellis and Solander, Nat. Hist. curious and uncommon Zoöph., etc., 1786, p. 38. Clark, Trans. Conn. Ac., 1876, III, p. 257.

Thuiaria argentea, Nutting, Proc. Wash. Ac. Sc., 1901, III, p. 184.

Distribution. San Francisco, Tomales Bay and Patrick's Point, Cal., shore rocks. Santa Barbara, Cal. (Clark). Puget Sound, Wash., and Yakutat, Al. (Nutting). "Ostend (Van Ben.); mouth of the Elbe (Kirchenpauer); Greenland (Fabr. and Morch); North Cape, in 30–50 fath. (Sars); Southern Labrador, Caribou Island, in 8 fath., not common (A. S. Packard, Jr.); Nova Scotia (Dawson): Grand Manan, common in 4–6 fathoms, attached to stones (Stimpson); Massachusetts Bay (Agassiz); South Africa (Busk)." (Hincks, '68.) Greenland (Levinsen).

All the colonies in the collection are of the small variety mentioned by Hincks as occurring between tides. The tallest stem is 35 mm. long. The hydrothecae vary in shape and position on the branches; the two teeth are usually of equal length. Gonothecae are present on some of the San Francisco colonies, several with acrocysts (Jan. 22, 1902). The dimensions of the gonothecae as well as the length of their horns, vary considerably. The acrocysts are borne by broad gonothecae with long horns. All gonothecae are compressed.

The habit of the San Francisco colonies of *S. argentea* seems to be controlled in an interesting fashion by gravity. The branches are borne on all sides of the stems, which were fastened by their bases to the perpendicular side of a shore boulder. Each stem had curved upward, so that while the basal portion was nearly horizontal, the terminal fourth or fifth was approximately vertical. In this terminal vertical portion the branches and the hydrothecae on them were arranged symmetrically with respect to the axis of the colony; and in this region the axis of the colony and the lines of force of gravity were parallel. At the base, where they were not parallel, branches and hydrothecae were oriented with respect to the force of gravity alone. Both hydranth and branch buds, as well as the stem, thus appear to be more or less negatively geotropic, the hydranths always being borne on the upper sides of the branches; the latter grow obliquely away from the centre of the earth but never become parallel to the main stem.

Sertularia filicula E. & S.

Pl. IX. Fig. 80.

Sertularia filicula, Ellis and Solander, Zoöph., p. 57. Hincks, Brit. Hydr. Zoöph., 1868, p. 264.
Sertularia anguina, Trask, Proc. Cal. Ac., 1854, I, p. 112.
filicula, Clark, Proc. Ac. N. Sc. Phil., 1876, XXVIII, p. 219.
anguina, Clark, Trans. Conn. Ac., III, p. 255.
var. *robusta*, Clark, *ibid.*, p. 256.
inconstans, Clark, Proc. Ac. N. Sc. Phil., 1876, p. 222.

Distribution. San Diego (15–25 fath.), San Pedro, San Francisco (shore rocks), Cal. Monterey to Pt. Reyes, Cal. (Trask). Vancouver I. (Dawson). Nunivak I. to Shumagin Is., Al. (10 fath.); San Miguel I., Cal. (Clark). Grand Manan, 20 fath. (Stimpson). Labrador (Packard). British shores (Hincks).

Gonothecae are present on colonies from San Francisco Bay, and leave no doubt of the identity of *S. anguina* and *S. filicula*. It is probable, as Clark suggests, that the robust variety may prove to be identical with the European *S. abietina*, in which case the species will take the latter name. I do not agree, however, that the habit of *S. inconstans* is sufficiently distinct from that of *S. filicula* to cause a separation of the species.

Sertularia greenei Murray.

Sertularia tricuspidata, Murray, Ann. N. H., 1860, p. 250.
Sertularia greenei, Murray, *ibid*, p. 504.
Cotulina greenei, A. Agassiz, Ill. Cat., 1865, p. 147.
Sertularia greenei, Clark, Trans. Conn. Ac., 1876, III, p. 257.

Distribution. Navarro, Cal. Vancouver I. to Santa Barbara, Cal. (Clark). San Francisco, Cal. (Agassiz).

Sertularia incongrua, sp. nov.

Pl. IX. Figs. 81, 82.

Trophosome. Stems long, sub-cylindrical. Branches pinnately arranged, alternate, longest less than 15 mm. in length. Both stem and branches without nodal septa. Hydrothecae on stem in two rows, completely immersed, alternate, three or five intervening between contiguous branches, one being axillary; margin entire. Hydrothecae on branches similar to those on stem, in two rows proximally, usually in three rows on distal half of each branch, spirally arranged.

Gonosome absent.

Distribution. San Pedro, Cal.

The stem is slender, with heavy, brown perisarc. The collection contains fragments only, the longest of these being 130 mm. in length. The branches are colorless, the perisarc being inconspicuous. The coenosarc is in poor condition, so that no data concerning the hydranth can be given.

The branches exhibit a transition from the *Thuiaria* to the *Selaginopsis* type. I have thought it convenient to consider it for the present a member of the former group.

Sertularia traski, sp. nov.

Pl. IX. Fig. 83.

Trophosome. Stems long, slender, divided transversely into internodes of variable length, branching dichotomously once at the distal end. Other branches pinnately arranged, alternate, three or five to each internode of the stem, without nodal septa; borne by a narrow base on a short shoulder process. Hydrothecae on stem well immersed, in two rows, alternate, three between contiguous branches, one of which is axillary. Hydrothecae on branches similar to those on stem, in two rows, alternate, the orifice of one reaching the level of the base of the next distal one. Orifice small, without teeth, semicircular, operculate.

Gonosome not present.

Distribution. San Pedro, Cal.

This species closely resembles *S. incongrua* in habit. It is distinguished from the latter by the shape and degree of immersion of the hydrothecae, the regularity of the interval between branches and the nodes on the stem. It is named in remembrance of that pioneer worker on Pacific Coast hydroids, Dr. J. B. Trask.

Selaginopsis group.

Hydrothecae in more than two rows; many to an internode.

Selaginopsis cylindrica (Clark).

Thuiaria cylindrica, Clark, Proc. Ac. Nat. Sc, Phil., 1876, XXVIII, p. 226.

Selaginopsis cylindrica, Mereschkowsky, Ann. N. H., 1878 (5) II, p. 445. Calkins, Proc. Bost. Soc. N. H., 1899, XXVIII, p. 362.

Distribution. Port Orchard, Puget Sd., Townsend Bay, dredged (Calkins). "Port Möller, Alaska Peninsula; 5–17 fathoms, sand, August. Hagmeister Island, Bering Sea; beach. Chirikoff Island; beach. Chiachi Islands; 8–15 fathoms, gravel" (Clark).

No gonosome. One colony.

Selaginopsis mirabilis (Verrill).

Diphasia mirabilis, Verrill, Am. Jour. Sc., 1873, (3), V, p. 9. Smith and Harger, Trans. Conn. Ac., 1875, p. 53. Clark, Proc. Ac. Nat. Sc. Phil., 1876, XXVIII, p. 219.

Selaginopsis mirabilis, Norman, Ann. N. H., 1878, (5), I, p. 192.

Polyserias hincksii, Mereschkowsky, Ann. N. H., 1877 (4) XX, p. 228.

Distribution. Port Orchard, Puget Sd. Hagmeister I., Al., beach; Shumagin Is., Al. (Clark). White Sea (Meresch.).

No gonosome. One colony.

Hydrallmania group.

Hydrothecae in one row, several to an internode.

Hydrallmania distans Nutting.

Hydrallmania distans, Nutting, Proc. U. S. Nat. Mus., 1899, XXI, p. 746.

Distribution. San Pedro, Cal. Puget Sound (Nutting).

Nutting does not mention the presence of hydrothecae in the axils of the branches. Otherwise the fragment in the University of California collection agrees well with his description.

Fam. Plumulariidae L. Ag.

Trophosome. "Hydrothecae cup-shaped, usually more or less adnate to the stem or branches, and always arranged on one side only of the hydrocladia or branches, on which they grow. Nematophores present.

Gonosome. "Reproduction by means of planulae. No medusae." (Nutting, '01.)

Aglaophenia.

Trophosome. Hydrothecal margin dentate; a posterior intrathecal ridge present and well marked; two supracalycine and one mesial nematophore attached to each hydrotheca.

Gonosome. "Gonangia inclosed in a true corbula formed of a modified pinna, its leaves without hydrothecae at their bases. The corbula may be either open or closed" (Nutting.).

Aglaophenia diegensis, sp. nov.

Pl. IX. Figs. 84, 85, 86.

Trophosome. Stems attaining a height of 150 mm., divided into short internodes. Hydrocladia alternating, one to an internode. They may be divided by very faint nodes into internodes of equal length, each bearing one hydrotheca, adnate for almost its entire length; the nodal constrictions are quite often wanting, however, or reduced to exceedingly faint grooves on the side opposite the thecae.

Hydrothecae one-fourth longer than the diameter of the mouth, laterally compressed but flaring distally so that the aperture is approximately circular. Rim ornamented with nine irregular teeth, the median tooth is sharp and recurved, though less abruptly than in *A. struthionides.* The teeth next the median one on either side are the longest and directed strongly forward and laterally. The next two on each side are curved upward and outward, sub-equal. The smallest teeth are those next the hydrocladium. The teeth in size and arrangement are more regular than in *A. struthionides.* There may be a faint intrathecal ridge near the bottom of the theca, running obliquely upward.

Mesial nematophore reaches level of hydrothecal mouth; tapers slightly to tip after leaving wall of hydrotheca. Supracalycine nematophores reach rim of theca; curve upward, forward and outward, narrowing slightly to the orifice.

Septal ridge just below supracalycine nematophores and one just above bottom of hydrotheca. Cauline nemataphores as in *A. struthionides:* one triangular, in axil of hydrocladium; another tubular, on base of shoulder supporting hydrocladium; and a third, larger, tubular, just proximal to latter.

Gonosome. Corbulae substituted for the usual hydrocladia. Each corbula is three times as long as broad, formed of eight pairs of alternating leaflets, each leaflet, save first and last, carrying on its anterior edge eight nematophores. There is one hydrotheca (exceptionally two) between corbula and stem. Gonophores in two rows, about twelve in number; oval statoblasts.

Color. Stem dark horn; hydrocladia light brown.

Distribution. San Diego, Cal., on piles of wharf, and at mouth of harbor in 3–7 fathoms, July, 1901.

This species differs from *A. pluma*, which it closely resembles, in the possession of a recurved median tooth and much longer stems and hydrocladia.

Aglaophenia inconspicua, sp. nov.

Pl. IX. Figs. 87, 88, 89.

Trophosome. Stems in clusters, stout, 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 internodes of equal length. A nematophore in the axil of each hydrocladium and two at its base, in line with its axis. Hydrothecae deep, slightly compressed, free for not more than one-fourth their length; median tooth recurved, the next one on either 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 theca. Supracalycine nematophore divergent, not reaching level of mouth of theca.

Gonosome. Corbulae in place of hydrocladia, not more than twice as long as deep, arched, slightly compressed; form of four to six leaflets the longest with ten nematophores on distal edge and occasionally one or two at tip of proximal edge. One well formed hydrotheca on distinct internode at base. Gonophores sporosacs, six to twelve in number.

Dimensions. Hydrotheca: length, .29 mm.; width, .155 mm. Hydrocladial internode, .24–.28 mm.; cauline internode, .18–.20 mm. Corbulae, 2 mm. long; greatest diameter, 1.1 mm.

Distribution. San Diego, Cal., 5 fathoms. July, 1901.

Several shoots were growing in a cluster of *A. struthionides*, and so closely resembled the smaller shoots of the latter in color and habit that at first I overlooked them. distinguishing them finally by the shape of the corbulae and the much smaller hydrothecae with nine instead of eleven marginal teeth.

A. inconspicua approaches the European *A. pluma*, from which it differs in the recurved form of the median tooth, the shape of the corbula and the stiff, ungraceful habit.

Aglaophenia pluma (Linn.).

Pl. X. Figs. 90, 91.

Sertularia pluma, Linn., Syst. Nat.
Aglaophenia pluma, Lamx., Hist. Pol. Flex., 1816.
Aglaophenia pluma, Hincks, Brit. Hydr. Zoöph., 1868, p. 286.

Distribution. Off Coronado, Cal., on kelp. South Africa. Belgium. Naples. Messina (30–40 fathoms). Gt. Britain (Hincks).

A. pluma has not been reported previously from North America, I believe. It is readily distinguished from the other species of *Aglaophenia* on the Pacific Coast by its non-recurved median tooth and the contrast of colors, first, between the dark brown stem and light brown hydrocladia; second, in the arched corbulae, which are light brown, with dark brown stripes along the ribs. Three or four stems arise from the same spot on the kelp, to the height of 25–35 mm. Spread of hydrocladia 8–10 mm.

Aglaophenia struthionides (Murray).

Plumularia struthionides, Murray, Ann. N. H., (3), V, 1860, p. 251.
Aglaophenia franciscana, A. Ag., Ill. Cat. N. A. Acal., 1865, p. 140.
Aglaophenia arborea, Verrill, Rep. Comm. Fish and Fisheries, 1871–72, p. 730.
Aglaophenia struthionides, Clark, Trans. Conn. Ac., III, 1876, p. 272.

Distribution. Puget Sound to San Diego, 1–32 fathoms.

This species was obtained in almost every haul of the dredge off the Southern California coast. It is quite variable, especially in the length of the hydrocladia, the character of the teeth on the hydrothecae and the length of the mesial nemetophores. There are often two hydrothecae at the base of each corbula, instead of three. Branches are frequently present, though not commonly numerous. Corbulae present in January, June, July (University of California Collection).

Antenella Allman.

Trophosome. "Colony consisting of hydrocladia springing directly from the hydrorhiza without the intervention of stems or branches; hydrocladial internodes and hydrothecae as in the *catharina* group of the genus Plumularia." (Nutting, '00.)

Gonosome. Gonothecae ovate, unprotected.

Antenella avalonia, sp. nov.

Pl. X. Figs. 92, 93, 94.

Trophosome. Stems rooted by creeping stolon, unbranched; longest 7 mm. high, with five hydrothecae. Each stem divided by alternately oblique and transverse nodes, which are always weak, into alternating thecate and intermediate internodes. Hydrothecae as deep as broad, free for half their length, with slightly everted circular margin. Mesial nematophores borne on small processes of the stem. Intermediate internodes with one or two nematophores, never three.

Gonosome. Gonothecae broadly ovate, with short, slightly ringed peduncles, borne in pairs on the thecate internodes, one on each side of the mesial nematophore. Pair of nematophores at the base of each.

Distribution. Avalon, Catalina I., Cal.

This species differs from *Monostaechas quadridens* McCrady only in size, absence of hydrocladia and the occurrence of the gonothecae in pairs. It is possible that the first two differences may be due to immaturity; yet on no stem was there a remote sign of a branch. On one stem 5 mm. long there were three pairs of male gonothecae, decreasing in size distally, none quite mature, though suggesting the maturity of the colony.

The branching form is probably to be derived from the unbranched form, the first branch arising from the base of the proximal hydrotheca and remaining non-thecate in its proximal portion; the second branch would arise at the base of the proximal hydrotheca of this first branch, and possess a distal thecate and proximal non-thecate region; the third branch would develop in a similar way on the second, and so on. Two branches may arise at the same point, producing a false dichotomy, as in *M. quadridens.*

Cat. No. 689a., University of California Collection. Type.

Halicornaria, Busk.

Trophosome. "Stem not fascicled, no posterior intrathecal ridge; an anterior intrathecal ridge usually present; hydrocladia not branched; hydrocladial internodes without septal ridges.

Gonosome. "Gonangia borne on the stem or on the bases of the hydrocladia not taking the place of hydrothecae, and not protected by corbulae or phylactocarps of any description." (Nutting, '00.)

Halicornaria producta (Bale).

Pl. X. Fig. 95.

Azygloplon productum, Bale, Linn. Soc. N. S. W., 1888, (2), III, Pt. I, p. 774.

Kircheupaueria producta, Bale, Proc. Roy. Soc. Vict, VI, p. 111.

Trophosome. Colony with simple stem, divided obliquely into internodes which vary in length according to age; those on the same stem are equal. Hydrocladia alternate, each from a shoulder projecting from the middle region of each internode. Each hydrocladium divided more or less obliquely into equal hydrotheeate internodes. Hydrothecae somewhat compressed, with a broadly oval, smooth orifice which may be roughened by wear; about as deep as long; free for one third its length. Strong intrathecal septum about two-thirds the length of the hydrotheca from bottom, and reaching about one-third across theca at widest point.

No cauline nematophores. Mesial thecate nematophore very short, not reaching the base of the theca, expanding into the form of a sickle-shaped segment of a saucer, with a diameter two-thirds that of theca and embracing the internode for half its circumference. Pair of supracalycine nematophores, seldom reaching higher than two-thirds the height of the theca, never reaching the rim.

Height of longest stem 10 mm. Hydrothecae .2 mm. broad and long. Internodes of stem .3 to .4 mm. in length, in breadth varying from .2 in older to .12 mm. in younger colonies. Internodes of pinnae about the same length, but somewhat slenderer than younger stems.

Gonosome absent.

Distribution. San Diego, Cal., along shore of Ballast Point; growing on seaweed. Australia (Bale.)

The trophosome agrees so well with Bale's description that I do not hesitate to indentify my material with his species, even though the gonosome is lacking.

Plumularia.

Trophosome. Coenosarc of stem not canaliculated. hydrocladia unbranched, pinnately disposed, alternate or opposite. Hydrothecae with smooth margins; all nematophores movable.

Gonosome. Gonothecae borne on hydroçaulus or hydrocladia, without corbulae or protective structures of any kind. (Nutting's definition, slightly modified.)

Plumularia alicia, sp. nov.

Pl. X. Figs. 96, 97.

Trophosome. The colony is composed of a cluster of slender, loosely branching stems rising from a creeping hydrorhiza to a height of three to five inches. Each stem is divided transversely by inconspicuous nodes into short internodes of equal length. Hydrocladia are borne alternately on either side of the stem, one from the distal end of each internode. There are four to seven hydrothecae in each hydrocladium. Thecate alternate with non-thecate internodes, the basal internodes being non-thecate. The nodal joints are alternately transverse and oblique, beginning with the basal joint. The thecate are less than twice the length of the non-thecate internodes.

Each hydrotheca rests on a swelling of the proximal portion of the internode. In profile the outer edge is straight, forming an angle of forty-five degrees with the axis of the hydrocladium. The inner edge is free for a distance equalling more than half the length of the outer edge, and while approximately parallel to the latter, flares slightly near the theca-mouth. It reaches the level of the distal extremity of the internode.

The hydrotheca is laterally compressed, the sides straight and diverging slightly from a narrow base to the mouth, which is broadly oval with smooth margin.

Each internode has a septal ridge near each end: the distal ridge on the hydrothecate internode is less conspicuous than the others, which are moderate.

A single nematophore is borne on each internode of the stem on the side opposite the origin of tne hydrocladium. Two nematophores occur in each axil. Each hydrocladial non-thecate internode bears a single mesial nematophore; each thecate internode bears one mesial nematophore just below the point at which the hydrotheca becomes free from the hydrocladium.

The perisarc of the stem is thick and brown; that of the hydrocladia is delicate and colorless.

Gonosome. Male gonophores small, ovate, attached by very short peduncles between the nematophores in the axils of the stem or branches, one to an axil. Chitinous investment very thin.

Distribution. San Diego (15–25 fathoms) and Long Beach (5–13 fathoms), Cal., on rocky and sandy bottoms. June and July, 1901.

Plumularia goodei Nutting.

Pl. X. Figs. 98. Pl. XI. Figs, 99, 100.

Plumularia goodei, Nutting, Am. Hydr., Pt. I., Special Bull. U. S. Nat. Mus., 1900, p. 64.

Distribution. Pacific Grove, Cal., shore. Santa Barbara Cal., outside reefs (Nutting).

The gonosome is present (July 25, 1899), and is remarkable for the fact that the gonothecae take the places of hydrothecae. They are borne near the base of the stem or on the hydrorhiza. There are no traces of regeneration. Apparently a bud which would ordinarily become a hydrocladium may change its function under the influence of appropriate stimuli.

There are not always two hydrocladia to an internode of the stem, as stated by Nutting with reference to the specimens from Santa Barbara. On the same stem there may be one, two or three to an internode, according as none, one or two nodes respectively have been suppressed. The tentacles number 17–22. In other respects, the Pacific Grove specimens agree with Nutting's description.

Plumularia lagenifera Allman.

Plumularia lagenifera, Allman, Jour. Linn. Soc. Lond., Zoöl., 1885, XIX, p. 157.

Plumularia californica, Marktanner-Turneretscher, Ann. desk. k. nat. Hofmus., 1890, V, No. 2, p. 255.

Plumularia lagenifera, Nutting, Am. Hydr., Pt. I. The Plumularidae, 1900, p. 65.

Distribution. Off San Pedro and Santa Cruz, Cal. Berg Inlet, Al. Puget Sound (Nutting).

The single specimen from San Pedro is a slender stem 200 mm. long, of uniform thickness and almost denuded of hydrocladia. Here and there, however, are hydrocladia with one or two hydrothecae. There are from one to four non-thecate internodes at the base of each hydrocladium, one to three between hydrothecae, varying in length. The thecate internodes have the characteristic shape, septa and hydrothecae of *P. lagenifera*.

Gonosome absent (August, 1901).

The Santa Cruz material consists of several stems growing on *Styela montereyensis* attached to wharf piling. Their great variability gives them a position intermediate between the typical *P. lagenifera* and the variety *septifera* which at first I took to be a distinct species. One or several internodes may intervene between hydrothecae. They may each have one or two septal ridges. The supracalycine nematophores may originate below the margin of the hydrothecae. Some cauline internodes are furnished not only with proximal and distal septal ridges but with one between these and one on the shoulder supporting the hydrocladium.

The stems reach a height of 20–25 mm. There is no gonosome (December, 1895).

Plumularia lagenifera, var. septifera.

Pl. XI. Figs. 101, 102.

Trophosome. Stems 10–15 mm. high, from creeping stolon, in loose clusters. Divided by transverse septa into equal internodes with a conspicuous septum at each end and on the shoulder which carries hydrocladium. Nematophores in axils of hydrocladia and one on each internode on side opposite branch and immediately distal to proximal septum.

One hydrocladium from the distal portion of each internode; branches alternate, all in one plane; divided transversely into unequal internodes, the intermediate usually less than half as long as the thecate, with one strong septum near the proximal end and one nematophore immediately distal to it. Thecate internodes alternate with intermediate; hydrothecae near middle of each internode, slightly broader than deep. Three septa, all heavy, on distal side of branch: one at proximal end on a slight swelling of internode, one at distal end, one opposite hydrotheecal septum, and sometimes a fourth between the latter and the distal septum. Mesial nematophore attached immediately above proximal septum; supracalycine nematophores attached below the mouth of hydrothecae. Hydranth with fifteen tentacles.

Gonosome. Gonothecae borne in pairs, one on each side of the shoulder processes of the stem internodes; broadly ovate, compressed, with narrow neck terminated by small circular orifice. Gonophores in the form of sporosacs, numerous, packed together without apparent order.

Stem and branches light brown to colorless.

Distribution. Catalina I., Cal. Growing on seaweed frond. July, 1901.

This variety closely resembles the typical *P. lagenifera* Allman, from which it may be distinguished by its unusually heavy septal ridges. It is more constant than the latter in certain characters; there is never more than one internode between thecate internodes, and no intermediate internode has more than one septal ridge, which is always very heavy.

Plumularia plumularoides Clark.

Pl. XI. Figs. 103, 104.

Halecium plumularoides, Clark, Proc. Ac. Nat. Sc. Phil., 1876, XXVII, p. 217.

Plumularia plumularoides, Nutting, Am. Hydr. Pt. I. The Plumularidae, 1901, p. 62.

Distribution. San Diego, Cal., dredged from a bottom of cobbles and sand, 15–25 fathoms. Cape Etolin, Nunivak I., Al., 8–10 fathoms (Clark).

There are but two small fragments in the collection. The coenosarc is lacking in many places, but the perisarc is in good condition, The internodes of the stem are of constant length, separated by well marked nodes and each bearing distally one hydrocladium. Each hydrocladial internode possesses mesial and supracalycine nematophores, all monothalamic, as in *P. goodei*.*

The internodes of both stem and hydrocladia are much longer than those of the latter species, and the hydrocladia are not so strongly arched. The hydrothecae are similar in shape. In the hydrothecae of *P. plumularoides* are series of bosses similar to those found in *Halecium*.

Three empty gonothecae are present, borne singly on the cauline processes supporting the hydrocladia. All are evidently immature, having no external aperture. They are widest distally, tapering abruptly from the truncated end to the base. The wall is more or less irregularly wrinkled.

Plumularia setacea (Ellis).

Pl. XI. Fig. 105.

Sertularia setacea, Ellis, Nat. Hist. Zoöph., 1786, p. 47.

Plumularia setacea, Lamarck, Anim. sans Vert., 1st ed., 1815, p. 129. Calkins, Proc. Bost. Soc. N. H., XXVIII, 1899, p. 362. Nutting, Am. Hydr. Pt. I. The Plumularidae, 1900, p. 56.

Plumularia palmeri, Nutting, *ibid*, p. 65.

Distribution. San Diego (1–25 fathoms), Avalon, San Pedro, and San Francisco, Cal. Victoria, B. C. and San Diego (Nutting).

In a careful examination of numerous colonies of *P. palmeri* from Monterey, San Pedro and San Diego, I was unable to find any constant characters distinguishing it from *P. setacea*. The colonies range in height from 5 mm. to 100 mm. The longest have the stoutest, darkest stems, and the most conspicuous septal ridges. In the smallest colony the various ridges are present or absent, usually weak when present, and the stem is colorless, sllghtly sinuous toward the tip. The larger stems are

*In both species the nematophores are delicate, with narrow bases, and are frequently wanting, while their sarcostyles may remain. I have not seen more than one supracalycine nematophore or sarcostyle to each hydrotheca. Clark, who described *P. plumularoides*, saw nothing of either.

sparsely and irregularly branched. Gonosome absent in colonies collected in San Pedro Harbor, December 30, 1901. Male gonothecae are present in colonies from San Diego (July) and Monterey (December). They may be borne in pairs on the stem, one on each side of the shoulder that supports each hydrocladium. The members of each pair are not of the same age, one being mature before the other is half grown. Mature male gonophores are elongated and compressed, the proportions of length, breadth, and thickness being as 10:4:2. The neck is moderate, with a small circular terminal aperture.

Large colonies dredged off San Diego in 1–25 fathoms, on sandy and rocky bottom; also on float in San Pedro Harbor, and outside the harbor in several fathoms, on sandy bottom covered with loose masses of *Nitrophyllum*. Small colonies on kelp and eel grass, Avalon, Catalina I.

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For fuller bibliographies see Allman ('71), Calkins ('99), Marktanner-Turneretscher ('90), and Nutting ('00).

PLATE I.

Fig. 1.—**Bimeria annulata.** Perisarc surrounding hydranth, the latter having been removed by caustic potash. x 30.

Fig. 2.—Same species. Hydranth, showing continuation of perisarc upon tentacles. x 30.

Fig. 3.—Same species. Gonophore, with original perisarcal investment partially retracted. x 30.

Fig. 4.—**Bimeria franciscana.** Portion of a main branch. x

Fig. 5.—**Bimeria robusta.** Hydranth. x 40.

Fig. 6 —Same species. Young hydranth; perisarc extending over bases of tentacles. x 40.

Fig. 7.—Same species. Semi-diagramatic view of a developing hydranth from above, to show the order of appearance and arrangement of the tentacles. x 40.

Fig. 8.—**Clava leptostyla.** Heteromorphic regeneration of a piece of stem; a set of tentacles at each end.

Fig. 9.—Same stem, two days later.

Fig. 10.—**C. leptostyla.** Regeneration of a hydranth; stage with four tentacles.

Fig. 11.—Same individual, twenty-four hours later; second quartette of tentacles appearing.

Fig. 12.—Same; third quartette appearing.

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PLATE II.

Fig. 13.—**Eudendrium californicum.** Blastostyle, with young hydranth fastened to its stalk.

Fig. 14.—Same species. Young blastostyle.

Figs. 15–20.—**Hydractinia milleri.**

Fig. 15.—Sterile hydranths. x 27.

Fig. 16.—Distal portion of fertile hydranth with six tentacles. x 90.

Fig. 17.—Fertile hydranths with three tentacles. x 27.

Fig. 18.—Large sterile hydranth; proboscis contracted, club-shaped. x 27.

Fig. 19.—Spine. x 30.

Fig. 20.—Sterile hydranth, showing arrangement of tentacles in quartettes.

Fig. 21.—**Corymorpha palma.** Gonophore.

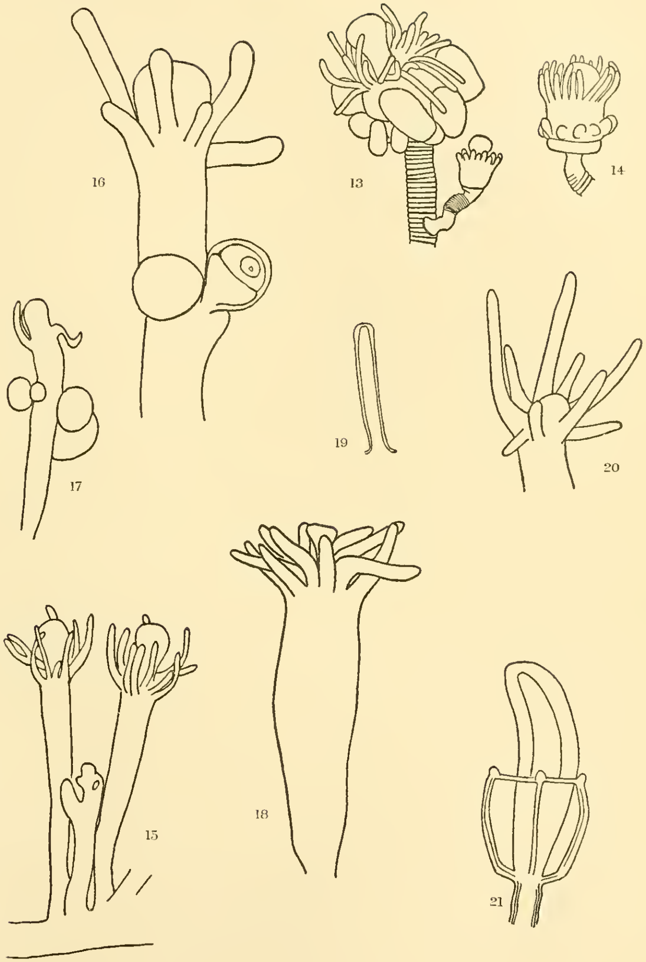

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PLATE III.

Fig. 22.—**Tubularia crocea.** Male gonophore.

Fig. 23.—Same species. Female gonophore with ova.

Fig. 24.—**Tubularia marina.** Male gonophores.

Fig. 25.—Same species. Female gonophores.

Fig. 26–29.—**Campalecium medusiferum.**

Fig. 26.—Hydrotheca. x 45.

Fig. 27.—Hydranth. x 45.

Fig. 28.—Gonotheca with four gonophores. x 45.

Fig. 29.—Gonophore. t_1 t_1, first pair of tentacles; t_2, one of the second pair, much smaller; *ec*, ectoderm of umbrella, subumbrella and manubrium. The specimen from which this figure was drawn showed no canals in the endoderm of the bell.

Fig. 30.—**Halecium annulatum.** Portion of branch. x 30.

Fig. 32.—Same species. Female gonotheca and gonophore. x 30.

Fig. 32.—**Halecium kofoidi.** Portion of trophosome. x 40.

Fig. 33.—Same species. Gonotheca, arising from base of hydrotheca.

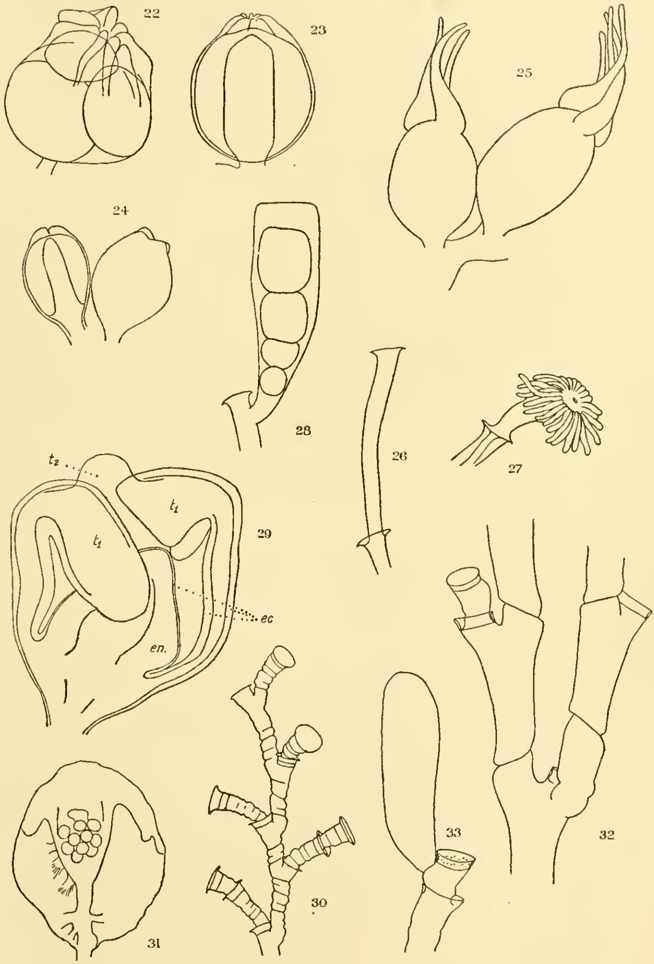

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PLATE IV.

Fig. 34.—**Campanularia denticulata.** Hydrotheca and pedicel, showing "knee." x 40.

Fig. 35.—*a*, *b*. **Campanularia everta.** Types of hydrothecae, in optical sections. x 45.

Fig. 36.—*a*, *b*. Same species. Two views of male gonotheca. x 45.

Fig. 37.—*a*, *b*. Same species. Two views of female gonotheca, with acrocyst, gonophore and embryos. x 45.

Fig. 38.—**Campanularia fascia.** Hydrotheca. x 40.

Fig. 39.—**Campanularia pacifica.** Two hydrothecae, from slightly different points of view. x 45.

Fig. 40.—Same species. Female gonangium. x 45.

Fig. 41.—Same species. Male gonangium. x 45.

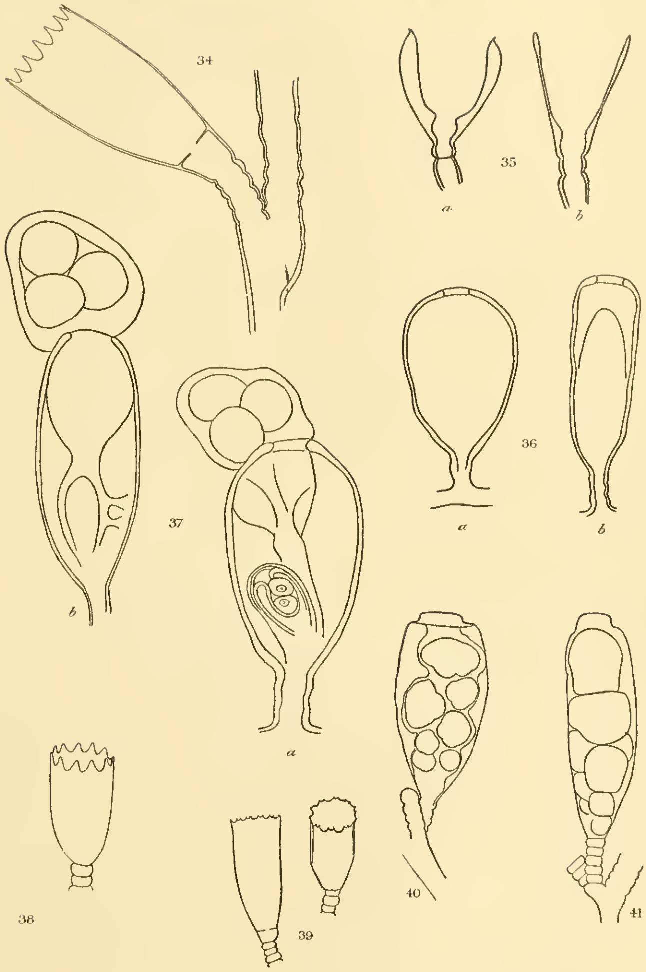

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PLATE V.

Figs. 42–47.—Campanularia urceolata.

Fig. 42.—Hydrothecae from same colony. *a*. Typical *C. urceolata* Clark (x 45); *b*. Typical *C. reduplicata* Nutting (x 45); *c*. Portion of colony showing position of *a* and *b* on stolon. From Yakutat, Alaska.

Fig. 43.—*a*, *b*, *c*. Hydrothecae showing variations in form. From Pacific Grove, Cal. x 45.

Fig. 44.—*a*, *b*, *c*, *d*. Hydrothecae (x 45). *e*. Gonotheca (x 30). From San Francisco, Cal.

Fig. 45.—Gonothecae (x 27). From Yakutat, Alaska.

Fig. 46.—Gonotheca (x 45). From Pacific Grove, Cal.

Fig. 47.—Hydrotheca and pedicel terminating a free stolon. x 45.

Fig. 48.—Campanularia volubilis.—*a*, *b*, *c*. Types of hydrothecae, same colony. x 45.

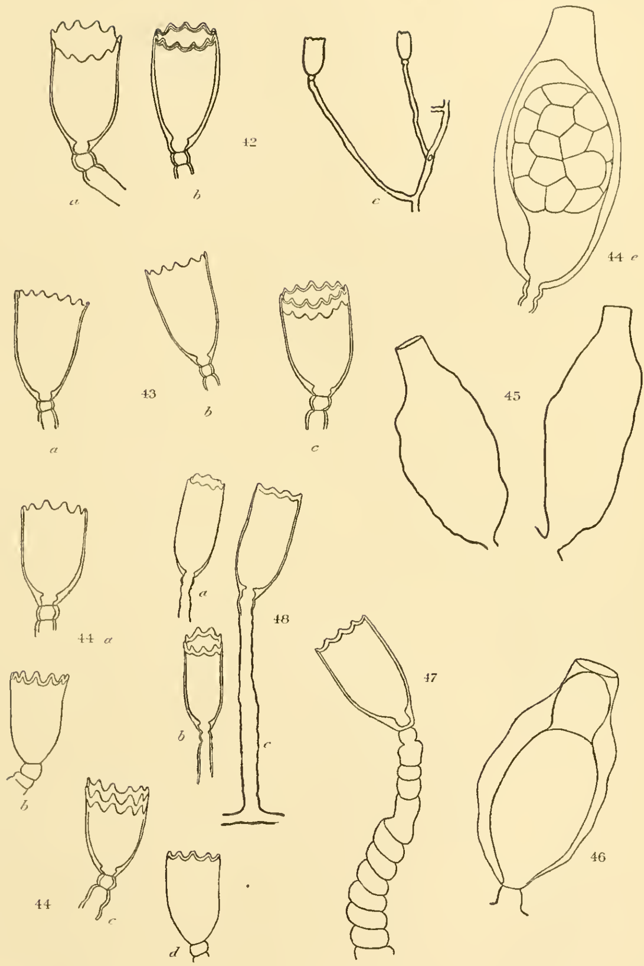

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PLATE VI.

Fig. 49.—**Clytia compressa.** *a*, *b*, *c*. Types of hydrothecae. *d*. Medusa about to leave gonotheca. Immature gonophore near base of latter. x 60.

Fig. 50.—**Calycella syringa.** Hydrotheca; gonothecae, each with a single ovum.

Fig. 51.—**Sertularella dentifera.** Portion of stem, with two hydrothecae. x 30.

Fig. 52.—Same species. Portion of stem, with bases of two branches arising from hydrothecae. One hydrotheca slightly ruptured. x 27.

Fig. 53.—**Sertularella fusiformis.** Portion of stem. x 30.

Fig. 54.—Same species. *a*. Female gonotheca. x 30. *b*. Female gonotheca with acrocyst; ova within gonotheca. x 30.

Fig. 55.—**Sertularella halecina.** Hydrothecae. x 30.

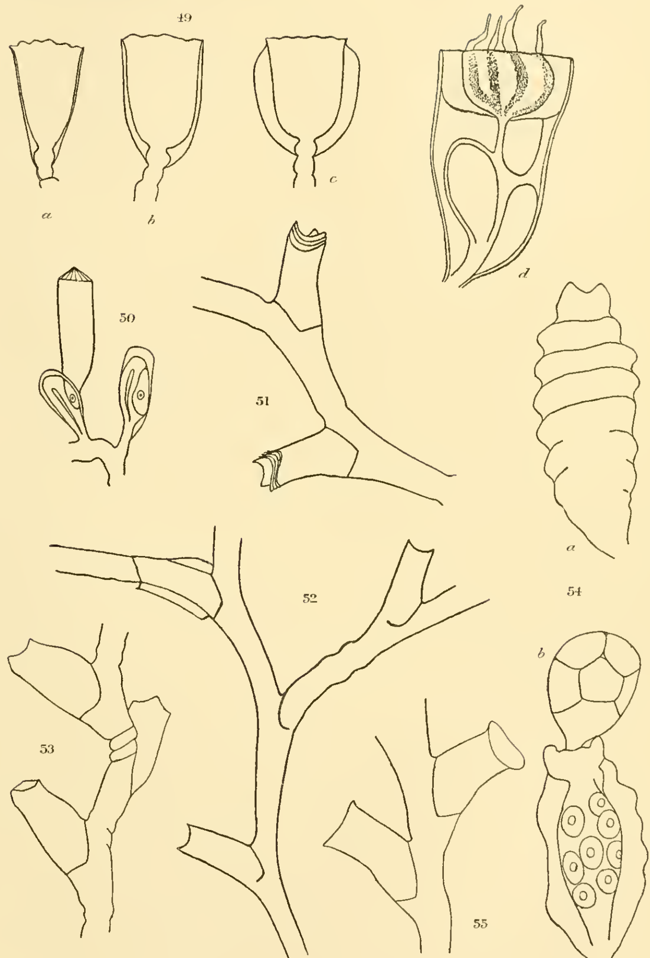

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PLATE VII.

Fig. 56.—Same species. *a*. Gonophore arising from hydrotheca. x 30. *b*. Gonotheca somewhat collapsed; gonophore indicated. Reduplicated hydrotheca. x 30.

Fig. 57.—Sertularella hesperia. *a*, *b*, *c*, *d*. Types of hydrothecae. x 45.

Fig. 58.—Same species. Stem. x 45.

Figs. 59–69.—Sertularella turgida.

Fig. 59.—Gonotheca. From San Francisco. x 22.

Fig. 60.—Gonotheca. From San Francisco. x 22.

Fig. 61.—Hydrothecae. From San Francisco. x 22.

Fig. 62.—Gonotheca. From San Pedro. x 22.

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PLATE VIII.

Fig. 63.—Sertularella turgida. Gonotheca. From San Pedro. x 22.

Figs. 64, 65.—Hydrothecae. From San Pedro. x 22.

Fig. 66.—Portion of stem. From San Pedro. x 22.

Fig. 67.—Gonotheca. From San Pedro. x 22.

Fig. 68.—Gonotheca. From San Diego. x 22.

Fig. 69.—Hydrothecae. From San Diego. x 22.

Fig. 70.—Sertularia desmoidis.—*a*, face; *b*, reverse. x 22.

Fig. 71.—Same species. Hydrothecae, face view. x 22.

Fig. 72.—Same species. Gonanginm. x 27.

Fig. 73.—Sertularia furcata. Hydrothecae. *a*, face; *b*, reverse. Extreme type. x 30.

Fig. 74.—Same species. Hydrothecae from proximal portion of stem. Face view. x 30.

Fig. 75.—Same species. Gonangium, showing a large and a small gonophore, and coenosarcal processes. x 30.

Figs. 76–79.—Sertularia argentea.

Fig. 76.—Young hydrothecae. x 30.

Fig. 77.—Young gonotheca. x 30.

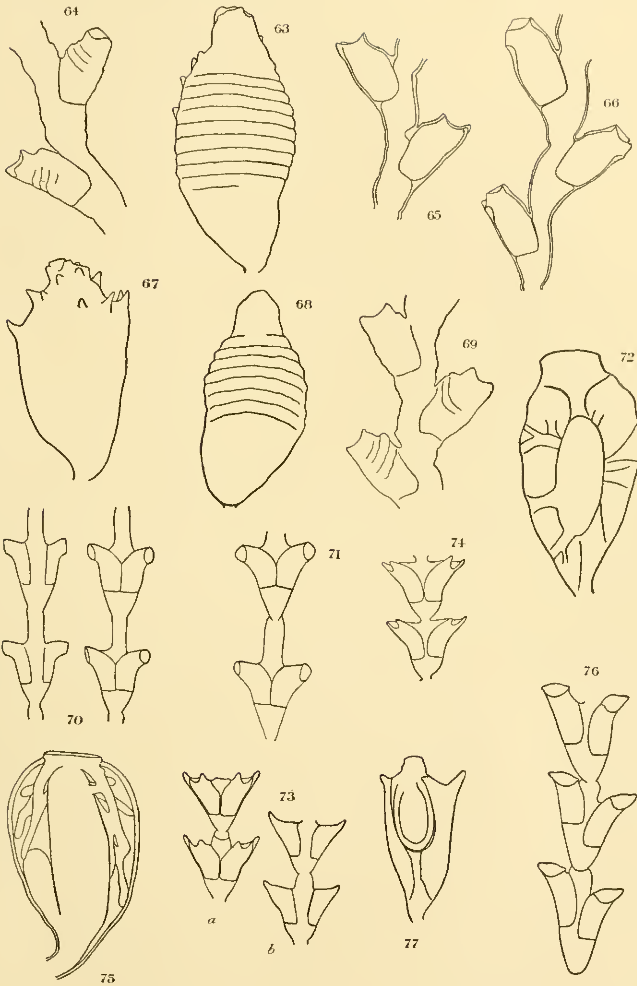

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PLATE IX.

Fig. 78.—**Sertularia argentea.** Gonotheca with acrocyst, showing horns, and maximum breadth. x 30.

Fig. 79.—Gonotheca with acrocyst, from the side. Horns not shown. x 30.

Fig. 80.—**Sertularia filicula.** Gonothecae.

Fig. 81.—**Sertularia incongrua.** Near distal end of branch; three rows of hydrothecae. x 30.

Fig. 82.—Same species. Proximal portion of branch; two rows of hydrotheca. x 30.

Fig. 83.—**Sertularia traski.** Stem with proximal portion of one branch and origin of another. x 30.

Fig. 84.—**Aglaophenia diegensis.** Hydrothecae, lateral view. x 52.

Fig. 85.—Same species. Hydrotheca, front view. x 52.

Fig. 86.—Same species. Corbula. x 18.

Fig. 87.—**Aglaophenia inconspicua.** Hydrothecae, lateral view. x 45.

Fig. 88.—Same species. Hydrothecae, front view. x 45.

Fig. 89.—Same species. Corbula. x 18.

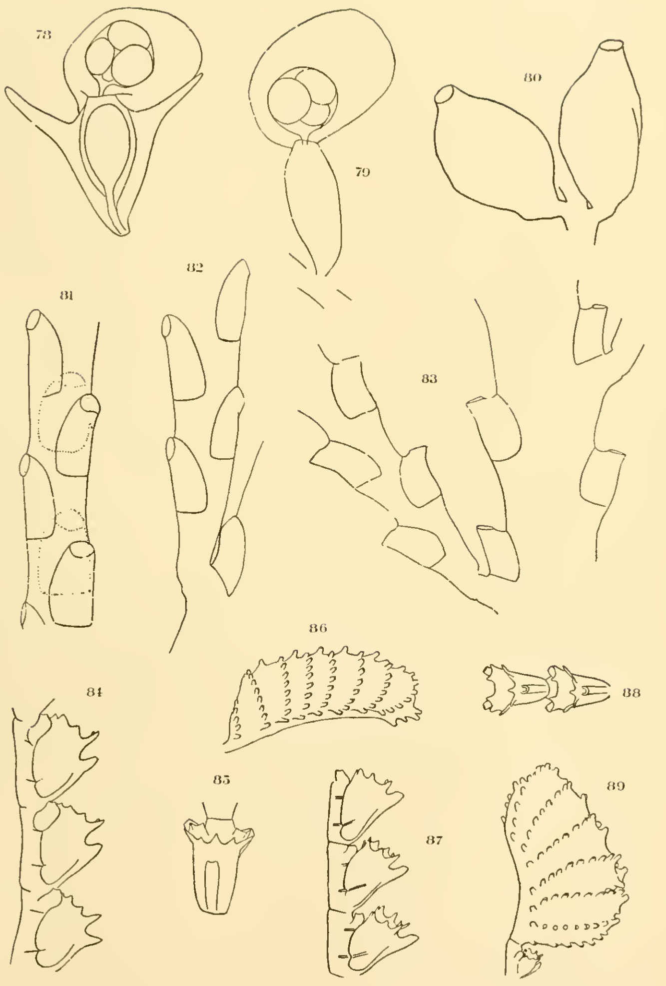

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PLATE X.

Fig. 90.—Aglaophenia pluma. Hydrothecae. x 45.

Fig. 91.—Same species. Corbula. x 14.

Fig. 92.—Antenella avalonia. Stem. x 45.

Fig. 93.—Same species. Showing a pair of gonophores arising from the base of a hydrotheca. x 45.

Fig. 94.—Same species. Gonotheca, one with two basal nematophores.

Fig. 95.—Halicornaria producta. Hydrothecae. x 60.

Fig. 96.—Plumularia alicia. Portion of hydrocladium. x 40.

Fig. 97.—Same species. Portion of stem, with gonophores. x 30.

Fig. 98.—Plumularia goodei. x 45.

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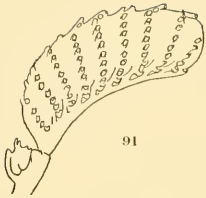

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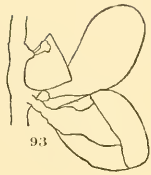

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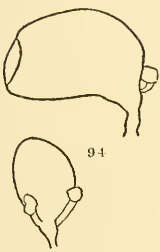

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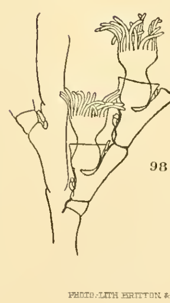

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PLATE XI.

Fig. 99.—**Plumularia goodei.** Gonotheca on hydrohiza. x 27.

Fig. 100.—Same species. Female gonangia taking the place of hydrocladia. x 27.

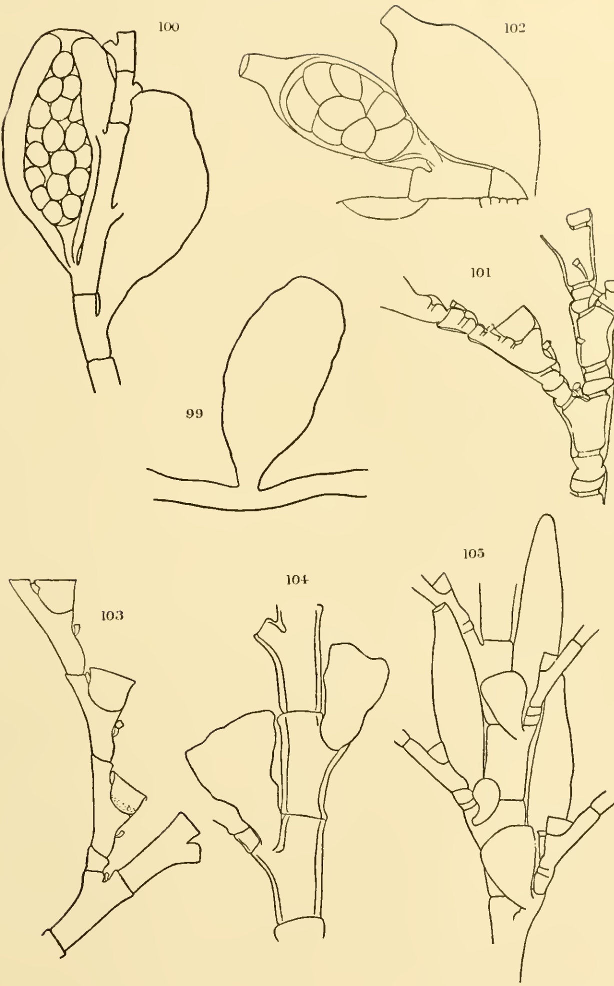
Fig. 101.—**Plumularia lagenifera**, var. **septifera.** Portion of stem and hydrocladium. x 40.

Fig. 102.—Same species. Gonangia. x 40.

Fig. 103.—**Plumularia plumularoides.** Portion of stem and hydrocladium. x 45.

Fig. 104.—Same species. Stem with immature gonothecae. x 45.

Fig. 105.—**Plumularia setacea.** Stem with gonothecae in pairs. x 45.



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