A NEW SPECIES OF ACONTIATE ANEMONE FROM SOUTHERN CALIFORNIA (SAGARTIIDAE: *SAGARTIA*)

RONALD H. MCPEAK

Marine Resources Operations
California Department of Fish and Game
Terminal Island, California

INTRODUCTION

The actinarian fauna of California is poorly known; few species of acontiarian anemones have been described from the West Coast of North America. Hand (1955) reported six species of acontiarian anemones from the intertidal zone of Central California: *Metridium senile fimbriatum, M. exilis* (Metridiidae); *Diadumene leucolena, D. lighti, D. franciscana* (Diadumenidae); *Haliplanella luciae* (Haliplanellidae) and Hand and Bushnell (1967) a new acontiate anemone, *Flosmaris grandis* (Isophelliidae), from the intertidal mud flats of San Francisco Bay. *Aiptasia californica* (Aiptasiidae) was described from immature material collected at San Diego's Mission Bay (Carlgren, 1952) and in deep water three species of hormathiid acontiarians were described from California: *Amphianthus californicus, Stephanauge annularis* (Monterey Bay; Carlgren, 1936) and *Actinauge verrillii* (Catalina Basin; McMurrich, 1893).

Sagartia, established by Gosse (1855), has undoubtedly been one of the most mistreated of actinian generic names. Before the establishment of a sound classification of Actiniaria, most authors assigned anemones possessing acontia to the genus *Sagartia.* The resulting genus was obviously not natural. When Carlgren and T. A. Stephenson established their classification of actinians based on nematocysts and other aspects of anatomy, a basis for dividing acontiarians resulted. Carlgren (1949) recognized only three species of *Sagartia: S. elegans* (Type), *S. troglodytes,* and *S. herpetodes.* The first two species are European (Carlgren, 1949), and the latter is reported from Chile (McMurrich, 1904). In a more recent paper Carlgren (1959) placed *herpetodes* provisionally in the genus Cerus[1]. *S. catalinensis* here proposed is the first member of the genus *Sagartia* reported from North America. The specific name of this new Californian sagartian is taken from Santa Catalina Island where this anemone was discovered and is common.

Systematics

Sagartia catalinensis n. sp. belongs to the family Sagartiidae which according to Carlgren (1949) contains ten genera. Two sagartiid genera have been described since Carlgren's 1949 paper; *Carcinactis* Uchida (1960) collected in Japanese waters as a commensal with the crab *Dorippe granulata* and *Habrosanthus* Cutress (1961) collected in New Zealand waters. Carlgren (1949, p. 100) defined the family as follows: "Thenaria (Acontiaria) with mesogleal sphincter. Mesenteries not differentiated into macro- and microcnemes. Acontia with micro-basic amastigophores and basitrichs."

Genus *Sagartia* Gosse, 1855.

Diagnosis

Sagartiidae with well developed base. Column with cinclides and with modified adhesive verrucae (suckers) capable of attaching foreign bodies. Sphincter mesogleal, strong or weak. Tentacles fairly numerous. Longitudinal muscles of tentacles and radial muscles of oral disc ectodermal. Siphonoglyphs variable in number. About the same number of mesenteries proximally and distally. More than six pairs of perfect mesenteries. No differentiation of mesenteries into macro- and microcnemes. Retractors of mesenteries diffuse to somewhat restricted, never circumscribed. Gonads present from the mesenteries of the first cycle onwards. Sometimes asexual reproduction. Acontia well developed. Cnidom: spirocysts, basitrichs, microbasic p-mastigophores, microbasic amastigophores. The above generic description is from Carlgren (1949, p. 101).

Sagartia catalinensis n. sp.

Base: Strongly adherent, broad, generally assuming contour of substrate to which attached, but often circular in outline. Mesenterial insertions on base white to flesh-colored in life.

Column: Orange to salmon in life with scattered darker orange spots (suckers) upon slight elevations occurring from margin to limbus. Suckers of salmon-colored anemones not as bright as suckers of orange variety. White flecks or scattered longitudinal white lines generally best developed on proximal part of column. Mesenterial insertions visible; transparent to flesh-colored (Fig. 1A). Small elevations mark postition of cinclides and suckers. Suckers contain numerous granular gland cells at base; rarely with sand or debris attached. Cinclides restricted to distal two thirds of column; associated primarily with endocoels of second

cycle of mesenteries, but occasionally associated with endocoels of primary mesenteries. Mucus coat often surrounds base. Longitudinal folds present in upper part of column during contraction.

Column not divisible into regions. Mesenterial insertions visible through body wall, especially in fully relaxed or young specimens. Insertions orange along most of column, tending towards transparency at margin. In extreme extension column a narrow cylinder; generally column length two times width. Ectoderm equally developed proximally and distally; mesoglea at least as thick as ectoderm distally, usually developed less proximally; endoderm poorly developed distally, less than one half ectoderm.

Measurements: Largest specimen: 2.2 cm high, 1.0 cm limbus, 1.1 cm margin, and 0.8 cm tentacle length. Most specimens are approximately 1.0 cm in height.

Tentacles: Transparent in extension. Inner tentacles with or without scattered white or dull yellow flecks occurring mostly on inner surface. Smaller brown specks (endodermal pigmentation) often occur with or without white or yellow pigmentation. On inner tentacles of some specimens, white flecks fused into bars extending varying distance up tentacle. Base of outer tentacles with white band. The white band is generally accentuated by a background of orange pigmentation present on the upper ends of mesenteries and showing through the oral disc. Orange pigmentation of upper part of mesenteries may be absent in salmon variety. A second white band generally present one third to one half distance from base to tip of outer tentacles. One specimen had all tentacles of one side entirely white.

Tentacles arranged more or less hexamerously; completely retractile; up to four cycles. Up to 114 tentacles in large specimens; smooth; evenly tapered; acuminate. Innermost tentacles about three times as long as outermost. Catch tentacles lacking. Longitudinal muscles of tentacles ectodermal. Endoderm lacks symbiotic algae as in other species of this genus.

Disc: Radial muscles ectodermal. Mesenterial insertions evident; bright orange near tentacle bases becoming dull orange to cream near mouth. One half of disc, tentacle free; orange, olive brown, or salmon with white flecks variously developed (Fig. 1B).

Mesenteries and other aspects of internal anatomy: Mesenteries arranged in three or four cycles. Number of perfect mesenteries highly variable, 9-15 pairs (Fig. 2A). In one specimen, two pairs of secondary mesenteries were located in the endocoel of a pair of directives. Labial and marginal stomata present on perfect mesenteries. Retractors of perfect mesenteries diffuse to restricted. Young anemones often with

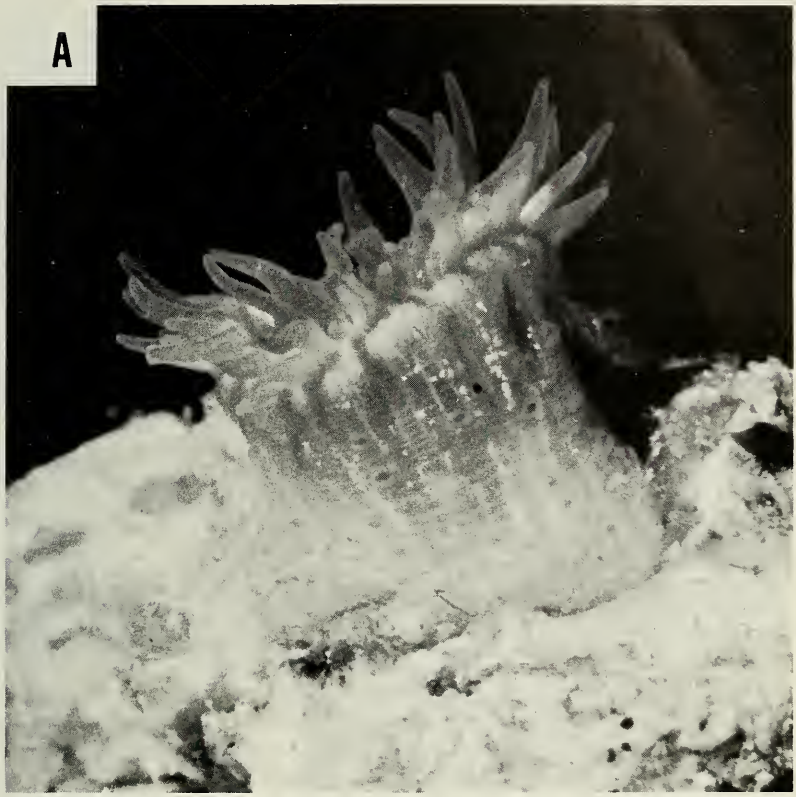
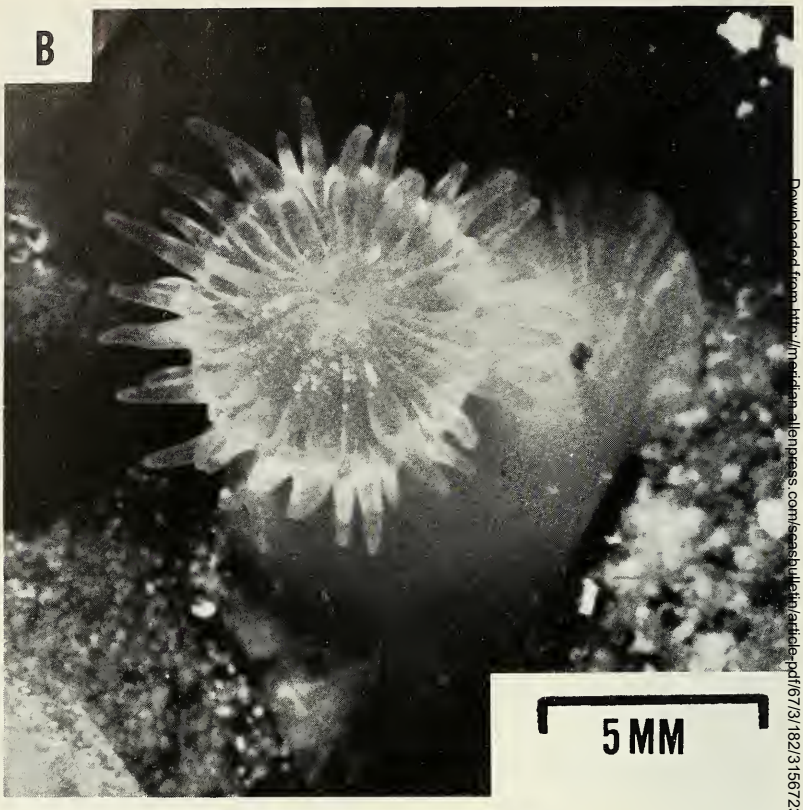


Figure 1, A-B. Sagartia catalinensis n. sp. A. Columnar view of nearly expanded specimen showing mesenterial insertions, white markings of column, suckers (lower column), cinclides (upper column), and tentacles which are approximately one half extended. B. Oral view showing tentacle markings, insertions of mesenteries including complete and incomplete mesenteries, and white markings of disc. A and B to same scale. Photos by Jack W. Schott.

only diffuse retractors. Directive retractors slightly more restricted than others (Fig. 2A, C, D). Up to about fifteen muscle processes per retractor; some processes quite branched. Mesenteries develop simultaneously from distal and proximal regions of anemone; fewer mesenteries seen in middle of column (Fig. 2A, B).

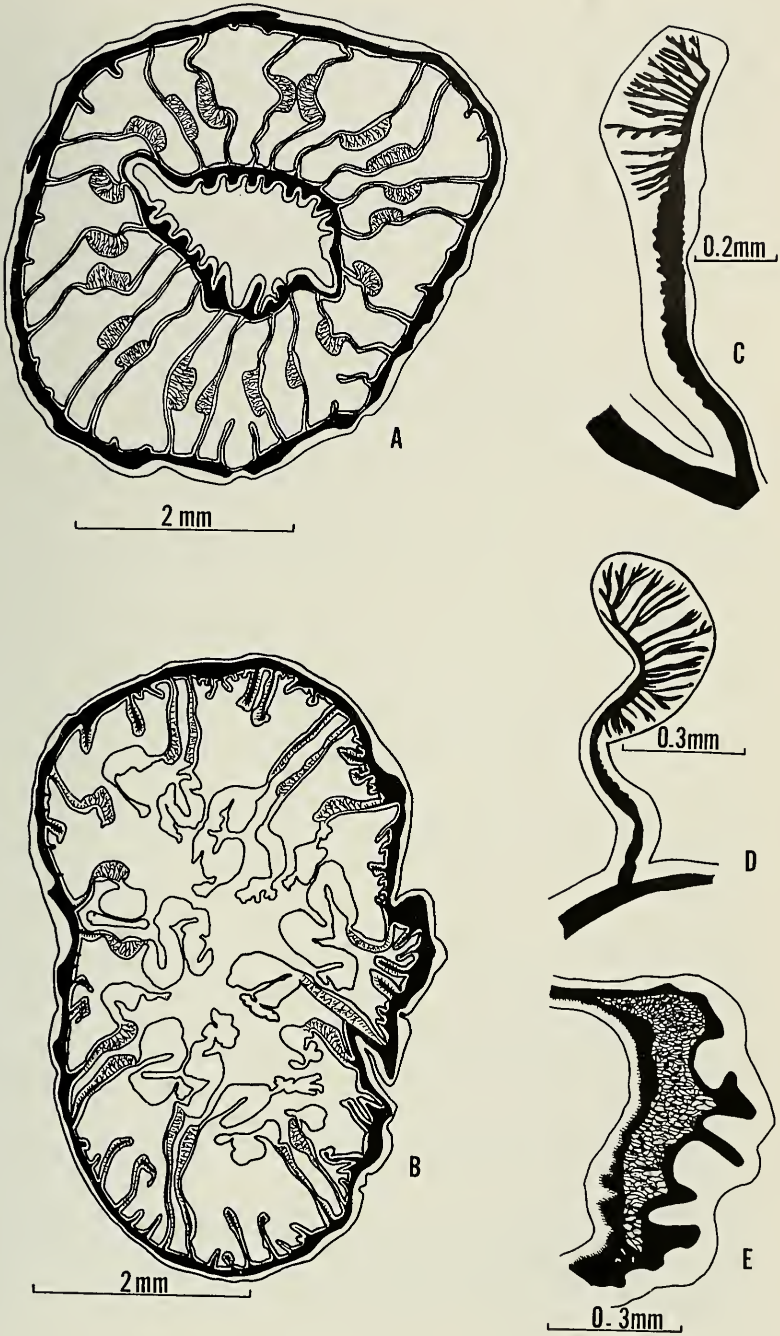
Actinopharynx orange to salmon; corrugations well developed and at least eighteen in number. Siphonoglyphs 1-3 in number; with associated directives. A mesogleal, reticular sphincter may be lacking in small specimens or weak to rather well developed in large specimens



(Fig. 2E). When well developed the sphincter is widest distally and tapers to a point proximally. Acontia normal; with a distinct fin, numerous nematocysts, and many gland cells. Acontia arise from mesenteries of first two or three orders; coloration white; released with medium agitation of anemone.

Cnidom: Spirocysts, microbasic b-mastigophores, microbasic p-mastigophores, and macrobasic p-mastigophores (Classification after Cutress, 1955). *Sagartia catalinensis* is the first species of the genus in which macrobasic p-mastigophores have been found. Nematocyst data were obtained from smears of living material from ten specimens

Figure 2, A-E. Sagartia catalinensis n. sp. A. Transverse section taken in mid region of column showing reduced number of mesenteries (2 cycles). B. Transverse section taken in lower part of column showing 3 cycles of mesenteries. C. Perfect mesentery in lower part of column. D. Directive mesetery in upper part of column. E. Reticular mesogleal sphincter in longitudinal section.



Measurements were taken from eight Santa Catalina Island and two Los Coronados Island specimens. At least 100 measurements were made, with a stage micrometer, for nematocysts of each category in the following regions of the anemone: tentacles, column, actinopharynx, filaments, and acontia.

Tentacles:	Microbasic p-mastigophore — 16-23 by 3.5-4 μ
	Microbasic b-mastigophore — 7-12 by 4-5 μ
	Microbasic b-mastigophore — 9-20 by 2-3 μ
	Spirocysts — 12-22 by 2.5-4.5 μ
Column:	Microbasic p-mastigophore — 16-22 by 3.5-5 μ
	Macrobasic p-mastigophore — 12-19 by 2.5-5 μ
	Microbasic b-mastigophore — 7-12 by 1.5-2.5 μ
	Microbasic b-mastigophore — 15-21 by 3-4 μ
Actinopharynx:	Microbasic p-mastigophore — 20-27 by 3.5-5 μ
	Microbasic b-mastigophore — 10-30 by 1.5-4 μ
Filaments:	Microbasic p-mastigophore — 17-26 by 4-4.5 μ
	Microbasic p-mastigophore — 9-15 by 4-5.5 μ (pyriform)
	Microbasic b-mastigophore — 10-17 by 2 μ
Acontia:	Microbasic p-mastigophore — 27-43 by 3.5-6 μ
	Microbasic b-mastigophore — 30-38 by 4-5 μ
	Microbasic b-mastigophore — 12-17 by 2-2.5 μ

Reproduction: Dioecious. Gonads develop on all perfect mesenteries, including directives. Second cycle of mesenteries (imperfect) may bear gonads. Asexual reproduction by pedal laceration (tearing); laceration common.

Habitat and distribution: Firmly attached to substrate; generally to vertical surface. Vertically distributed from slightly above mean lower low water to a depth of 30 m at Bird Rock, Isthmus of Catalina, California. Anemones very numerous in places. This species has been collected at Santa Catalina and Santa Barbara Islands, California; Cortez Bank, off the coast of Southern California; and Los Coronados Islands, Baja California, Mexico.

Type Locality: Bird Rock, Santa Catalina Island, Los Angeles Co., California.

Holotype: Deposited at the Allan Hancock Foundation, University of Southern California, Los Angeles; AHF Coeleterate number 1.

Paratypes: Abundant material deposited in the Allan Hancock Foundation as AHF Coelenterate numbers 2-10.

Discussion

Nematocysts, tentacle number and arrangement, and coloration distinguishes *Sagartia catalinensis* from the European species, *S. elegans* and *S. troglodytes*. *S. herpetodes,* the Chilean species, also differs markedly from *S. catalinensis:* McMurrich (1904) reported that in the 19 specimens of *S. herpetodes* studied all had more than one mouth (a result of asexual reproduction), generally one or two large central mouths and numerous smaller outer mouths. This species also differs from *S. catalinensis* in coloration, size, and nematocysts. Table I presents a comparison of the known species of *Sagartia*.

A closely related genus, *Actinothoë,* differs from *Sagartia* only in its lack of suckers. *Actinothoë californica,* described from the Gulf of California by Carlgren (1940), has more tentacles than *S. catalinensis,* different nematocyst size ranges, lacks suckers, and has been collected only on the shell of a *Murex*.

In Southern Californian waters *Sagartia catalinensis* might at first glance be confused with *Metridium exilis*. Both anemones are small, have approximately the same number of tentacles, an orange to salmon column and they occupy similar habitats. The two species, however, may be distinguished externally by the presence of a distinct thin-walled capitulum in *M. exilis* and the absence of such diffrentiation in *S. catalinensis*. Internally the two species are distinguished by differences in sphincter structure, mesenterial arrangement, and nematocysts.

The fact that *S. catalinensis* prefers vertical surfaces for attachment becomes very evident when one compares the populations of this anemone on the vertical mainland side (northeast) of Bird Rock and the gentle sloping isthmus side (southwest). On the mainland side anemones are very numerous. On the isthmus side, however, very few specimens of *S. catalinensis* can be seen. Vertical preference was also observed in the population of *S. catalinensis* at Los Coronados Islands. Some specimens on the isthmus side of Bird Rock, which live in depressions in which calcareous sands have collected, are attached to the rock below and are completely covered by sand except for the tentacles and disc. To these specimens particles of shell and sand are attached by the suckers to the column, especially to its upper part.

Sagartia catalinensis also attaches to hard parts of many organisms. It is commonly attached to the shell of *Pseudochama exogyra* and less frequently to *Hinnites multirugosus*. In fact, on the mainland side of Bird Rock *Pseudochama exogyra* is so common that it, or the barnacles attached to it, are frequently the only substrates available for attachment of the anemone. Other molluscs, *Haliotis corrugata* and *H. sorenseni*

have also been collected with *S. catalinensis* attached. Barnacles offer good substrates for attachment. When attached to the insides of empty barnacle tests, the anemones have only the upper part of the column or tentacles extended beyond the orifice of the barnacle. Very infrequently, *S. catalinensis* has also been collected from among the holdfasts of the large brown algae, *Egregia laevigata, Eisenia arborea,* and *Macrocystis pyrifera.*

Asexual reproduction is accomplished in *Sagartia catalinensis* by pedal laceration, which involves an elongation of the pedal disc until the body wall breaks with production of two fragments, normally a very large parent fragment with mouth and tentacles and a single small fragment (lacking mouth and tentacles). In a few instances small fragments proliferated in rapid succession were observed. The small fragments produced by pedal laceration are much larger in proportion to the size of the adult anemone than those produced by the pinching method seen in *Aiptasia californica* from the Gulf of California. Specimens of *S. catalinensis* maintained in petri dishes in aquaria frequently lacerate by extending the pedal disc over the lip of the dish. By continued stretching towards the base of the petri dish, with one lobe of the pedal disc on the inside and the other on the outside of the petri dish, fragmentation is accomplished. Stephenson (1929) observed this habit in *S. elegans* and *Diadumene cincta.*

Stephenson (1929) observed that asexual reproduction generally produced anemones with irregular symmetry. *Sagartia catalinensis* shows such irregularity in the numbers of tentacles, siphonoglyphs, and perfect mesenteries. Regular symmetry is seen in very few specimens of *S. catalinensis;* but when there is symmetry, one finds twelve pairs of perfect mesenteries, two siphonoglyphs, and hexamerous arrangement of tentacles.

Spermiogenesis in *Sagartia catalinensis* takes place in the usual manner for actinarians: spermatocytes and spermatogonia develop in the cortex of the folliculus and the more mature stages (spermatozoa) accumulate in the medullar region. As maturation occurs most of the follicular volume becomes occupied with spermatozoa. Nyholm (1943) reports that in *S. troglodytes* early spermatogonia are first seen at the bottom of grooves in the mesenterial epithelium. Grooves of this nature have not been observed in sections of *S. catalinensis.*

Spermatozoa are of the primitive type as described by Franzén (1956), consisting of a distinct head, a short middle piece containing mitochondrial spheres, and a tail. In *S. catalinensis* the head and middle piece combined are 4-5 μ long and pyriform. The middle piece contains at least two mitochondrial spheres. An acrosome could not be detected.

The tail is 50-55 μ in length and apparently lacks the terminal thinning reported for *Tealia crassicornis* (Retzius, 1904)[2].

In general an ovum of actinians can be divided into an outer ectoplasm and an inner yolk-laden endoplasm as in *Sagartia catalinensis*. The ectoplasm in *S. catalinensis* lies beneath a thin membrane and consists of numerous fine granules interspersed among much larger granules. Granules of both sizes readily take up neutral red. The endoplasmic zone of *S. catalinensis* contains fine granules of yolk which are also stained readily with neutral red. Observations on the cytology of *S. catalinensis* ova are based upon nearly mature examples, which are flesh colored and approximately 100-112 μ in diameter.

Future collections on other offshore islands and the mainland should reveal the presence of *Sagartia catalinensis* in suitable localities.

Summary

A new species of sea anemone, *Sagartia catalinensis,* is described from Southern California. A discussion of its habitat and general ecology are given. Spermatozoa and nearly mature ova are described. The asexual reproductive process is discussed.

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[1] Carlgren (1959) had with some reservations placed *herpetodes* in the genus *Cerus* which differed from *Sagartia* in the arrangement of mesenteries. His decision to consider *herpetodes* a species of *Cerus* was based upon the dissection of a single juvenile individual which had not lost its pedal disc as had the fourteen other specimens. The juvenile had 160 tentacles and 130 basal mesenteries. Carlgren stated that the material was poorly preserved and difficult to diagnose. There does not appear to be sufficient evidence to merit placing *herpetodes* in the genus *Cerus*. In this report *herpetodes* is considered a species of *Sagartia*.

[2] Nyholm (1949) believes that the *Tealia* studied by Retzius was probably *Tealia coriacea*.

Literature Cited

Carlgren, O. 1936. Some west American sea anemones. *J. Wash. Acad. Sci.* 26 : 16-23.

————. 1940. Eastern Pacific Expeditions of the New York Zoological Society. XIX. Actiniaria from the Gulf of California. *Zoologica.* 25 : 211-219.

————. 1949. A survey of the Ptychodactiaria, Corallimorpharia and Actiniaria. *Kungl. Svenska.* Fourth Series. 1 : 1-121.

————. 1952. Actiniaria from North America. *Arkiv för Zoologi.* 3 : 373-390.

————. 1959. Reports of the Lund University Chile Expedition 1948-49. Corallimorpharia and Actiniaria with description of a new genus and species from Peru. ACTA Mus. Lund NS (2), 56 : 1-38.

Cutress, C. E., 1955. An interpretation of the structure and distribution of cnidae in Anthozoa. *Syst. Zool.* 4 : 120-137.

————. 1961. *Habrosanthus bathamae,* n. gen., n. sp. (Actiniaria: Sagartiidae) from New Zealand. *Trans R. Soc. New Zealand.* 1 : 95-101.

Franzen, A., 1956. On spermiogenesis, morphology of the spermatozoon, and biology of fertilization among invertebrates. *Zoologiska bidrag från Uppsala* 31 : 355-380.

Gosse, Ph. H., 1855. On *Peachia hastata* with observation on the family of Actiniadae. *Trans. Linn. Soc.* 21 : 267-276.

Hand, C., 1955. The sea anemones of central California. Part III. The Acontarian anemones. *Wasmann J. Biol.* 13 : 189-251.

Hand, C. and R. Bushnell, 1967. A new species of burrowing acontiate anemone from California (Isophellidae: Flosmaris). *Proc. U.S. Nat. Mus.* 120 : 1-8.

McMurrich, J. P., 1893. Report of the Actiniaria collected by the U.S. Fish Commission Albatross. *Proc. U.S. Nat. Mus.* 16 : 119-216.

————. 1904. The Actinae of the Plate Collection (in Plate Faunna Chilensis 3.2). Zoologische Jahrbücher. Suppl. VI, Jena. 215-306.

Nyholm, K. G., 1943. Zur Entwicklung und Entwicklungsbiologie der Ceriantharien un Actinien. *Zoologiska bidrag från Uppsala.* 33 : 69-77.

Retzius, G., 1904. Zur Kenntnis der Spermien der Evertebraten. *Biol. Untersuch.* 11 : 1-31.

Stephenson, T. A., 1929. On methods of reproduction as specific characters. *J. Mar. Bio. Assn. U.K.,* 16 : 131-172.

————. 1935. British sea anemones. II, *Ray Soc.* 121 : 1-426.

Uchida, T. 1960. *Carcinactis ichikawai,* n. gen.; n. sp., an Actiniarian commensal with the crab *Dorippe granulata. Jap. J. Zool.* 12 : 595-601.

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TABLE I

A comparision of the common characteristics of species of *Sagartia*

	Species			
Characters	*catalinensis*	*elegans*	*troglodytes*	*herpetodes*
General Coloration and Markings	orange to salmon, pattern on tentacles	wide variation, bright orange, orange-brown, buffcolored, or light brown; tentacles with or without pattern	wide variation, generally dull, green, brown or flesh-colored; tentacles with or without pattern	body white, tentacles with light brown tint, oral disc sometimes brown, mouth white
Cinclides	scattered and situated on distal two thirds of column	arranged in two rings; one below margin, other above base	arranged in two zones; upper zone scattered among suckers, lower zone in rows above base	lacking (?)
Suckers	scattered from margin to base, visible as bright orange spots (generally), debris infrequently attached	generally visible as scattered pale spots, foreign material not attached	generally visible as pale spots which attach much debris, generally scattered but in some forms the suckers are arranged in longitudinal rows	not markedly visible, sand and shell fragments adhere
Maximum Height	2.2 cm	7.0 cm	var. *decorata* — 10.0 cm var. *ornata* — maximum diameter — 1.5 cm	9.0 cm
Tentacles	more or less hexamerous with up to 4 cycles and 114 tentacles, catch tentacles lacking	arrangement quite variable in 6 cycles, up to 192 in number, catch tentacles may be present	hexamerous, arranged by formula: 6 + 6 + 12 + 24 + 48 + 96 = 192, catch tentacles may be present	arranged in about 4 subequal cycles, more than 160 in number

Mesenteries	3 or 4 cycles, perfect pairs 9-15 in number	5 cycles, perfect pairs 18-29 in number	5 cycles, 12-24 perfect pairs	number of mesenteries extremely variable due to asexual mode of reproduction
Reproduction	dioecious, oviparous; asexual reproduction by pedal laceration (tearing)	dioecious, oviparous; pedal laceration (tearing)	monoecious, viviparous; no asexual reproduction	sexual not observed; asexual by longitudinal fission often incomplete giving rise to many mouths
Nematocsts of Acontia	micro-p-mastigophores 27-43 X 3.5-6 μ micro-b-mastigophores 30-38 X 4-5 μ 12-17 X 2-2.5 μ	micro-p-mastigophores 39-63 X 4-6.6 μ micro-b-mastigophores 24-39 X 2.6-4.5 μ	micro-p-mastigophores 20-29 X 2.5-4.6 μ micro-b-mastigophores 12-21 X 1.5-3.4 μ	micro-p-mastigophores 29.6-38 X 4.2-5 μ micro-b-mastigophores 28.2-35.2 X 3.5 μ
Geographical And Vertical Distribution	Santa Catalina Island, Santa Barbara Island, Cortez Bank (97 miles off coast of Southern California), California and Los Coronados Islands, Baja California, Mexico; about mean low tide to a depth of 95 feet	Sweden, Denmark, Germany, England, France probably to Mediterranean; usually intertidal but also to 300 feet	same distribution as *elegans*, however it only extends to a depth of 140 feet	Chile, intertidal