BARNACLES/INVERTS
G.H. BALAZS
FILE 1970s-19

Invertebrates Ingested

by

Sea Turtles

((Identifications of Stomach Samples))
((Collected by George Balazs))

William J. Cooke
MER - Marine Environmental Research
2351 Walu Way
Honolulu, Hi., 96822

11 XII 78

Identification of Invertebrates

from Turtle Stomach Samples

Sample		Description (Remarks)
GB-1	May 75 Waikiki TMR Adult	Brachidontes crebristriatus (approx. 100) Simocarcinus simplex (one)
GB-4	6/24/77 FFS Tiger mortality	Cerithiidae (micromolluscs, 2); pteropod shells, empty (blue green algal mat)
GB-6	7/12/77 Midway mortality	No invertebrates (algae, cloth fragments, thread, magnetic tape)
GB-24	11/5/77 Hono Harbor 2365	Unidentified tissue
GB-33	9/11/77 FG "A"	Chondrosia chucalla de Laubenfels, 1936 (fresh)
GB-38	7/28/77 Bellows feces	C. chucalla (partially digested; plant material present)
GB-41	11/20/77 V/s Kaneohe	C. chucalla (fresh)
GB-101	3/15/78 Bellows feces	C. chucalla (partially digested)
GB-112	3/15/78 Bellows feces	C. chucalla (partially digested)
GB-114	3/15/78 Bellows feces	Spongia oceania (?) see remarks
GB-115	3/15/78 Bellows feces	No invertebrates (unidentified algae)
GB-116	3/15/78 Bellows feces	Unidentified tissue (algal fragments)
GB-132	3/15/78 Bellows feces	C. chucalla (partially digested)
GB-139	3/15/78 Bellows feces	Unidentified tissue
GB-140	3/15/78 Bellows feces	C. chucalla (partially digested)
OCOMB		1 piece unidentified zoanthid coelenterate (Palythoa ?)

Remarks

Sponges

Chondrosia chucalla de Laubenfels, 1936

Syn. Chondrosia collectrix Lendenfeld, 1888, (nec. C. collectrix Schmidt, 1870.)

This sponge was described by Lendenfeld from Australia in 1888, but the specific name he gave it, collectrix, had earlier been used by Schmidt in 1870 for a different species in the same genus. To correct this nomenclatural overlap, de Laubenfels (1936) gave this species its present specific name, chucalla.

de Laubenfels (1951) recorded this species as common in tide pools at Halape, Island of of Hawaii. It also appears to be common around Oahu.

This sponge is unusual in that it lacks both mineral spicules, or a spongin fiber network. Its consistency is derived from a gel of "non-living colloidal material" (de Laubenfels, 1951). Perhaps this lack of spicules and fiber meshwork make this a more palatable (and the gel may make it more nutritious) item than other sponges.

Spongia oceania de Laubenfels, 1950

The spongin meshwork of this species is present, but most of the material surrounding this meshwork is algal. It is not clear whether this represents a spongin meshwork which had (in nature) been overgrown by algae, or a partially digested sponge mixed with algae in the turtles stomach. Probably the former is the case, as the algae seems more intimately associated with the meshwork than mixing would allow. Thus this would not really count as ingestion of this species of sponge.

Mollusc

Brachidontes crebristriatus

A small mussel (family Mytilidae) which grows in beds both intertidally and subtidally. Often intermixed with algae.

Crustacea

Simocarcinus simplex

A common decorator crab (family Majidae) usually found among algae on reef flats and subtidally. Noted as being a slow moving species.

Literature Cited

de Laubenfels, M. W., 1936
A discussion of the sponge fauna fo the Dry Tortugas in particular and the West Indies in general, with material for a revision of the families and orders of the Porifera.
Carnegie Inst. Wash. Pub., 467: pp. 1-225.

__________________, 1950 + DeVaney
The sponges of Kaneohe Bay, Oahu.
Pacific Science, 4: 3-36.

__________________, 1951
The sponges of the Island of Hawaii.
Pacific Science, 5: 256-271.

0 2 DEC 1985

The Occurence of the Caprellid amphipod *Caprella andreae* Mayer, 1890 on the Olive Ridley, *Lepidochelys olivacea*, in Hawaii.

George H. Balazs
National Marine Fisheries Service

William J. Cooke
MER - Marine Environmental Reearch

On July 29 1985 an Olive Ridley turtle was collected by one of the authors (GHB).

· Balazs collection data in here

Noticable among the algal fouling were many epifaunal orgasims which appeared quite different from those usually found on green and hawksbill turtles. Scrapings from the head were collected and forwarded to the second author (WJC). Sorting this collection yielded many specimens of the caprellid amphipod Caprella andreae Mayer, 1890, (synonymys with C. acutifrons forma andreae Mayer, 1890). As characterised by McCain, 1968, this species differs from the closely related C. penantis Leach, 1814 (syn. C. acutifrons Latreille, 1816) by the inflated peduncle of antenna one in adult males and convex palms with medial paired grasping spines on the propodus of pereopods 5-7.

This collection included all growth stages, juveniles of several sizes, as well as reproductive females and adult males. This fact, coupled with the presence of typical oceanic fouling indicated that the caprellid population had been resident on the turtle for some time and did not result from recent inshore fouling. According to McCain (1968), C. andreae is usually found on floating objects such as "driftwood, buoys and plants" and has been recovered from fouling on sea-turtles (Thalassochelys and Chelonia) from the Atlantic and Mediterranean. Although McCain (1968) cites collections from the western and north Pacific (Japan, Korea, "between Tokyo and Honolulu", 43°N, 152°W) there appear to be no records of this species from the tropical Pacific. In contrast, the C. penantis is listed as the most common caprellid in Hawaii (as C. acutifrons in Edmondson and Mansfield, 1948), the most abundant caprellid in Japan (Arimoto, 1976), and the most common caprellid along the east coast of the United States (McCain, 1968). Arimoto (1976) includes C. acutifrons forma andreae Mayer, 1890 within the synonymy of C. penantis Leach 1814, apparently disagreeing with McCain's (1968) elevation of this form to full species rank. However, the presence of this collection material morphologically identical to specimens from the Atlantic and the Mediterrean and distinguishable from the commonly collected C. penantis of Hawaiian inshore waters, argues that C. andreae represents a unique entity. Of the twenty forms of C. acutifrons which Mayer (1890, 1903) described, four (including C. andreae) have been raised to species rank distinct from C. penantis Leach, 1814, but the status of the remaining sixteen forms remains uncertain (McCain 1968). It seems likely that many of these forms would be full species if examined more closely. The characteristic differences found separating C. andreae from C. penantis are unlikely to result from the kind of variation in body development described by Bynum (1980) for C. penantis.

The presence of an epifaunal species tied to open ocean fouling, and absent on inshore fouling is not uncommon. If C. andreae is restricted to open-ocean floating objects it habitat specificity would be similar to that of the gooseneck barnacles (Lepas spp.) which are abundant on such surfaces but absent from inshore fouling. The commensal gammaridean amphipod, Hyachela tortugae, is even more restricted, having been collected only from turtle fouling. The wide ranging migration habits of turtles, as exemplified by this particular specimen, and the abundance of floating substrate in the open ocean assure wide distributions for such species.

A closer examination of epifaunal collections from off-shore fouling collected in Hawaii and the tropical Pacific should offer some insight into the true abundance of C. andreae in this area. This would allow us to judge whether this species is a typical, yet rarely recognized, component of mid-Pacific open-ocean fouling or an accidental record of what is normally a temperate ocean species.

LITERATURE CITED

Arimoto, I., 1976.
Taxonomic studies of caprellids (Crustacea, Amphipoda, Caprellidae) found in the Japanese and adjacent waters.
Spec. Pub. Seto Marine Biological Lab. Series III, v, 229 pp.

Bynum, K. H., 1980.
Multivariate assessment of morphological variation in *Caprella penantis* Leach, 1814 (Amphipoda; Caprellidae).
Estuarine Coastal Marine Science, 10; 225-235.

Edmondson, C. H., and G. S. Mansfield, 1948.
Hawaiian Caprellidae.
Occ. Papers B. P. Bishop Museum, 19(10): 201-218.

Mayer, P., 1890.
Die Caprelliden des Golfes von Neapel. Nachtrag zur Monographie deselben.
Fauna Flora Golfes Neapel 17, 157 pp.

__________ 1903.
Die Caprellidae des Siboga-Expedition.
Siboga Expedition 34, 160 pp.

McCain, J. C., 1968.
The Caprellidae (Crustacea: Amphipoda) of the Western North Atlantic.
U. S. National Museum Bulletin, 278, vi, 147 pp.

University of Hawaii at Manoa

9-IV-79

MEMORANDUM

To: G. H. Balazs, HIMB
From: W. J. Cooke, Zoology Dept.

I am returning some specimens of Hyachelia tortugae which I have identified. There are two lots, id # 2954, and 2503, with data as indicated on the labels. These are preserved in 70% isopropyl alcohol.

I still have one lot of approximately 9 specimens, all apparently collected at the same time, the collection data for which is missing. All that is available is a faded strip of masking tape around a screw top vial. It is labelled with our number 780010HA/3b, but no other writing on the tape. Could you please provide me with the information on this lot, so I can label this lot properly, and divide specimens for B.P. Bishop Museum, and our facility. This lot is the only one with males, females and juveniles together.

I hope these specimens are of interest to you, and that they will prove useful in your research.

If you need to contact me, please phone either 948-8617, or 254-4461 and leave a message if I am not in.

Thank you for the opportunity to examine these interesting amphipods, and I hope to see more the interesting material you so often provide.

Aloha,

W. J. Cooke

Sept 78

REPORT ON SAMPLES RELATING TO TURTLE BIOLOGY

TO: George Balazs, HIMB

FROM: William J. Cooke *WJ Cooke*

SAMPLES: MCOMB I, MCOMB 4, misc. skin barnacle

I: Sample: "MCOMB I, 5/78, G. Balazs"

Location: ?

Date: 5/78

Species: 1) Isaurus elongatus Verrill, 1928 Percentage of sample: 20%

2) Unidentified siphonaceous alga " " 75%

3) Misc. unid. algae " " 5%

II. Sample: "MCOMB 4, 5/78, G. Balazs"

Location: ?

Date: 5/78

sig more digested

Species: 1) Isaurus elongatus Verrill, 1928 Percentage of sample: 30%

2) Sargassum sp(p). " " 15%

3) siphonaceous algae as in MCOMB 1 " " 5%

4) Unid. algae and debris " " 50%

III. Sample: "skin barnacle, 28X77, HIMB stranded turtle, front limb, G. Balazs"

Location: Coconut Island, Kaneohe Bay, Oahu, Hawaii

Date: 28X77

Species: 1) Stephanolepas muricata Fischer, 1886 1 specimen

SUMMARY

The compostition of the first two samples indicates a shallow or intertidal reef (probably fairly exposed) origin for this material. Isaurus elongatus is a zoanthid coelenterate (Anthozoa, Zoantharia) related to Palythoa and Zoanthus. All of this group are usually found in open areas with fairly good water motion. Isaurus is not as common around Oahu as either Palythoa or Zoanthus, both of which are very common on the disturbed reefs of Kaneohe Bay. Palythoa produces a toxin, "palytoxin" originially isolated from Palythoa toxica, the "limu-make-o-Hana" well known in the recent history of HIMB. No toxicity has been reported for Isaurus. But this may be because it is not as common, and do one has looked for it.

The skin barnacle seems to be the rare Stephanolepas muricata, but the speciment evidently sat for some time in strong formalin, and is fairly well decalcified. The impression of the wall plates is left in the tissue, and coupled with the structure of the moutparts which have been dissected and mounted the identification is reasonably secure.

I would like to keep the Isaurus (my dissertation is on zoanthids), and I have taken the liberty of donating the barnacle and the slide to the NOSC Processing Center for permanent reference. Please advise about the disposition of the other material.

SUBMITTED: 19-IX-78

Samples to Bill Cooke listed as containing
animal material by Dennis Russell

September 1978

Sample no.	description and % by D. Russell
GB-1	pelecypod, worm tubes
GB-4	animal 5%
GB-6	animal 3%
GB-24	animal material 10%
GB-33	animal 10%
GB-38	animal 1%
GB-41	animal (black colonial tunicates) 3%
GB-101	animal 5%
GB-112	animal? 8%
GB-114	animal material? 50%
GB-115	animal 5%
GB-116	animal 10%
GB-132	animal (black) 5%
GB-139	animal (black) 25%
GB-140	animal (black) 10%

University of Hawaii at Manoa

Hawaii Institute of Marine Biology
P.O.Box 1346 • Coconut Island • Kaneohe, Hawaii 96744-1346
Cable Address: UNIHAW

Mr. George Balazs
NMFS - Southwest Lab.
2570 Dole St.
Honolulu, HI, 96822

13 JUN 1985

Dear George,

I have examined the material from your collection "36 cm HAWKSBILL 10/15/84 Anterior Stomach". It consists of nine (9) specimens (mostly intact carapaces) of the megalops (last larval) stage of a brachyuran crab, plus fragmentary (claws, limbs, tissue) material.

The specimens are identical to those described as Megalops alpha by Edmondson (1949). Crabs of this type had occasionally been erroneous described as adult species, but they are unquestionably larval forms of a common species (judging by their cited abundances). Megalops of this type have been described as monolepoid forms, and other monolepoid megalops have been associated with species in the genus *Ocypode*, the ghost crabs of sandy beaches.

Probably these specimens represent the megalops stage of one of the common *Ocypode* ghost crabs (although other genera or even families can not be ruled out at this stage). The megalops stage is adapted for the transition from free-floating larval pelagic life to the ambulatory benthic adult crab. Most similar collections came from beaches with a few from fish guts. As such, this form was most likely found in nearshore waters around the islands rather than on the high seas. If further research reveals a definite link to an adult form I will let you know.

The material has been returned separately. Thanks for the opportunity to examine these interesting specimens. Please feel free to contact me with any other such unique samples.

Aloha,

William J. Cooke, Ph.D.
Research Affiliate

ref: Edmondson, C. H., 1949.
Some Brachyuran Megalopa.
Occ. Papers B. P. Bishop Museum 19: 233-246.

WJC:mcii

TO: George Balazs, HIMB

FROM: William J. Cooke, Zoology Dept. 19 JUN 1980 W.J. Cooke

SUBJECT: Identification of Invertebrates Incidental to Turtle Studies.

Enclosed are two tables listing the invertebrate material identified from the samples you submitted to me. The first table lists the material by sample number, and includes all samples. The second table lists the material by phylum and includes only samples with significant material. Your original sheet with the sample descriptions is also included.

The material has been repacked in the original vials and box. Let me know when you want the material returned. If any of the material is to be permanently retained, i.e., barnacles, amphipods, etc., these should be placed in permanent containers (vials within taped bottles) and complete collection data should be added to waterproof labels within the vials. With the collection data you supplied, it would be inappropriate for me to attempt to curate this material.

Thanks for the opportunity to examine this material, and I hope the information is interesting and useful.

TABLE I

Sample #	Material	Identification	Remarks
GB-149	stomach contents	unid. debris	
GB-328	Amphipod	2 *Hyachelia tortugae* Barnard, 1967	
GB-331A	-	algal debris	
GB-331B	Black sponge	*Chondrosia chucalla* de Laubenfels ,1936	
GB-332	white tissue	tunic of unid. solitary tunicate	
GB-333	" "	tunic of unid. solitary tunicate	
GB-334	-	unid. flatworm	
GB-408	barnacles in mouth	No barnacles found	Apparently old infestation
GB-415	amphipod	2 *Hyachelia tortugae* Barnard, 1967	
GB-419	Formaminifera	several dead *Amphisorus hemiprichii*	
GB-422	ovoid brown pellets	unid. pellets	(not fecal pellets)
GB-423	" " "	unid. pellets	(not fecal pellets)
GB-427	ovoid pellets	unid. pellets	(not fecal pellets)
GB-428	round worm	-	Not found
GB-430	foraminifera micromolluscs	several dead *A. hemprichii* -	 Not found
GB-444	round worms	several unid. nematodes	
GB-501	colonial animal	-	Not found
GB-502	colonial animal	-	Not found
GB-503	colonial animal	*Chondrosia chucalla* de Laubenfels, 1936	
GB-504	black colonial animals	" "	
GB-505	" " "	" "	

19 JUN 1980

TABLE I (continued)

Sample #	Material	Identification	Remarks
GB-506A	silicate sponge	<u>Halichondria</u> (?) sp.	See note 1.
GB-506B	" "	<u>Halichondria</u> (?) sp.	" "
GB-522	"round worms" as per Russell	-	Not found 1/27/81 sample discarded
GB-606 Fiji	-	Cast of barnacle	
GB-607 Fiji	-	<u>Codium</u> (?) 1/27/81 - out of algae ID'd by Russell	
GB-609 BP Museum	-	<u>Dictyosphaeria</u> (?) 1/27/81 agreed sample discarded	
3295	amphipod Kahaluu	1 <u>Hyachelia</u> <u>tortugae</u> Barnard, 1967 12/12/79	
2995	amphipod	1 <u>H.</u> <u>tortugae</u> Barnard, 1967	
3280	barnacles [illegible] of front flippers	36 <u>Stephanolepas</u> <u>muricata</u> Fischer, 1886	juveniles
6666	worms	Lumbrineridae, species unid.	CI [illegible] captive turtle from tag
2335	- May 1980	<u>Brachidontes</u> <u>crebristriatus</u> (Conrad, 1837)	in tag? mollusks
pressed spec.		<u>Vellela</u> <u>vellela</u> Linnaeus, 1758	

Note 1

The spicules of this sponge do not seem to match any species in literature I have available. Based on gross appearence, and the spicules, it seems most like a <u>Halichondria</u>. If this continues to be a significant diet item, perhaps it would be worth a more thorough examination, or enlisting the services of a sponge specialist.

TABLE II

TAXA	Sample	Remarks
Porifera		
Halichondria (?) sp.	GB-506A, B	See Note 1 on Table I.
Chondrosia chucalla de Laubenfels, 1936	GB-331B,503,504,505	Often grows on reef flats.
Cnidaria		
Vellella vellella Linnaeus, 1758	pressed from beach drift	Common neuston species.
Mollusca, bivalves		
Brachidontes crebristriatus (Conrad, 1837)	2335	Common mussel on reef flats.
Arthropoda, Crustacea		
Stephanolepas muricata Fischer, 1886	3280	36 juveniles in good condition.
Hyachelia tortugae Barnard, 1967	GB-328,415,3295,2995	Commensal amphipod. 6 specimens in good condition.

Samples to Bill Cooke
10 hours @ $6.50 hour May 1980 from G. Balazs - HIMB

✓GB-149 unid debris tag 2460 - stomach contents 2/23/78
✓GB-328 amphipod ? 2 Hyalella tortugae
✓GB-331A Oct 1978 powerhead mortality
✓GB-331B " " Chondrosia chucalla " (BIK SPONGE!)
✓GB-332 white tissue ? Tunicate unid
✓GB-333 " " ? Tunicate
✓GB-334 ? unid Flatworm

✓GB-408 March 1979 Barnacles in mouth ? No barnacles
✓GB-415 amphipod ? 2 H. tortugae
✓GB-419 " Foraminifera (protozoan)" as per D. Russell ? 4 Amphisorus hemprichii (dead)
✓GB-422 "Ovoid brown pellets" not fecal pellets " " " ?
✓GB-423 "Ovoid brown pellets" " " " " " ?
✓GB-427 "ovoid pellets" not fecal unid " " " "
✓GB-428 "male round worm in *Codium*" as per Russell ? → not found) 1 unid gammarid amphipod
✓GB-430 "Foraminifera (protozoans) as per Russells ?
"Micromollusks" (3)" A. hemprichii
GB-444 "many round worms up to 2mm long" Nematoda ?

✓GB-501 "colonial animal, trace" not found Russell
GB-502 "colonial animal, trace" not found Russell
✓GB-503 "colonial animal, trace" Chondrosia chucalla Russell
✓GB-504 "black colonial animals, 4" Chondrosia chucalla Russell
GB-505 "Achrochaetium on *Codium*" Chondrosia chucalla
"black colonial animal trace" - Russell

Samples to Bill, continued
May 1980 – from Balazs

✓ GB-506A Halichondria(?) "colonial animals" "silicate sponge on Amansia" – Russell
✓ GB-506B " " 18 July 1979
✓ GB-522 "round worm assoc. w/ *Codium*" – Russell (not found)

✓ GB-606 Fiji confiscation — Barnacle cast
✓ GB-607 " " — Codium
✓ GB-609 Kahala mortality — Dictyosphaeria

✓ 3295 amphipod? 1 H. tortugae ♀♀
✓ 2995 amphipod? 1 H. tortugae ♂♂
✓ 3280 barnacles embedded in front flippers
✓ 6666 worms scraped from tag
✓ 2335 May 1980 – from turtle tag — Brachidontes crebristriatus

+ Pressed specimen Velella

sc juv. (?) *Stephanolepas muricata*

several loose egg masses

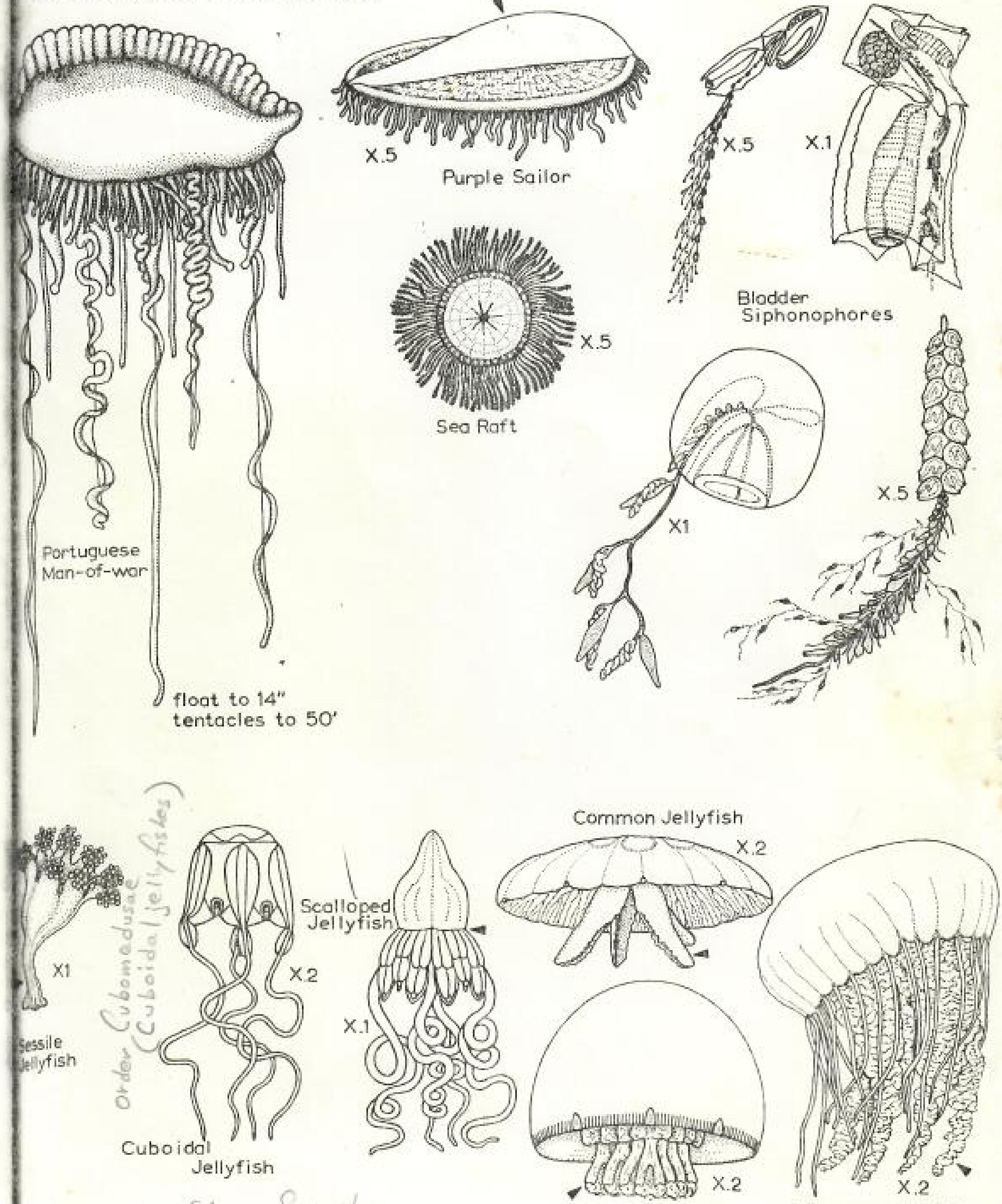
UNIVERSITY OF HAWAII
Hawaii Institute of Marine Biology
Coconut Island • P. O. Box 1346 • Kaneohe, Hawaii 96744

Class.- Hydrozoa

D. Chave

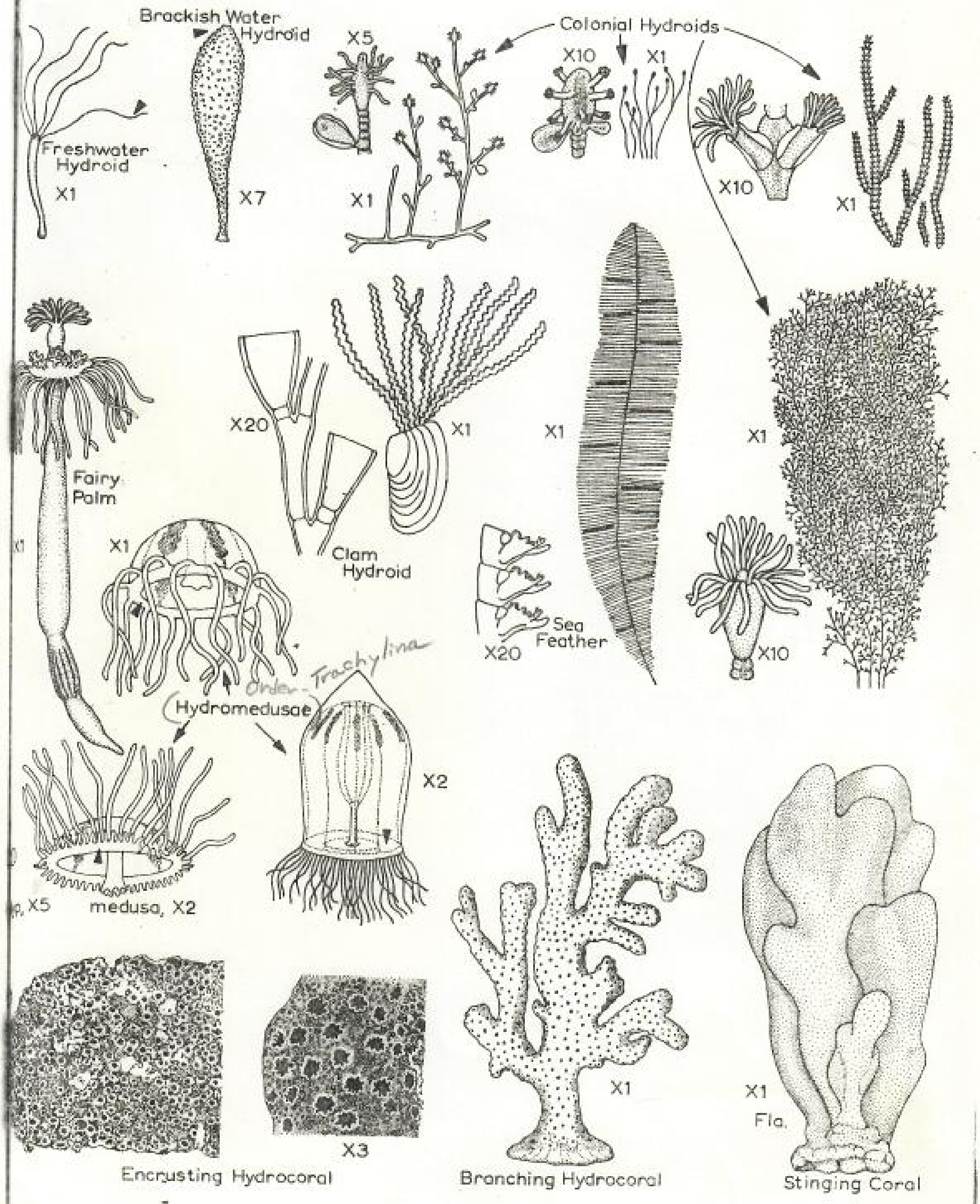
See "Marine Life" MS 402

HYDROZOANS II-JELLYFISHES



Class Scyphozoa (jellyfishes)

YDROZOANS I


Brackish Water Hydroid
Freshwater Hydroid
X1
X7
X5
X1
Colonial Hydroids
X10
X1
X10
X1
Fairy Palm
X1
X20
Clam Hydroid
X1
X1
X1
X1
Sea Feather
X20
X10
Order-Trachylina
Hydromedusae
X2
p, X5
medusa, X2
X3
Encrusting Hydrocoral
X1
Branching Hydrocoral
X1
Fla.
Stinging Coral

COASTAL OCEANOGRAPHY AND CLIMATOLOGY NEWS

Recent Events in United States Coastal Waters

Volume 3 Number 3 **Spring 1981**

The purpose of Coastal Oceanography and Climatology News *(COCN)* is to provide timely dissemination of information concerning environmental events and research activities in U.S. coastal waters. We will publish brief articles describing recent events and unusual phenomena. Also, announcements of cruises, meetings, and investigations will be posted. Since the emphasis is on timely reporting of early results, observations older than six months will not be accepted unless they are used as a basis for comparison with more recent observations. The newsletter is not a substitute for publication in professional journals or presses. *COCN* is not copyrighted, and any reference to material printed in the newsletter must be approved by the author.

Editors:
Merton Ingham, *National Marine Fisheries Service*
H. Perry Jeffries, *University of Rhode Island*

Technical Editor:
Elisabeth Keiffer

Published by:
Center for Ocean Management Studies
University of Rhode Island, Kingston, RI 02881

John Knauss, *Chairman, Executive Board*
Walter J. Gray, *Acting Director*

In This Issue

Environmental Events

Warm Water Intrusions off California Linked with *Velella* Strandings

An extensive stranding of the pelagic coelenterate *Velella* ("By the wind sailor") was observed along the shoreline near Scripps Institution of Oceanography during the first days of April 1981. Densities were on the order of 3000 organisms per meter of beach. Mean length was about 1 cm; and probably less than 1% of the stranded organisms was longer than 3 cm (L. Haury, pers. comm.). *Velella* is not a common resident of the Southern California nearshore area. It is usually found further offshore in truly oceanic waters (J.A. McGowan, pers. comm.). In the past, however, strandings have been reported on Southern California beaches (e.g. May 1967 and April 1972; in Cheng, 1975), and it is occasionally abundant in some regions of the California Current.

Coincidentally with the *Velella* stranding unusual temperature and chlorophyll-like pigment distributions were observed in satellite imagery at the Scripps Remote Sensing Facility. Figure 1 shows an enhanced infrared satellite image of the Southern California region, covering an area of about 280 km on a side, on the evening of April 5, 1981. It shows a warm water intrusion 5 to 10 km wide (darker gray tones indicate warm temperatures) reaching the coast in a region extending from La Jolla to about 30 km northward. Sea surface temperatures within the intrusion are about 16°C; outside the intrusion they are about 15°C. Sea surface temperature gradients of 0.3-0.4°C/km delineate the boundaries. Figure 2 shows a processed image of chlorophyll-like pigment boundaries in the Southern California region, covering an area of about 210 km on a side at noon on April 4, 1981. Data were obtained by the Coastal Zone Color Scanner of the NIMBUS-7 spacecraft. Images on figures 1 and 2 are not registered to the same coordinate system and have different spatial resolutions.

The data for the pigment boundaries in Figure 2 were collected about thirty hours before the data for the thermal image of Figure 1. Figure 2 shows, however, a narrow, 5 km wide, low chlorophyll-like pigment tongue (shown as darker gray tones) intruding from the southwest into the La Jolla area and extending coastally to the north. Despite the approximately thirty-hour difference between the data collection time for the

Figure 1. Magnified and enhanced infrared image of the Southern California region received at the Scripps Remote Sensing Facility on the evening of April 5, 1981, from the Advanced Very High Resolution Radiometer of the NOAA-6 spacecraft. Image is about 280 km on a side (scale reference: large islands in middle of image are each about 33 km long).

Figure 2. Magnified, enhanced, processed image of chlorophyll-like pigment ocean structure of the Southern California region received at the Scripps Remote Sensing Facility about noon April 4, 1981, from the Coastal Zone Color Scanner of the NIMBUS-7 spacecraft. Image is about 210 km on a side.

two images, the tongue in Figure 2 shows a similar spatial pattern to the warm water intrusion in Figure 1. The *Velella* stranding seems to have been associated with the observed coastal ocean features of both images. These nearshore features appear to be a weakening extension of an offshore, warmer water mass. The processed visible-band image in Figure 2 shows a considerable amount of fine structure. However, these pigment patterns do not always appear to be directly related to the spatial thermal structures.

During the month of March 1980, a similar warm water core was detected with simultaneous satellite and shipboard observations slightly farther to the south and offshore. The shipboard measurements showed that salinity was high in this area, and that anchovy unexpectedly avoided this region during the peak of the spawning (Lasker, Pelaez, and Laurs, 1980). Also, results from satellite imagery analysis corresponding to the Fall 1980 and Winter 1980-81 for the coast of California showed a narrow and sluggish California current, and a persistent southern warm water influence in the Southern California region throughout the period. Strengthening of the California current and onset of more or less persistent cool water conditions in the Point Conception area was apparently delayed by almost a month in 1981, as compared to 1980. This delay seemed to result in a reduced ability of the cool water masses of northern origin to displace the warm, more saline waters during this time of year.

When this note was written, R/V *David Starr Jordan* (National Oceanic and Atmospheric Administration/National Marine Fisheries Service) and R/V *New Horizon* (Scripps Institution of Oceanography) were sampling a broad region covering the area of interest during monthly cruises of the 1981 CalCOFI program. Detailed comparisons of *in situ* and satellite data will be performed when shipboard data become available to explore possible relationships between the imagery, shipboard oceanographic measurements, and the *Velella* stranding.

References

Cheng, L. 1975. Marine Pleuston-Animals at the Sea-Air Interface. Oceanogr. Mar. Biol. Ann. Rev. 13:181-212.

Lasker, R., J. Pelaez and R.M. Laurs. 1980. The Use of Satellite Infrared Imagery for Describing Ocean Processes in Relation to Spawning of the Northern Anchovy (*Engraulis mordax*). Presented to the 1980 meeting of the International Council for the Exploration of the Sea. Submitted to *Remote Sensing of Environment*.

Jose Pelaez
Scripps Institution of Oceanography
La Jolla, CA 92093
714-452-4135

Disappearance of Soft Coral in Narragansett Bay

Soft coral, *Alcyonium digitatum*, is normally an abundant member of boreal rock bottom communities to 39°N (Gosner 1971). Since 1968 we have observed and photographed a perennial population of both young and old colonies in our study area at Fort Wetherill, east passage, Narragansett Bay, Rhode Island (41.5°N). In this area *Alcyonium* frequently occurred in concentrations of 50-100 colonies•m^2 at depths greater than 10 m on flat, rocky substrates. At Fort Wetherill, the populations have consisted of many thousands of colonies and covered

Consider the sponge,

an animal that cannot move around, possesses neither heart, lungs, nor brain, exhibits no complex behavior patterns, has no nervous system and no apparent means of defense, yet has survived for hundreds of millions of years essentially unchanged.

Conglomerates of simple cells, each kind with a specialized task to do, sponges draw in water through pores in their skin. Inside the sponges, whiplike flagella propel the nutrient-laden water through labyrinths of canals and chambers. The sponges then expel the water from vents, or oscula—

each of the island's districts, many of the men wearing white turbans, which signified that they had visited Mecca. A huge painted dove hung behind the rostrum, and the head of the government delegation, Rear Adm. Romulo Espaldon, wore a bright floral garland around his neck.

Admiral Espaldon took the floor to hear grievances. An old man, a refugee from the fighting, said he wished to return to his home. Espaldon pointed to the local military commander and said, "Colonel, you will arrange for him to go to his original abode." Another man complained that federal funds due his community had not yet arrived, and Espaldon called the local commissioner in charge to the platform. When the man made excuses about the funds not yet arriving through channels, Espaldon strode to the microphone and thundered, "*You*, commissioner, will go to Manila yourself and *get* the funds!" The audience applauded.

It was an impressive display of on-the-spot problem solving. Later, riding back to Zamboanga on a patrol boat, I asked the admiral about it. "The rebels who are still in the mountains are watching to see what we do," he said. "The President has appointed Muslim judges, mayors, governors. The government is building irrigation systems, roads, schools. In this area within a year's time there will be no major fighting."

If Minds Are Won, Do Hearts Follow?

Moros I talked with seemed less sanguine. In Zamboanga I met a rebel who had accepted government amnesty. He showed me an ugly scar on his chest, the souvenir of one of his numerous battles with government troops. "The fighting will go on," he said. "The Muslims want Mindanao back again."

After I left Mindanao, geologic forces exercised their own influence on the future of the rebellion. Last August a cataclysmic earthquake struck the Moro heartland north and east of Zamboanga. The quake shattered homes, hotels, and office buildings in the city of Cotabato. Twenty-foot waves raced across the Moro Gulf, wiping out entire coastal villages. The quake left 8,000 dead and 175,000 homeless. Nearly all of the victims were Muslims. Surveying the damage, President Marcos speculated that the disaster might end the rebellion.

Perhaps. Certainly the quake would have had little effect on guerrillas in mountain strongholds. What *will* count is how effectively the government helps the Moros to rebuild their communities and their lives.

What Kind of Future Awaits?

Today the Philippines is going through a difficult period of readjustment. Sadly, true democracy seems further away than ever. Marcos is firmly in control, and some of his programs are genuinely progressive, but he has achieved order dearly, at the cost of personal freedom.

Aware of the new realities of power in the Pacific, the Philippine Government has established diplomatic ties with mainland China, and has demanded that the United States meet stiff new terms to keep Clark Air Base and Subic Bay Naval Base, its big military installations on Luzon.

In the past Filipinos have looked on the U.S. as something of a big brother, and Americans there have enjoyed privileges amounting almost to honorary citizenship. But nationalism has been steadily growing, and it is reflected in some of Manila's newspaper columns, which snipe at the U.S. incessantly.

Yet what anti-American feeling I encountered seemed only a veneer; everywhere I found the old warmth still surfacing in small ways. As I traveled around the country, young children in small villages sometimes grinned at the sight of my Caucasian face, thrust up their fingers in a V and shouted, "Victory, Joe!" It was their recognition of our alliance in a war they were far too young to remember.

Today the Filipinos' struggle is more subtle, the enemy harder to identify, and Americans can do little to help. One can simply wish them good luck. And—Victory, Joe! □

Man of the "Wild South," a hunter on Mindanao returns with his bait after failing to ensnare other fowl for food and breeding. Viewed as the Philippine equivalent of America's Old West, Mindanao offers resources, land, and hope to the overpopulated, overexploited north.

the holes at the tips of little chimney-pot sponges (**below**) decorating a coral head near Roatán Island off the Caribbean coast of Honduras.

Sponges inhabit all the world's oceans and many freshwater streams, ponds, and lakes. Though they live anchored to one spot, the animals prove themselves tough competitors in the arena of survival.

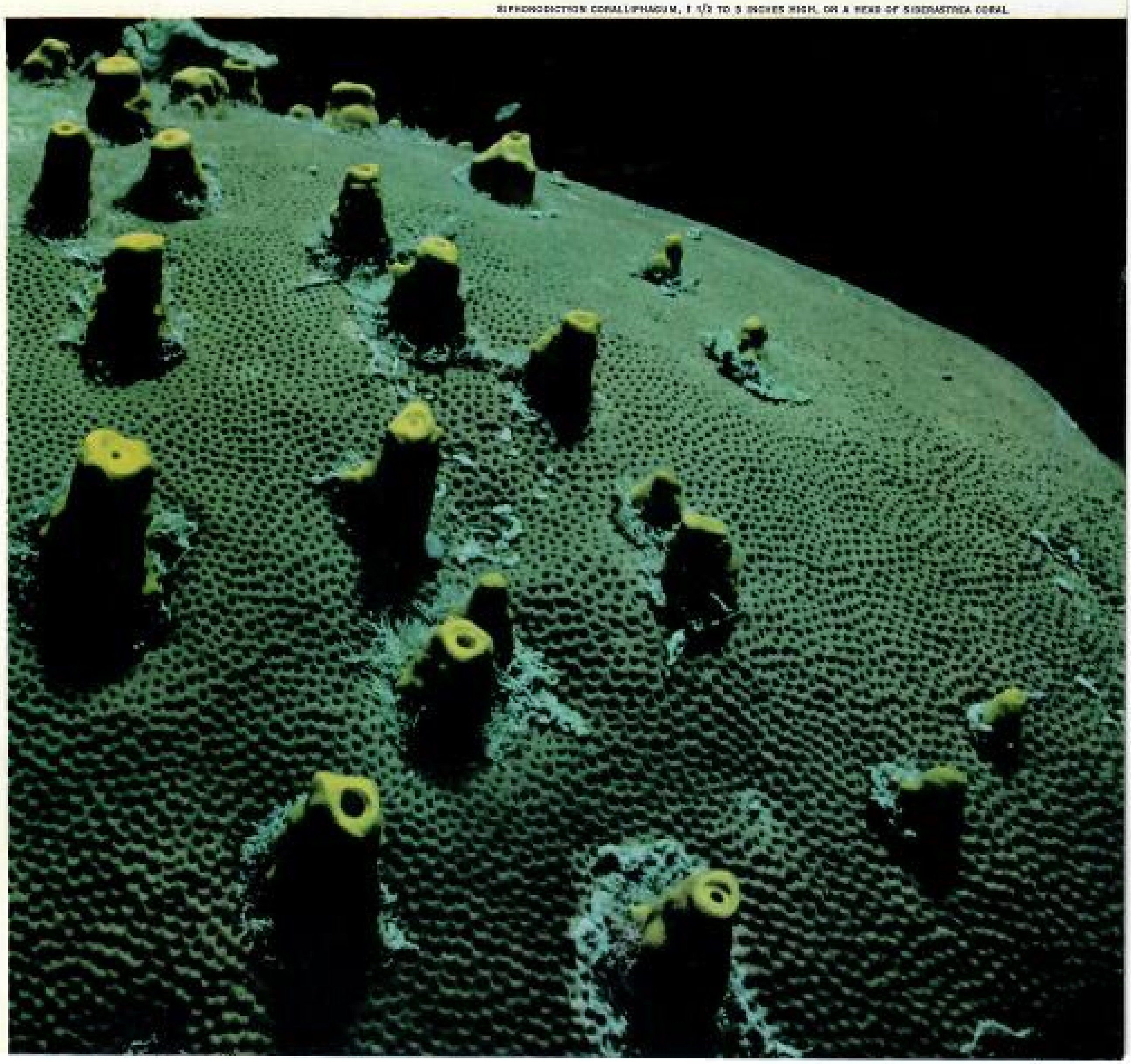
Many marine species, especially those from tropical waters, are virtually immune to bacterial infection and attack from predators. In tests at the University of Southern California, reef-dwelling fish avoided them and died when force-fed bits of sponge.

A Yale University scientist was surprised to discover that a dead Caribbean sponge immersed in fresh water resisted bacterial decay for more than five years.

The study of these antibiotic mechanisms has now proven valuable in fighting human illnesses.

PHOTOGRAPHS BY
DAVID DOUBILET

SIPHONODICTYON CORALLIPHAGUM, 1 1/2 TO 3 INCHES HIGH, ON A HEAD OF SIDERASTREA CORAL



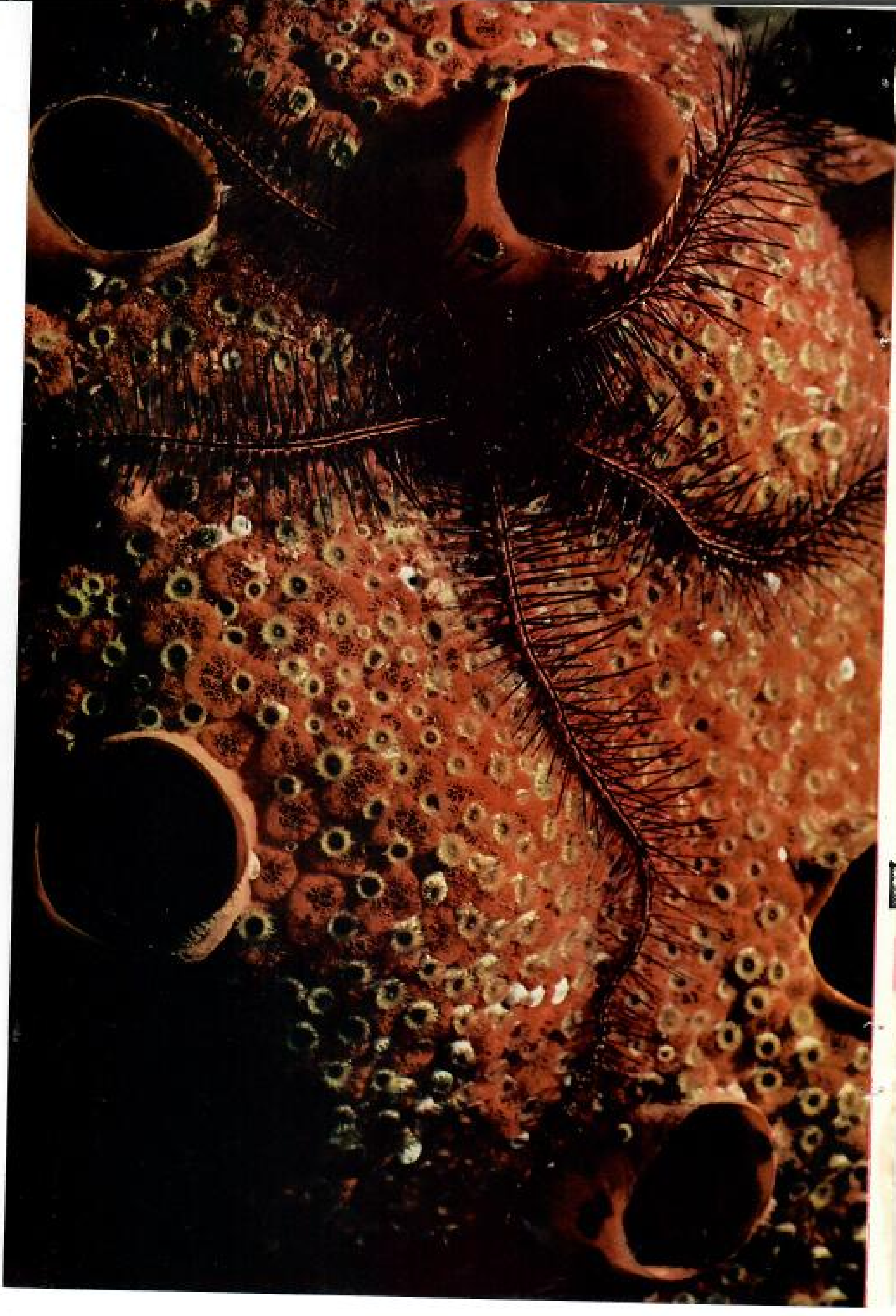
BEAUTY AND THE BLOB. Elegant in color and design, *Callyspongia plicifera* (**right**) from the Bay Islands of Honduras contrasts with pale, pudgy *Geodia* (**below**), found clinging to a wall of a cave on Virgin Gorda in the British Virgin Islands (**left**).

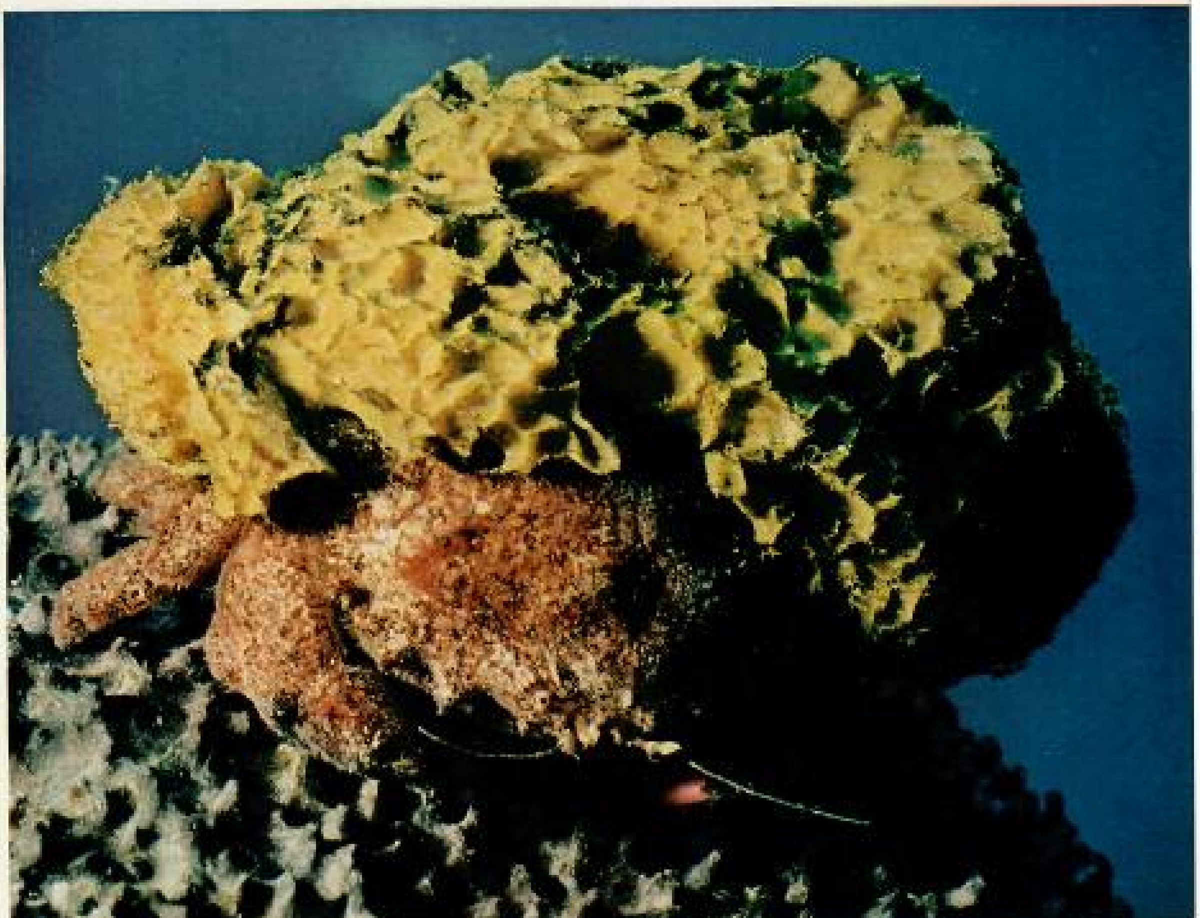
The 5,000 known species of sponges span an incredible range of sizes and colors: small as beans or giants six feet or more in height; subtle

TWICE LIFE-SIZE (RIGHT); 8 INCHES WIDE (ABOVE)

pastels or blazing reds, yellows, and blues.

They all cling tenaciously to life. In the sea a broken piece of sponge will attach itself to coral and continue its existence. Even sponge cells squeezed through a fine silk cloth will regroup to function again.





4 TIMES LIFE-SIZE, HONDURAS (LEFT); VERONGULA WITH CRAB, DROMIA ERYTHROPUS (ABOVE), BRITISH VIRGIN ISLANDS, APPROXIMATELY 1.5 TIMES LIFE-SIZE

PURVEYOR OF CAMOUFLAGE, hotelkeeper, exterior decorator, the sponge is a good neighbor to fellow creatures. Carrying a *Verongula* sponge (**above**), a crab conceals itself from predators. Rear legs hold the sponge on its back.

A red encrusting sponge (**left**) covers a limestone tube occupied by an arrow blenny. A former resident, perhaps a marine worm, built the tube.

In the spiny embrace of a wandering brittle star, *Cliona delitrix* (**facing page**) offers permanent residence and even room service to scores of beige anemones. These anemones, zoanthids, probably benefit from the nutrients in the water swirling into the sponge's red pores. Inside the sponge, freeloading crustaceans forage for table scraps.

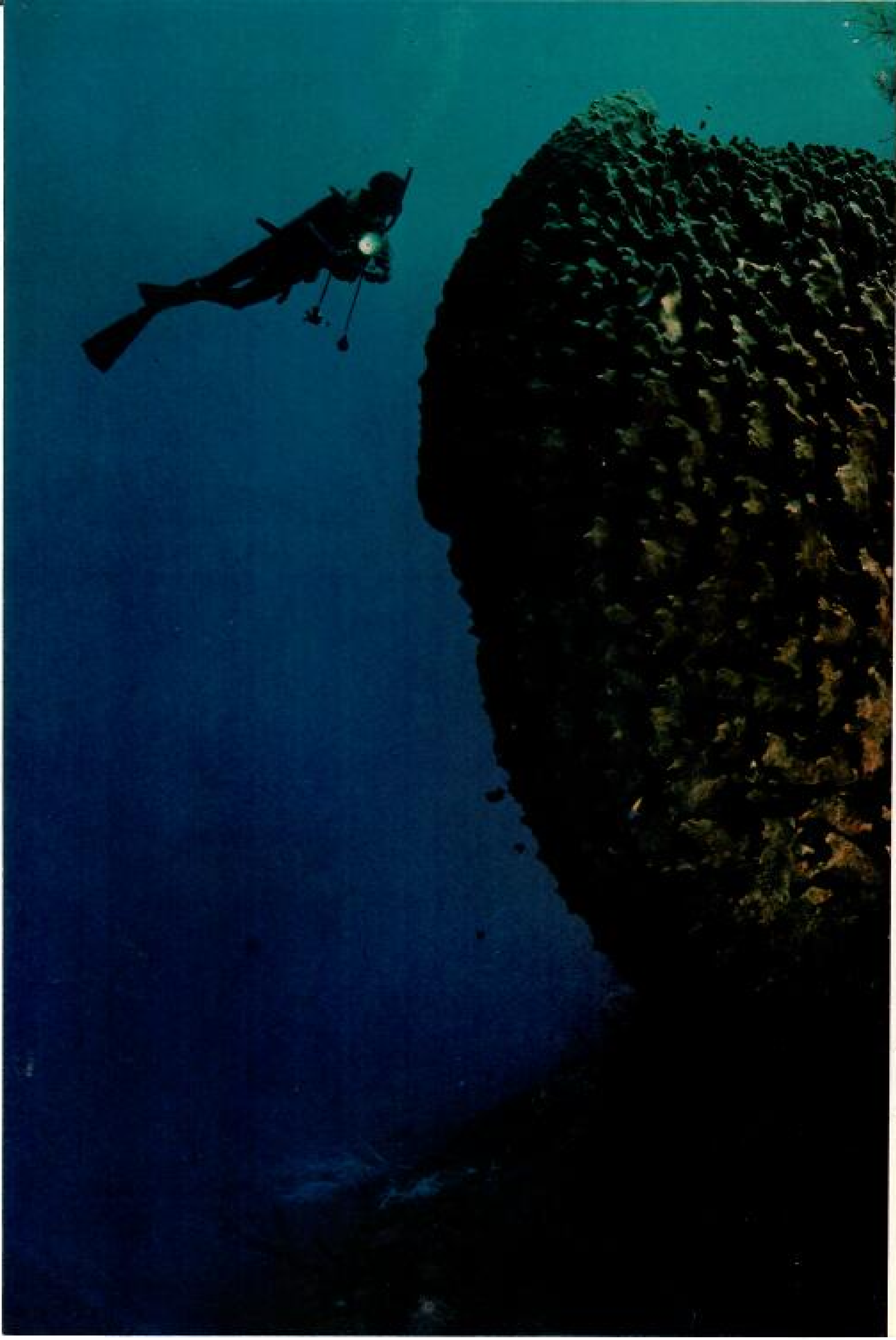
DETERMINED MINER with a chemical drill, *Cliona lampa* bores into rock, coral, or shell by releasing a substance that dissolves limestone. On the surface the sponge appears to be merely a veneer of red tissue (**left**); a resident amphipod peers from one of its vents.

But underneath, *lampa* patiently tunnels away. Here (**above**) advance squads of excavating cells, seen in the shape of a sea horse and as little brown dots, break through to the inside of a barnacle's shell. The sponge may destroy its host, but thereby recycles calcium to the sea.

Lampa also has an unusual means of renewing itself—with tiny pods of nutrients and cells called gemmules. If exposed to sun and air, the sponge itself will die. But when awash again, the gemmules can open and form a new sponge.

Within a *lampa*-encrusted mollusk shell, split by a chisel, the egglike gemmules (**right**) surround one of the sponge's many canals.

18 TIMES LIFE-SIZE (FACING PAGE); 27 X (TOP); 9 X (ABOVE). ALL BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON AT THE ROSENSTIEL SCHOOL OF MARINE AND ATMOSPHERIC SCIENCE, UNIVERSITY OF MIAMI



GIANT *XESTOSPONGIA*, a barrel sponge six feet tall, clings to the side of a reef off Roatán Island (**left**). In addition to their extraordinary powers of regeneration, sponges reproduce themselves sexually. Another barrel sponge releases a cloud of sperm (**below**), relying on the current to carry it to other sponges of the same species.

Some sponges exhibit both male and female characteristics at the same time; others have been observed to change their sex from month to month; still others maintain constant sexual identities.

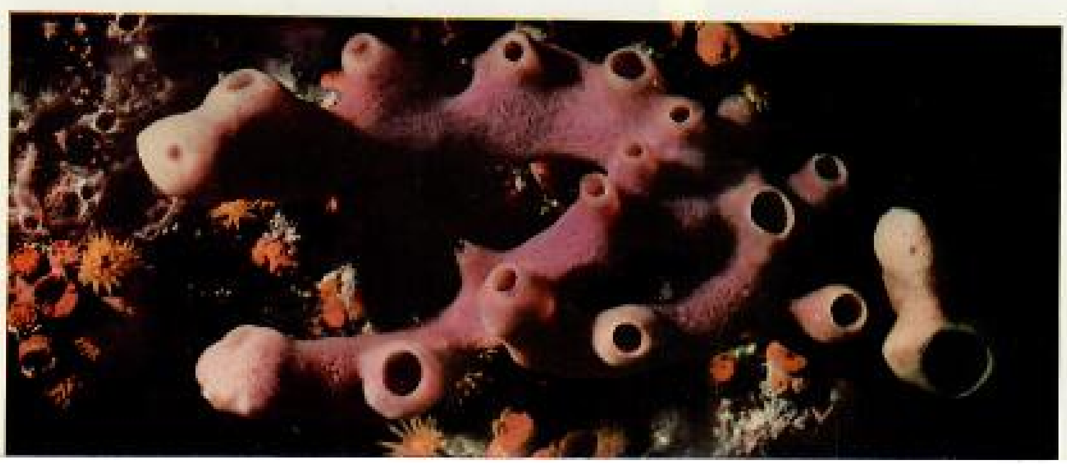
6 FEET TALL (ABOVE), GRAND CAYMAN ISLAND, PAUL HUMANN

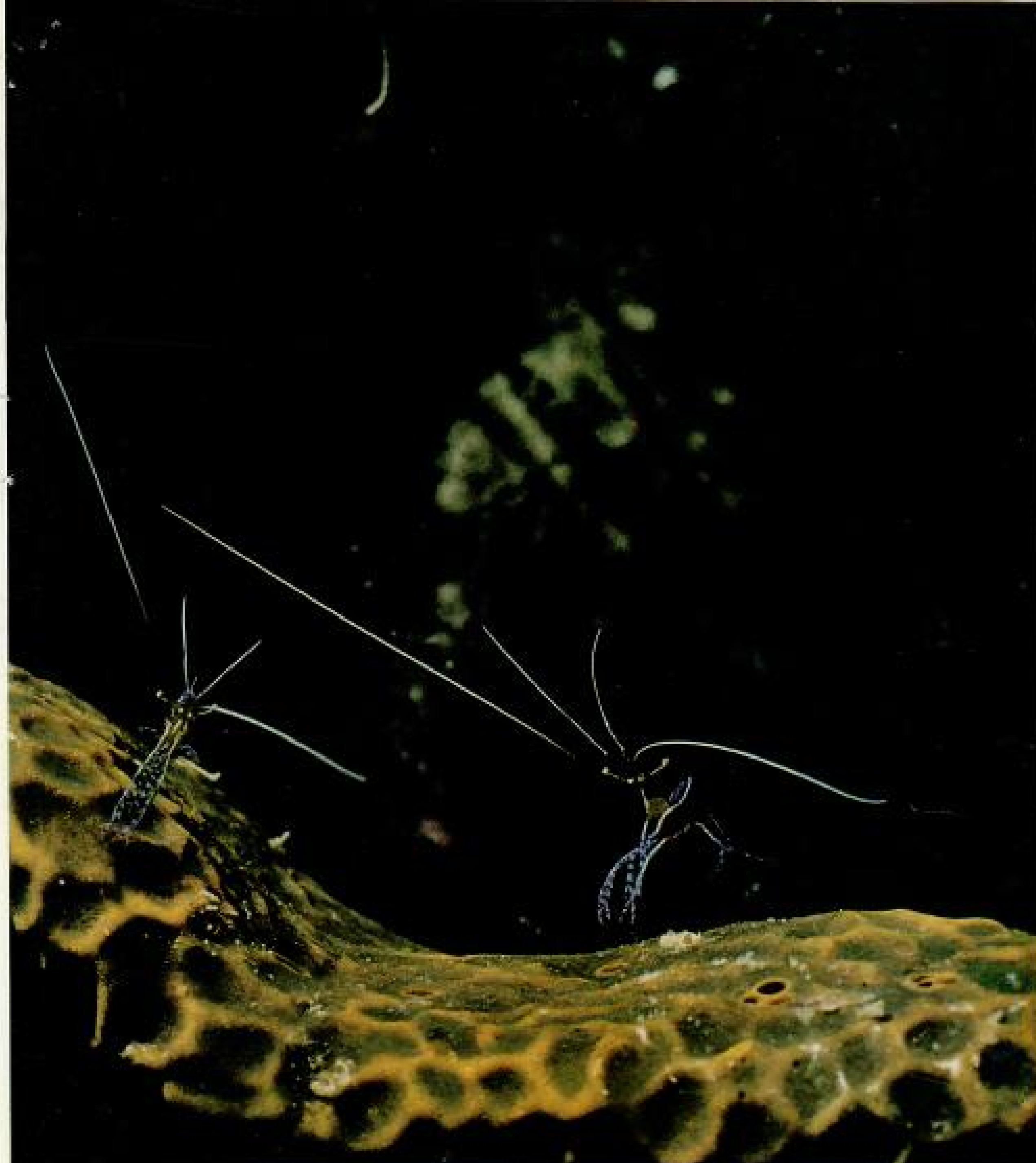
CONDUCTORS with multiple batons, cleaner shrimp on the rim of a *Verongula gigantea* wave antennae to attract fish. Groom-and-clean specialists, the shrimp scavenge tiny food particles from the fish and trim away their diseased or injured tissue. A cleaner shrimp once even snipped a blister from the finger of a scientist diver.

Another species of shrimp actually lives inside a deep-sea sponge. Entering the sponge as a larva, the shrimp soon grows too large to escape and spends the rest of its life inside, dining on the sponge's flesh.

Happily the sponge manages to regenerate tissue faster than its boarder consumes it.

Nearly transparent, a triplefin fish blends with the shiny mucus of *Mycale* (**lower right**). The mucus is thought to help the sponge repel pore-clogging sediment. *Callyspongia fallax* (**below**), one of the Caribbean's most colorful sponges, branches out from a bed of coral.





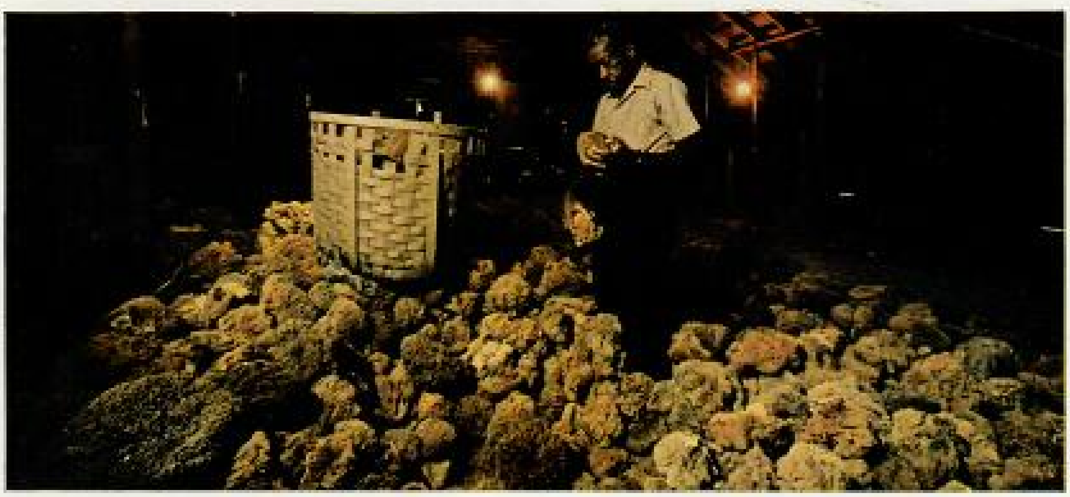
SHRIMP, PERICLIMENES PEDERSONI, TWICE LIFE-SIZE, ANDROS ISLAND, BAHAMAS (ABOVE); MYCALE, 1 1/2 TIMES LIFE-SIZE, HONDURAS (BELOW); APPROXIMATELY ONE-HALF LIFE-SIZE, BRITISH VIRGIN ISLANDS (LEFT)

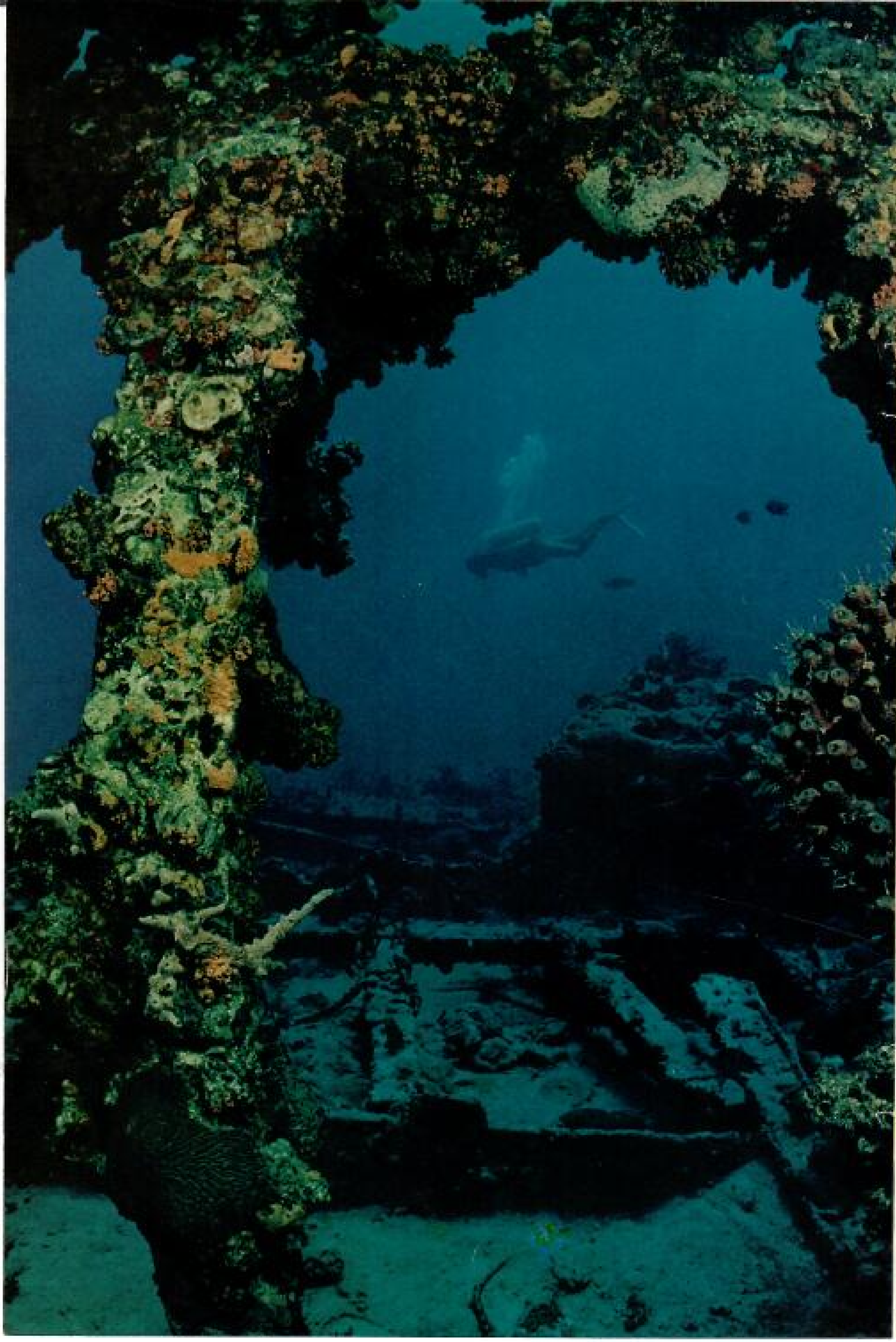
COURTESY GIALLOURAKIS FAMILY

USED BY ANCIENT Greeks and Romans as mops, paintbrushes, and padding for armor, sponges find industrial use today as polishers.

Bonanza harvests littered the Sponge Exchange (**above**) at Tarpon Springs, Florida, in the 1920's, but red tides, killer fungi, foreign competition, and the synthetic sponge combined to squeeze the life out of the industry.

Only a handful of divers still roam the seafloor out of Tarpon Springs seeking sponges (**facing page**). A worker (**below**) sorts them in the warehouse of one of the two chief remaining buyers.

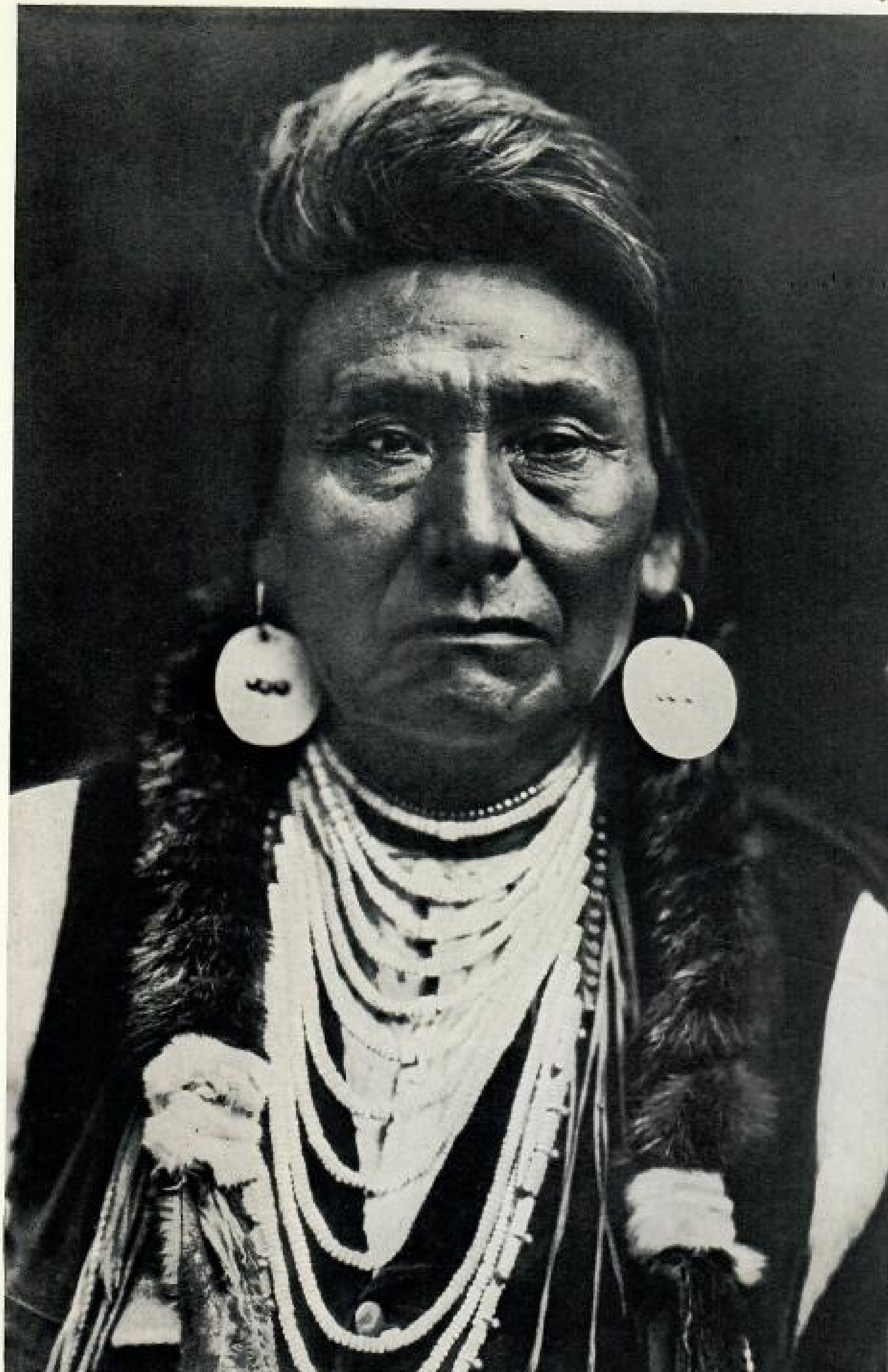




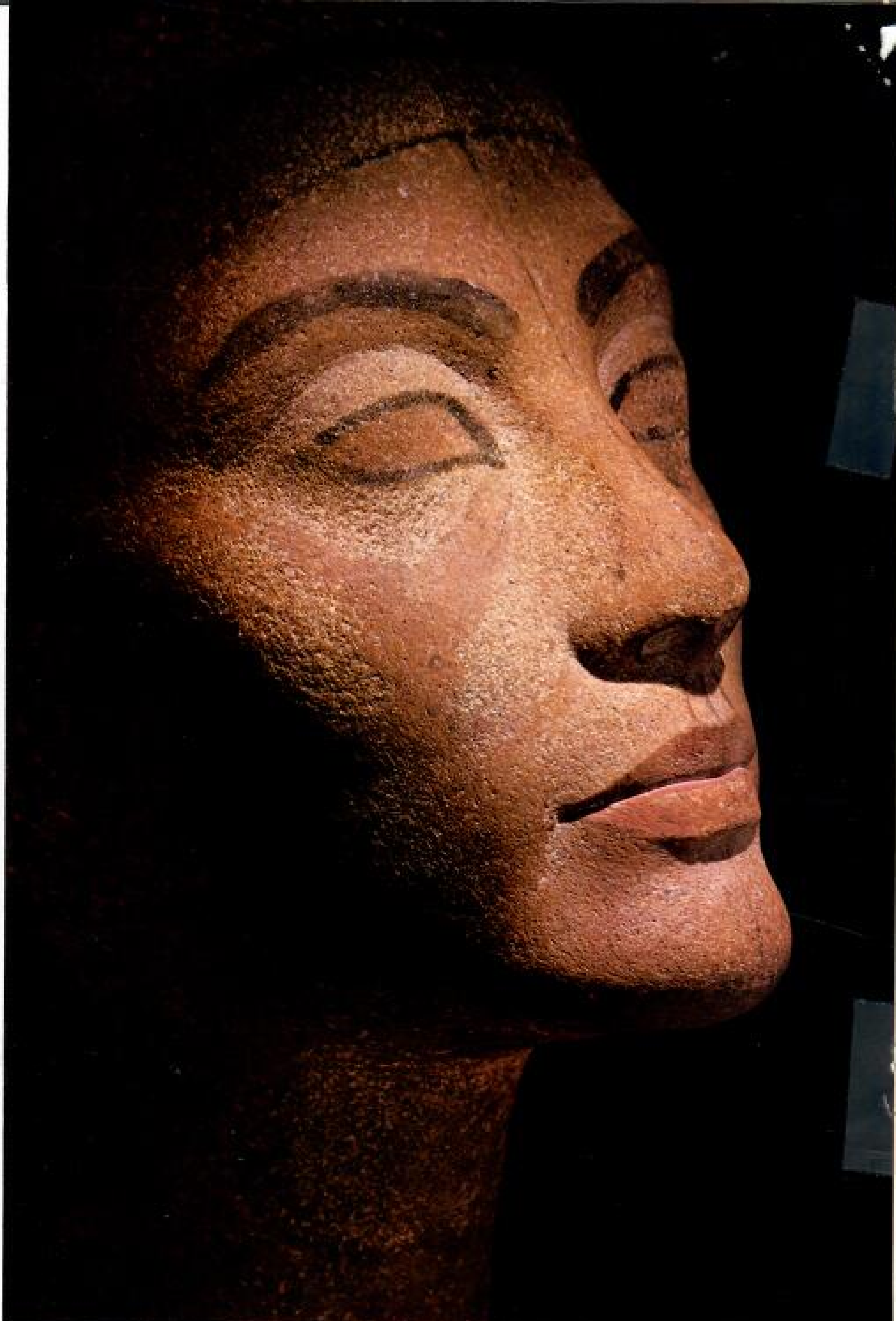
UNDERSEA WRECKS create new worlds for marine life to colonize. The skeleton of the *Rhone*, a steamer that sank in a hurricane off Salt Island in the British Virgin Islands in 1867, is home to dozens of sponges, which share the housing development with corals, algae, and other organisms. The most prominent tenant is *Verongia fistularis*, the cluster of tube sponges at right.

Humble animals with a formidable biochemistry, sponges have made significant contributions to medicine. Numerous substances with antibiotic properties have been discovered, and research on the Caribbean's *Tethya crypta* led to the synthesis of a compound that doctors now use to combat leukemia. □

TEXT BY
MICHAEL E. LONG



CHIEF JOSEPH IN 1903, BY EDWARD S. CURTIS, NATIONAL GEOGRAPHIC COLLECTION



A FEW YEARS AGO, a Geographic writer assigned to do an article on Cairo set out to report on that city's movie industry, which furnishes a steady stream of films to the Arabic-speaking world. He journeyed to an obscure desert location south of the Egyptian capital where a historical drama was being filmed. Across the dunes charged the present-day version of a seventh-century hero's army. Thousands of extras poured toward the cameras, scimitars waving and mouths ascream. In the horde, the astonished writer recognized a familiar face—that of his colleague Thomas J. Abercrombie.

Tom, who came to the Geographic in 1956 from the *Milwaukee Journal*, has made a career of thus blending into, and brilliantly interpreting, the world's far places—including Nepal, Cambodia, Easter Island, Antarctica—and particularly the Middle East. His Geographic coverage of this vital sector of the world began in 1957 with an assignment in Lebanon. Since then, Tom has covered Muslim lands from Morocco to Afghanistan. He so immersed himself in Arab culture that in 1965, in the Saudi Arabian city of Jidda, he was received into the Muslim faith. Twice he has made the pilgrimage to Mecca and Medina and as a result bears the honored title of Haj Omar.

Tom's artistry with a camera has won him many prizes. In 1954 he was named Newspaper Photographer of the Year. In 1959, his previous year's work, including photographs taken during a winter at the South Pole, made him Magazine Photographer of the Year. He was the first person ever to receive both of these National Press Photographers Association awards.

All of Tom's skills, both with notebook and camera, have been brought to bear in fashioning his perceptive article on Egypt today—a pivotal country in the volatile Middle East—which begins on page 312. For millenniums history has lain over Egypt like a hard crust, and below it the lives of countless fellahin have proceeded in the immemorial ways of illiteracy and poverty and want.

As Tom reports, Egypt may now be catching up to its past, on its way to closing one of the world's widest generation gaps.

Gilbert M. Grosvenor

NATIONAL GEOGRAPHIC

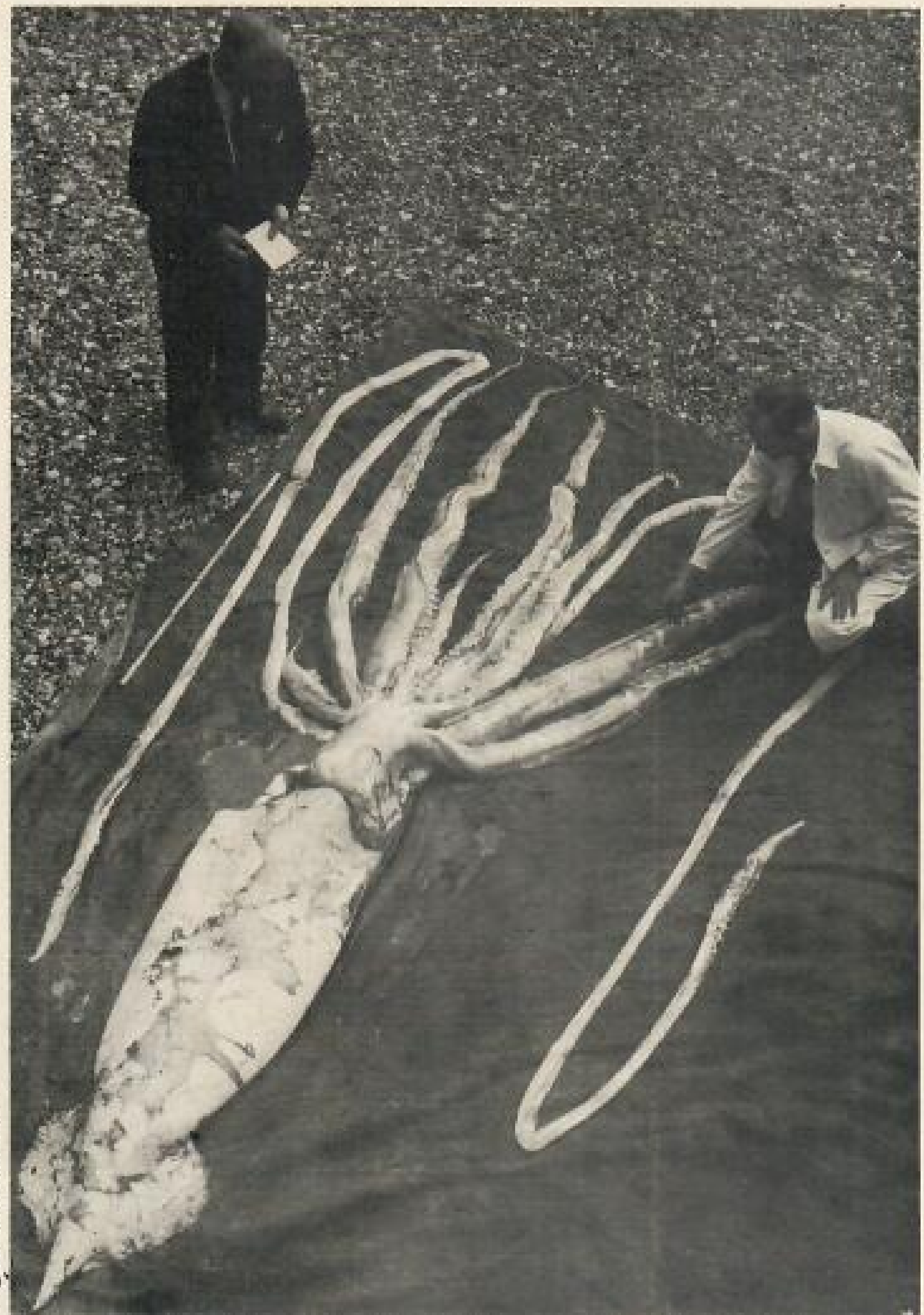
THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 151, NO. 3

March 1977

TENTACLE TALES

BY ROGER A. CARAS

How dangerous is wildlife to man? Roger Caras, one of America's most popular writers on wildlife, has sifted through the tangle of truth, hearsay and superstition to separate the facts from the fiction. In this first extract from his book *Dangerous to Man,* he turns his attention to the fear-inspiring tentacles of the octopus and squid



rling Siversen /Frank Lane

If anyone is really intent on creating an animal horror story, and wishes to launch his tale from a familiar point, he can do no better than use the octopus and squid. Wonderfully morbid tales about these molluscs without external shells have been drifting around for centuries. Because these incredible stories have often been offered as personal narratives, legends have grown to absolutely monstrous proportions. This ancient race of animals has inspired an almost impenetrable fog of ignorance and misinformation which rivals even that concerning venomous snakes.

Perhaps no single aspect of the octopus' appearance gives rise to more conversation than size. People always ask, when the subject of the animal is raised, 'How big do they grow?' The size ranges from approximately two inches (*Octopus arborescens*) to thirty-five feet (*Octopus hongkongensis*); that is, by measuring the diameter of the animal's eight arms stretched equally in all directions to form a circle like the spokes of a wheel. The latter form, the presently known giant of the group, seems to reach maximum size in Alaskan waters and in waters off Washington State. It must be pointed out that even a thirty-five-foot specimen, and that is being generous, is about 16/17ths arms.

Octopuses, like squids, are active hunting animals. Specimens establish territories, and either chase away or eat intruders. They can move with considerable speed by jetting water from an adjustable siphon, cloud the water around them with their ink, change colour to a degree and with a speed that puts the legendary chameleon to shame, and hold on with a tenacity that is nothing short of astounding, once they take hold with their suckers — adjustable discs that line the inner surface of their arms. These devices consist of a muscular membrane with a thick rim. The centre acts somewhat like a piston and is controlled by the animal with delicate precision.

Octopuses can squeeze themselves through any hole or crevice large enough to admit their hard, parrotlike beak, walk on their arms, hang suspended in midwater, jet around with fine control, or lie patiently for hours waiting for their prey. They are stubborn, tenacious, efficiently predatory animals of considerable economic importance to man. In many parts of the world they are fished for as food along with other cephalopods (squids are more significant as a food source, however). The range of the various octopus species is global. I have seen them in coral formations astride the equator, and once sat watching a newly caught specimen acclimatise itself to an aquarium in a biology laboratory 840 miles from the South Pole. It had been taken only hours before through a hole in sea ice several feet thick, a few hundred yards off frigid Ross Island. They range into Arctic waters as well.

Is any octopus dangerous to man? Only under special circumstances. A man in a boat is almost assuredly safe from them as long as he leaves the octopus in the water. Attacks on boats by cephalopods appear to have been

A giant squid, stranded in Norway in 1954 (left), measured almost 30 feet long, and others twice this length are recorded. This species — the 'kraken' — is the largest invertebrate apart from the giant jellyfish

made by squid, not octopus, even though the latter animal, being better known, has been accused. A man in the water, *if* attacked, *could* be placed at considerable disadvantage, particularly if the attack occurred near a solid anchor point. In midwater, the octopus might have a great deal of trouble overcoming a well-set up, well-organised man. Skin divers from Washington regularly catch the largest known octopuses with their bare hands, as a kind of sport!

Frank Lane, in *Kingdom of the Octopus*, gives these figures: a man weighing 200 pounds can be held below the surface by a pull of about 10 pounds, if he doesn't struggle. A medium-sized octopus can exceed that pull several times over. If a man were grabbed firmly by an octopus that was achored equally firmly to a solid foundation, he might be held down long enough to drown. Certainly, if the man was inexperienced in the water and panicked, the octopus might very well have an advantage. It is a reasonable assumption — but only that — that this has happened on rare occasions. It is certainly not a common occurrence, and must be looked upon as a freak accident involving a very large and particularly determined animal, and a very weak and inept person. A diver inadvertently intruding into a cave lair might trigger an attack, particularly with a sexually excited animal that could mistake an arm or leg for a potential mate's member.

Once engaged, an octopus frequently, but not always, tends to hang on. As capable a predator as the octopus is, however, its energy is expended on practical prey like crustaceans and molluscs. The octopus has many enemies in the sea — even the large octopuses are regularly attacked by moray eels, sharks, and some of the toothed whales — and are wary of large animals approaching them. Faced with anything as formidable as a man, the octopus is generally shy and retiring. To characterise it as an enemy of man (at least any of the species presently known) is absurd. Man is certainly an enemy of the octopus (he collects millions every year for food), but the converse is rarely true.

Frank Lane researched a number of cases of attack and came to the conclusion that there is occasional danger to man. In 1940, in Poverty Bay, New Zealand, a Maori lad was grabbed by a thirty-six-inch specimen, and was unable to free himself. Friends saved him in time. During World War I, a parson was taking a group of boys on an outing along the Victoria coast of Australia. An octopus *left the water* and attacked the parson, rapidly encircling him with its arms. It was apparently a good-sized animal and it took the combined efforts of several teenage boys to rescue the man. Since octopuses are occasionally reported leaving the water to attack shore-dwelling rats, this may not be as strange as it sounds. Just how far from the water they will go, or how long they will stay out, is not clear. There are other accounts, as well, of attacks on men that would appear to be reliable, but they are few in number, and the circumstances under which they allegedly took place are generally open to question. So much obvious nonsense has been written — and believed, and repeated, and believed again — that there is the equally unscientific temptation to ignore all stories one encounters.

Under no circumstances does any octopus strangle or crush anything to death with its arms. Its arms are for holding things. When hunting, it holds victims while it eats, or first administers a venomous bite. Some octopuses, at least, are venomous. Their posterior salivary gland produces a glycoprotein of immense complexity. This substance paralyses their prey and enables their chitinous beaks to dismember and devour their meal without struggle. The venom apparently inhibits respiration. Tests on laboratory animals reveal it to be quite potent, and it is known that it can affect man.

The bite of the octopus usually consists of two small puncture wounds. The beak is not particularly dangerous, although a good-sized animal is capable of giving a pretty good bite. When venom is involved, a local burning sensation will be the first symptom. There may be an anticoagulant constituent in the venom, since profuse bleeding has been reported a number of times. Octopus bites are relatively rare, and reactions to the venom beyond that of purely local discomfort, rarer still. But there are cases that do demand our attention.

On September 18, 1954, twenty-one-year-old Kirke Dyson-Holland, an Australian skin diver, was killed by the bite of a *six-inch octopus*. He and his diving companion, John Baylis, were coming ashore near Port Darwin when Baylis saw the little blue creature. He caught it, played with it, allowing it to crawl over his arms and torso, and tossed it to Dyson-Holland, a quite natural thing for a diver to do. Octopuses, it seems, are rarely left in peace by energetic young enthusiasts out for a day in coastal waters. The animal evidently hung on to Dyson-Holland's arm or shoulder for a moment, then crawled across to the middle of his back before dropping off into the water. The men came ashore without further regard for the creature which made off in typical fashion the moment it hit the water.

No sooner had the two men come up on the beach when Dyson-Holland complained of a dry sensation in his mouth, and difficulty in swallowing. Baylis said he noticed a small puncture wound and trickle of blood on his companion's back where the octopus had lodged briefly. The afflicted man rapidly became violently ill. He vomited, began to lose muscular coordination, and finally collapsed. He was carried to a car and rushed four miles to a Darwin hospital muttering, 'It was the little octopus'. He lost consciousness during the brief but frantic run for medical help. By the time they got to town he had turned blue (cyanosis), and his breathing could no longer be detected. Adrenalin and an iron lung failed to help. Without rallying, he died fifteen minutes after being placed in the respirator. Less than two hours after handling a six-inch octopus, he was dead. The species has not been positively identified. It was probably an animal variously known as *Octopus maculosa* or *Hapalochleana maculosa*— the little blue-ringed octopus.

How was Kirke Dyson-Holland killed? It first appeared as if he might have been particularly susceptible to foreign proteins, since he did have a history of asthma and one allergy can indicate the presence of others. Subsequent to his death three other young men were made very seriously ill by the bite of what was then and is now believed to be the same species. Then, on June 21, 1967, James Ward became the second verified death from the bite of the little blue-ringed octopus. We know young Ward was in good condition since he had been inducted into the Australian

The common octopus (below) has up to a 10-foot span in the warm waters of the Mediterranean. It does not deliberately attack humans, but will grab hold of them out of curiosity. The little blue-ringed octopus (opposite) is the most venomous of all octopuses. Though its span is only 5 inches, it contains enough venom to kill several people

Laurence E. Perkins / Frank Lane

Army two days earlier. On the day of his death he was exploring some rock pools in the Camp Cove area near Sydney. According to the two soldiers who were with Ward, the animal which bit him was less than four inches across. Ward died of respiratory failure in less than ninety minutes.

The octopus is equipped with venom as a food-getting device, and any use in defence would be secondary. The animal is not equipped to inject the venom but rather bites with its beak and then spits venom down into the wound. They are separate actions and one need not follow the other. The same venom, it is believed, can be discharged into the water near potential prey and is said to cause convulsions and total loss of motor control in crabs and similar animals. As far as is known, the little blue-ringed octopus is the only species seriously venomous enough to be of danger to man. It is not an uncommon animal in shallow coastal waters around Australia and warrants a great deal of care when being handled, if it must be handled at all.

Although the octopus is the cephalopod with the reputation for mayhem, it is the squid which might answer to some of the seemingly fantastic tales that are told. If there are sea monsters, certain squids are the most likely suspects. They are the most varied and colourful of the class, the most numerous, and among them are numbered the largest of the cephalopods. Lane says they are the most ferocious of all invertebrates. Aside from the giant *Cyanea* jellyfish with their endless stream of tentacles, these giant squid are the largest invertebrates known to exist. They might even exceed the *Cyanea's* length of 120 feet!

There are over 350 species of living squid recognised today. The smallest known is probably *Sandalops pathopsis*, measuring under one inch at maturity. The giant is *Architeuthis* sp, whose maximum length is a matter of great debate with 60 feet at one end of the spectrum, and 300 at the other! Squids are widely distributed in the seas and oceans, both vertically and horizontally. In addition to eight arms, squids have two tentacles which they shoot out with considerable speed to capture prey and draw it towards their beaks.

Since before the birth of Christ, writers had been recording tales of monster cephalopods. The conservatives in the sciences tended to

Walter Deas / Seaphot

pooh-pooh the whole thing right up the end of the last century, when it finally became eminently clear that they did exist. *Architeuthis* came into being officially, and is the genus now used to define the animals popularly known by the old Norse name of 'kraken'. Giant squid, true giants, do exist, and are to the everyday squid what the 110-foot blue whale is to the common dolphin. Thirty to sixty-foot specimens have been taken, and the maximum size they may reach is not known. They appear to be nocturnal creatures of the deep coastal shelves. The fact that they have been occasionally troublesome when encountered during the day may indicate that only sick and disoriented specimens come up to the surface when the sun is high. Nothing like a definitive answer exists.

A gentleman from West Mystic, Connecticut, kindly supplied this quote from the *Mystic Press*, dated July 31, 1874:

> SCHOONER SUNK BY A SQUID
>
> Schooner *Pearl*, 150 tons, James Floyd, master, with a crew of six, was reported sunk by a giant squid in Lat. 8.50 N., Long. 84.05 E. on May 10th, 1874. The sinking was witnessed and reported by passenger steamer *Strathowen* bound from Columbo to Madras. Passengers first noted a large brownish mass lying on the surface between the steamer and the schooner, which was becalmed two or three miles away. Someone on the schooner fired a rifle at the object and it began to move toward the schooner and squeezed on board between the fore and mainmast, pulling the vessel over and sinking it. Its body was as thick as the schooner and about half as long, with a train that appeared to be 100 feet long. The steamer put out boats and picked up five of the crew swimming in the water. The other member of the crew was crushed between the mast and one of the creature's tentacles, which were as thick as a barrel.

This story of the disaster of the *Pearl* has been quoted innumerable times. It has been a favourite of the sea-monster set. Any attempt to really evaluate it is virtually hopeless. Witnesses swore it was true,and we are stuck with what they had to say. Either we accept the notion that squids exceed 100 feet in length, or we don't. Since the burden of the *Pearl* is known to have been 150 tons, there are calculations of a sort that might be made to determine what pull would have been necessary to roll her over. However, unknown factors like the weight and distribution of cargo, skill of the skipper, direction of sail in relation to the prevailing wind, velocity of the wind (slight, at best, since the *Pearl* was reportedly becalmed), amount of ballast being carried, and amount of water in the bilges would tend to make these calculations about as speculative as your own good guess!

The *Pearl* wasn't the only vessel reputed or reported to have encountered these giants of the cephalopod tribe. Captain Haley, a harpooner on the last of the old wooden whalers, the *Charles W. Morgan*, wrote in his *Whale Hunt* of seeing a squid 300 feet long! He judged its length by comparing it to the vessel on which he was sailing. Carl C. Cutler, the gentleman who supplied the report on the *Pearl*, is a relative of Captain Haley's and refers to him as a sober and trustworthy man. Captain Haley reported that the monster was accompanied by two smaller squids, each about 150 feet long. Cutler, as a boy in the nineties, knew a good many old whalemen. He reports there was a general acceptance among them of the existence of these giants. The French steam dispatch boat *Alecton* met and unsuccessfully attempted to capture one in 1861. This latter reported incident, however, involved a specimen very much smaller than 150 feet.

In the 1870s, for reasons not known, kraken considerably larger than the ones known as good bait to European fishermen, began to appear off Newfoundland. A large specimen, inadvertently prodded with a boathook, attacked a fishing droy off Portugal Cove, Newfoundland, on October 26, 1873. Quick action with a hatchet by the twelve-year-old son of one of the two fishermen aboard saved the three occupants from drowning. The severed tentacle of the beast was presented to an amateur biologist, Rev Moses Harvey, of St John's. It was Harvey who subsequently purchased the carcass of a thirty-two-foot specimen taken in the same general waters in November 1873.

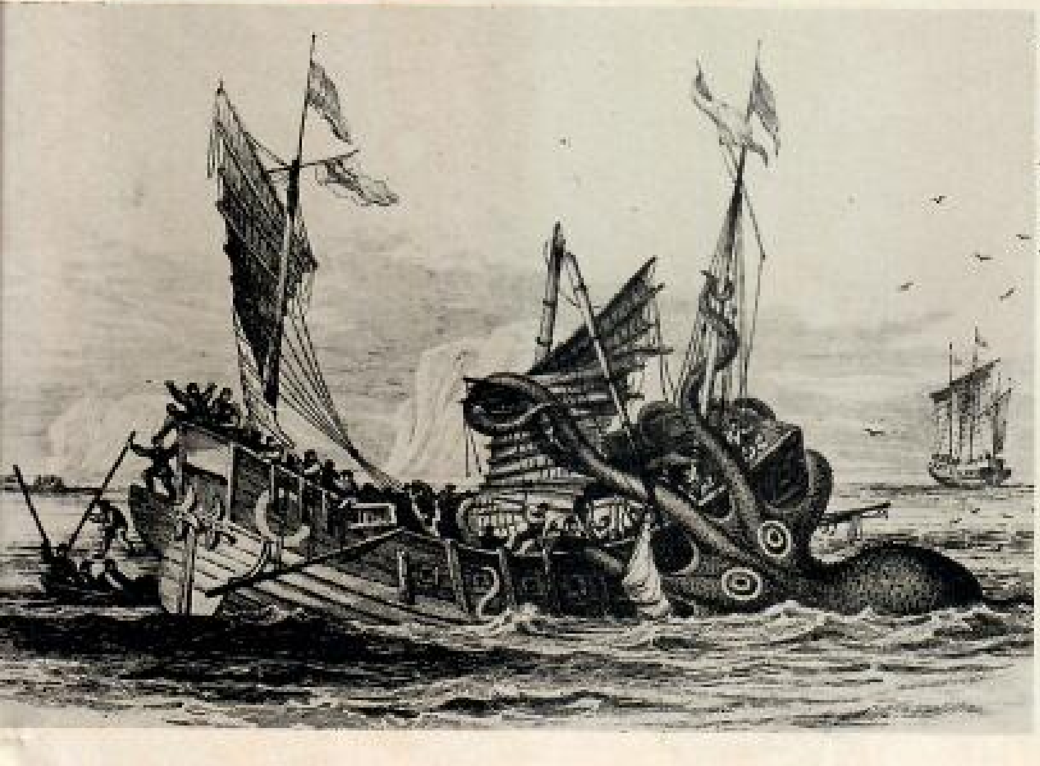
It is known that the sperm whale feeds on giant squids. Captured sperms almost always are scarred by sucker marks. The suckers of the giant squid are tooth-rimmed, and, once affixed to a whale's hide, cannot be ripped free without the squid's cooperation except by colossal effort, and not without leaving scars. Sucker marks have been found on sperm whales' heads measuring three inches across. Whalers reported harpooned sperm whales vomiting up hunks of squid arms as thick as barrels while in their death throes. The battle between a sperm whale and a giant squid must be a sight to behold!

There is a Humboldt Current squid *(Ommastrephes gigas)* taken regularly by fishermen off the west coast of South America. These animals are very aggressive and may weigh three hundred pounds and stretch twelve feet in length. It is said that their beaks can do more damage to a steel boathook than the bite of a big shark. Native fishermen allegedly fear these animals more than any other in the sea.

Are squids dangerous to man? Aside from a sailor who was reputedly pulled under as he clung to a raft following the sinking of the troopship *Britannia* in the mid-Atlantic, on March 25, 1941, there are few if any authentic reports of men in the water being injured or killed by these creatures. Certainly, anyone in the water when a thirty to sixty-foot *Architeuthis* is around had better get out. Similarly, a swim in the Humboldt Current at night when masses of feeding squids are on the prowl would be unwise. These animals are probably dangerous under the right set of circumstances. Large squids are almost nocturnal animals and lie off in deeper water during the day, making an encounter with one by a man in the water an exceptional case. Serious injuries could result from carelessness with freshly caught specimens, however.

As for the giants which attack vessels: it is pretty much a case of what you want to believe. All manner of logic can be applied, but logic isn't the answer when the number of unknowns surpasses the number of established facts. The answers are reliable eyewitnesses, photography, and calm evaluation. The eyewitnesses of these recounted tragedies of course aren't around any longer, no pictures are known to exist, and calm evaluation of something that may have occurred scores of years ago isn't too profitable. Time will no doubt yield further information. ●

A mythical attack by an octopus (below) — or a true record? Seemingly reliable accounts of attacks on vessels by giant squids do exist



Denys de Montfort (Frank Lane)

This extract is taken from Dangerous to Man, *by Roger Caras, published by Barrie & Jenkins Ltd at £4.95.*

Southern California Ocean Studies Consortium

P.O. Box 570, LONG BEACH, CALIF. 90801

213 – 437-0041

S C O S C Members

California State College, Dominguez Hills
California State University, Fullerton
California State University, Long Beach
California State University, Los Angeles
California State University, Northridge
California State Polytechnic University, Pomona

April 12, 1979

Mr. George Balazs
Hawaii Institute of Marine Biology
c/o University of Hawaii
Honolulu, Hawaii 96822

Dear George:

It was good to talk to you during my recent visit to Honolulu. I was disappointed we didn't get to share the EASY RIDER cruise but certainly understand about the Costa Rica meeting.

I have keyed out the leech from the turtle to Ozobranchus margoi (Apathy, 1890). It was reported from this host originally. If you run across any other parasites either inside or out during your studies, I would appreciate the opportunity to examine them.

I will look forward to meeting you on my next trip to Hawaii.

Thanks again for being so patient on this identification. I will do better next time.

Best regards,

Murray

Murray D. Dailey, Ph.D.
Director

MDD/lh

VELELLA VELELLA

Nature's By-the-wind Sailor

by John Dillon ?

THOUGH SCIENCE has given it the most mellifluous of names, *Velella velella* is better known as the by-the-wind sailor. It is a creature of the open sea, which holds up a two-inch sail to the winds of tropical and temperate latitudes. It is suggestive of the Portuguese man-of-war, a colonial siphonophore to which it was once thought to be closely related; but *Velella* is not a colonial assemblage. It is a highly specialized individual animal, properly called a chondrophore, with a central mouth surrounded by feeding and reproductive polyps, and an oblong gas-filled float bearing its distinctive triangular sail.

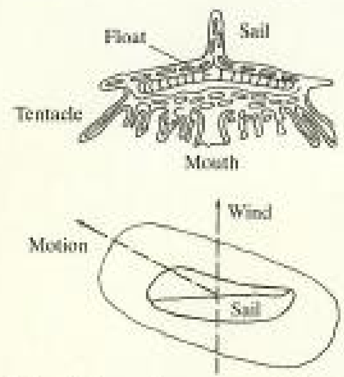
Knowledge of *Velella*'s natural history is a patchwork. The fringing polyps bud off small medusae, which gradually sink to the bottom of the sea. There they develop into separate sexes, but in those lightless depths the details of their reproduction and early development are poorly known. Eventually, the nascent *Velella* develops its gas-filled float, allowing it to rise to the sea surface where it finishes its days feeding on the planktonic creatures it encounters.

But not all it encounters is harmless. The pelagic sea slug, *Glaucus*, drifts about with the currents, clinging to the underside of the water's surface, where it meets prey such as *Velella*. Another predator is the shelled snail, *Ianthina*. This snail constructs a raft of bubbles, which bears it along at the sea surface until it too chances upon suitable prey.

If the living tissues of *Velella* are devoured, the lifeless float may become the attachment site for yet other creatures, especially the leaf barnacle, *Lepas*, and the corpse continues its navigation as a Lilliputian Flying Dutchman.

The sail is set at forty-five degrees to the long axis of the float so that a light breeze will cause the animal to tack at forty-five degrees off the wind—a skill that led fascinated sailors to coin its common name. In north temperate oceans, prevailing winds are from the northwest. Along the eastern margins of these seas, the sails of *Velella* are aligned so that prevailing winds keep the animals offshore. Curiously, along the western margins of the same oceans, the sails are oriented in the opposite direction so that the same prevailing winds propel the animals in the opposite direction—still offshore. ?

But prevailing winds do not always prevail. In early spring, the burgeoning new population may be caught by a prolonged southwesterly wind, which drives the animals to shore and eventual death. Here the living tissue disintegrates and the colorless husks blow higher onto the beach to fascinate curious children and mingle with less ancient debris.



Top: The translucent, two-inch mainsail of Velella velella. *[Chriss Poulsen] Bottom: The same species in perspective.*

A Most Ingenious Paradox

When is an organism a person; when is it a colony?

by Stephen Jay Gould

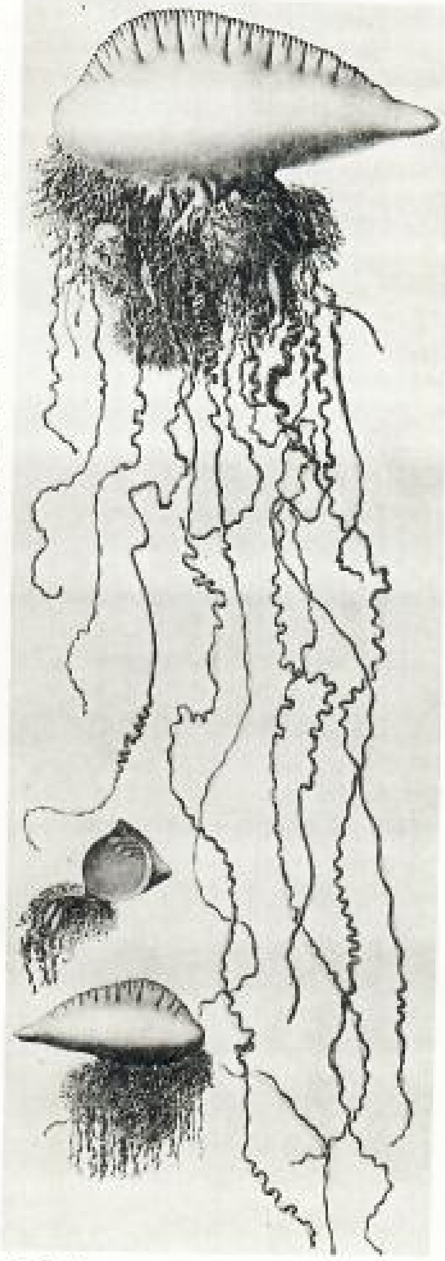
Abstinence has its virtuous side, but enough is enough. I have always felt especially sorry for poor Mabel, betrothed to Frederic the pirate apprentice. On the very threshold of married happiness, she discovers that she must wait another sixty-three years to claim her beloved at age eighty-four—and, as could only happen in Gilbert and Sullivan, she actually promises to wait.

The Pirate King and Ruth, Frederic's old nursemaid and jilted paramour, present the reason for this extraordinary delay. Frederic, wrongfully apprenticed to the pirate band, has reached his twenty-first year and longs for freedom, respectability, and Mabel. But he was formally bound until his twenty-first *birthday*, and he was born on February 29. "You are a little boy of five," the Pirate King informs him with glee and expectation of prolonged service. The three principals of the *Pirates of Penzance* then analyze the complexities of this predicament in the famous paradox song:

> How quaint the ways of paradox
> At common sense she gaily mocks.

The classic paradox presents us with two contradictory interpretations, each quite correct in its own context. Consider our western prototypes, the so-called paradoxes of Zeno: the arrow that can never reach its destination because, at any instant, it must occupy a fixed position; and Achilles who will never catch the tortoise because he must first traverse half the remaining distance, and any gap, no matter how small, can still be halved. We delight in paradox because it appeals to both the sublime and whimsical aspects of our psyche. We laugh with Frederic, but also feel that something deep about the nature of logic and life lies hidden in Zeno's conundrums.

Biology too has its classical paradox. It flared as a major issue in the nineteenth century, probably because scientists then felt that it might be resolved. All the best naturalists struggled with it: Huxley and Agassiz lined up on opposite sides; Haeckel tried to mediate. The twentieth century has largely bypassed it, probably because we now realize that no simple answer can be given. Yet if our fascination with paradox be justified, the question can still enlighten us by virtue of its stubborn intractability.



In the Portuguese man-of-war, the upper float is an individual organism (or "person"), as is each lower tentacle; the entire creature is a colony.

Illustration by Louis Agassiz

Physalia, the Portuguese man-of-war, embodies all this fuss. It is a siphonophore, a relative of corals and jellyfish. The old paradox addresses an issue that could not be more fundamental—the definition of an organism and the general question of boundaries in nature. Specifically: Are siphonophores organisms or colonies?

Siphonophores belong to the phylum Cnidaria (or Coelenterata). Two aspects of cnidarian biology set the context of our paradox. First, many cnidarians live as colonies of connected individuals—our massive coral reefs are gigantic congeries made of many million tiny, conjoined polyps. Second, the cnidarian life cycle features a so-called alternation of generations. The sessile polyp, a fixed cylinder with a fringe of tentacles, is asexual and generates by budding the free-swimming medusa, or "jellyfish." The medusa produces sexual cells that unite and grow into a polyp. And so it goes.

Different kinds of cnidarians may emphasize one of these generations and suppress the other. Of the three major cnidarian groups, the Scyphozoa (or true jellyfish) have abandoned polyps and emphasized medusae, while the Anthozoa (or true corals) have dispensed with medusae and constructed their reefs of polyps and their skeletons. In the third group, the Hydrozoa, many members retain the full cycle, with prominent polyp and medusa.

ion.

Siphonophores are hydrozoans. The technical literature, not usually noted either for charm or directness, has transcended its usual limitations in this case: amidst a forest of formidable jargon for other parts of cnidarian anatomy, it refers to the polyp and medusa stages of a single life cycle as "persons."

The Portuguese man-of-war, with its float above and tentacles below, looks superficially like a jellyfish (that is, a single medusa). When studied more carefully, we find that this floating weapon is a colony of many persons, both polyps and medusae. The pneumatophore, or float, is probably a greatly modified medusa (though some scientists think that it may be an even more altered polyp). The "tentacles," though varied and specialized for different roles of capturing food, digestion, and reproduction, are not simple parts of a jellyfish but modified polyps—that is, each tentacle arises as a discrete person. (Another common siphonophore, *Velella*, literally the "little sail" but popularly given the lovely name of "by-the-wind sailor," provokes even more confusion. Its persons are few enough and so well coordinated that the colony looks like a simple float surrounded by tentacles—in other words, like a simple jellyfish. But the float is a medusa person and each tentacle a polyp person.)

If this degree of division of labor among persons impresses you, nature has much more to offer. *Physalia* and *Velella* are simple siphonophores, with relatively few types of modified persons. The more complex siphonophores are, by far, nature's most integrated colonies. Their parts are so differentiated and specialized, so subordinate to the entire colony, that they function more as organs of a body than persons of a colony.

Most siphonophores are small, transparent creatures of the open sea. They float at the surface among the plankton or swim actively, usually at shallow depths. As carnivores, they capture small planktonic animals in their net of tentacles. Larger siphonophores, *Physalia* among them, can ensnare and devour fish of substantial size; as many of us know to our sorrow, they can also inflict painful stings upon human bathers.

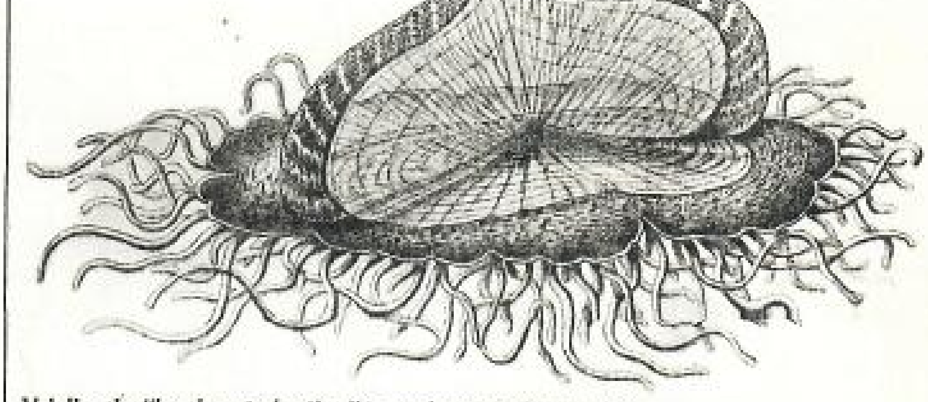
Complex siphonophores include an imposing array of well-differentiated structures. Their bodies may be roughly divided into two parts: an upper set of bulbs and pumps for locomotion and a lower set of tubes and filaments for feeding and reproduction. Each part contains a series of different polyps and medusae.

Consider first the range of forms and activities assumed by polyp persons. We find three basic types and a myriad of modifications. The feeding organs, or siphons (hence the group's name—*siphonophore* means "siphon bearer"), are tubular structures with a stomach and trumpet-shaped mouth, usually hanging in profusion below the floats and swimming persons. The siphons are minimally modified polyp persons, and we can easily comprehend their origin as complete organisms. All other types of polyps (and medusae) are more highly altered and specialized, and therefore more difficult to link with their original personality. The second order of polyp persons, the so-called dactylozooids ("finger," or touching, animals), capture and transport food to the siphons. These are the extended thin tentacles, sometimes more than fifty feet long in *Physalia*, that carry the painful nematocysts, or stinging cells, and form a transparent web to ensnare prey. They have retained neither mouth nor digestive apparatus and might easily be taken for parts rather than persons if we could not trace their origin as discrete buds in growth.

These capturing parts often display a remarkable complexity of form and function. The stinging cells may be concentrated into swellings, or "batteries," sometimes protected by a hood. In *Stephanophyes*, each battery ends in a delicate terminal filament and contains about 1,700 stinging cells of four different types. The terminal filament lassoes the prey and discharges its few stinging cells. If these fail to dispatch the victim, the filament contracts and carries the prey to the far end of the battery itself, where another volley of larger stinging cells transfixes it. If the prey continues to struggle, another contraction moves it up the battery to the near end, where the largest and most powerful stinging cells finally end its torment before passing it along to the siphon for ingestion.

Jennifer E. Purcell has recently presented further evidence that feeding and capturing persons do not form a simple passive network, like the web of a spider, but play an active role in obtaining food (*Science*, vol. 209, 1980, pp. 1045–47). She found that the stinging cell batteries of two species function as lures by resembling, in both form and motion, small zooplankton that serve as prey for animals eaten by siphonophores. The batteries of *Agalma okeni* look like a copepod with two long antennae; each contracts independently at varying intervals of five to thirty seconds, creating a web of motion that simulates the darting and swimming of a copepod school (or whatever you call an aggregation of these tiny planktonic ar-

From Ernst Haeckel's *Challenger* monograph, 1888



Velella, *the "by-the-wind sailor," is a colony. Each tentacle is a person.*

thropods). To seal the story, Purcell opened the stomachs of *Agalma* and found the remains of three creatures, all predators of copepods. The batteries of another species, *Athorybia rosacea*, resemble the planktonic larvae of fish and contract rapidly, mimicking the swimming and feeding motions of their models.

Gonozooids, the third type of polyp persons, are reproductive structures. They are usually short, simple tubes, without mouth or motion. But they bud off the medusa persons, which make reproductive cells to produce the next generation of siphonophores.

The medusa persons of a complex siphonophore include four basic types: swimming, floating, protection, and reproduction. The swimming organs, or nectophores, are minimally modified medusae—the upper swimming bells without the lower tentacles. Some siphonophores carry several orderly rows of nectophores; their rhythmic muscular contractions propel the creature, often in elaborate, looping trajectories. The passive floats, or pneumatophores, are filled with gas (of a composition near ordinary air) and maintain the siphonophore at the surface or at some intermediate depth. Their origin is a matter of controversy: long interpreted as modified medusa persons, some biologists now regard pneumatophores as even more elaborately transformed polyps. The two most familiar siphonophores, *Velella* and *Physalia*, build large floats but have no nectophores. They therefore move passively on winds and currents, often drifting into bays and beaches in vast accumulations.

The covering organs, or bracts, are the most curiously modified structures of all. They are usually flat, shaped like a prism or a leaf, and so different in form and function from a medusa person that we would scarcely suspect their origin if we could not follow their growth and budding.

The reproductive medusae, or gonophores, are budded off from polyp persons, the gonozooids discussed earlier. In a few species, gonophores are detached and float in the ocean as independent objects. But they cannot feed and die soon after releasing their sex cells. In most siphonophores, however, gonophores never separate from the parental colony and remain attached as a kind of sexual organ.

The paradox of the Siphonophora expresses an issue that I have been avoiding, or rather skirting about, in presenting this taxonomy of persons or parts. I have described the various swimming, floating, protecting, feeding, capturing, and reproducing structures as persons—that is, as individual polyp or medusa organisms. Using evolutionary history as a criterion, this designation is almost surely correct and accepted now by nearly all biologists. By history, siphonophores are colonies; they evolved from simpler aggregations of discrete organisms, each reasonably complete and able to perform a nearly full set of functions (as in modern coral colonies). But the colony has become so integrated, and the different persons so specialized in form and subordinate to the whole, that the entire aggregation now functions as a single individual, or superorganism.

The persons of a siphonophore no longer maintain individuality in a functional sense. They are specialized for a single task and perform as organs of the whole. They do not look like organisms and could not survive as separate creatures. The entire colony works as a single entity, and its parts (or persons) move in a coordinated way. Although each nectophore (or swimming bell) has its own nervous system, all are connected by a common nerve tract. Impulses along this pathway regulate the rows of nectophores in an integrated manner that permits the whole colony (or animal) to move with precision and grace. Touch the float of *Nanomia* at one end and nectophores at the other extremity contract to remove the animal (or colony if you will) from danger. Siphons pump their digested food along the common stem to the rest of the colony, but empty siphons also join in the general peristalsis and food, as a result, reaches the entire colony (or organism) more effectively.

My studied parentheticals of the last paragraph underscore the fundamental paradox. Shall we call the entire siphonophore a colony or an organism—for it is a colony by evolutionary history but more an organism by current function. And what of the parts or persons? By history, they are modified individuals; by current function, they are organs of a larger entity. What is to be done?

This issue fueled the great siphonophore debate of nineteenth-century natural history. T.H. Huxley studied siphonophores during his long apprenticeship at sea on H.M.S. *Rattlesnake* (less celebrated than Darwin's adventure on the *Beagle*, but another example of the same extended, exemplary, and largely extinct style of training in natural history). He interpreted siphonophores as conventional organisms, their parts as true organs and not modified persons. They served as his primary example in a famous essay on the nature of individuality in biology.

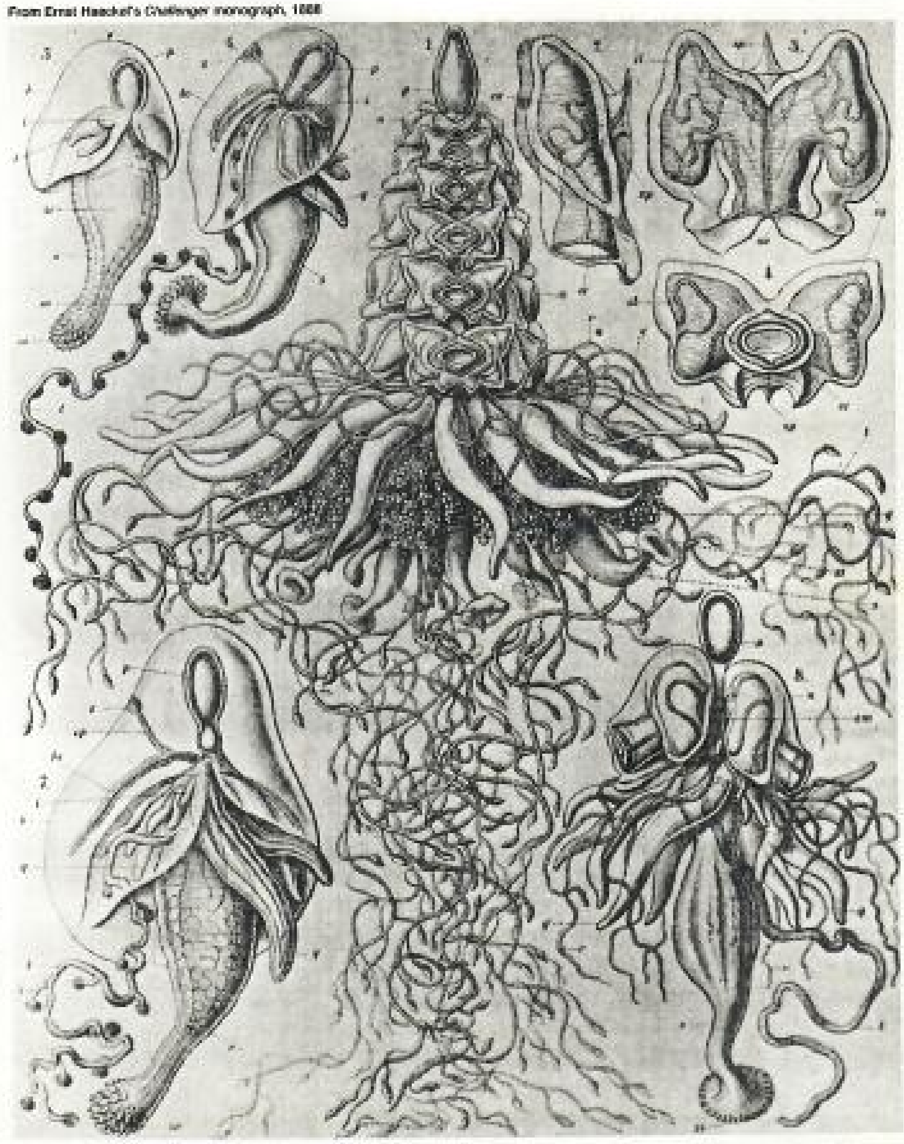
Louis Agassiz studied the Portuguese man-of-war on the shores of his adopted America (I have included his beautiful lithograph of *Physalia* with this essay) and decided that siphonophores are colonies, their integration a sign of divine handiwork.

Ernst Haeckel, artist and naturalist *extraordinaire*, described the siphonophores collected on that most celebrated of scientific expeditions in oceanography, the voyage of H.M.S. *Challenger*, 1873–76. He published with his report a series of plates (including all other illustrations in this essay), unmatched ever since for beauty (though a bit short on accuracy, since Haeckel often added a touch of heightened symmetry for artistic effect). Haeckel also included several plates of siphonophores in his *Kunstformen der Natur* (*Art Forms in Nature*) of 1904, the great series of 100 lithographs, with plants and animals arranged in weirdly distorted form and swirling symmetry, in the best tradition of reigning *art nouveau* so well embodied in contemporary kiosks of the Paris Métro.

Haeckel's theory of siphonophores would require an essay in itself to explain and explore, but it tried to mediate between Huxley and Agassiz by viewing these creatures in part as colonies (the poly-person theory in his words), in part as organisms (the poly-organ theory). Haeckel also used siphonophores, as Huxley had, to illustrate by dubious analogy his views on the proper organization of human societies. In his *Über Arbeitstheilung in Natur und Menschenleben* (*On the Division of Labor in Nature and Human Life*), he compared the simple colonies of other cnidarians with the life styles of "primitive" humans and their limited division of labor for repetitive tasks performed by all: "The wild people of nature, who have remained on the lowest level right to our own day, lack both culture and division of labor—or they limit division of labor, as do most animals, to the different tasks of the two sexes." He then compared complex colonies of siphonophores with the "advances" that division of labor permits in "higher" human societies—including modern warfare, whose instruments of destruction "require hundreds of human hands, working in different ways and manners."

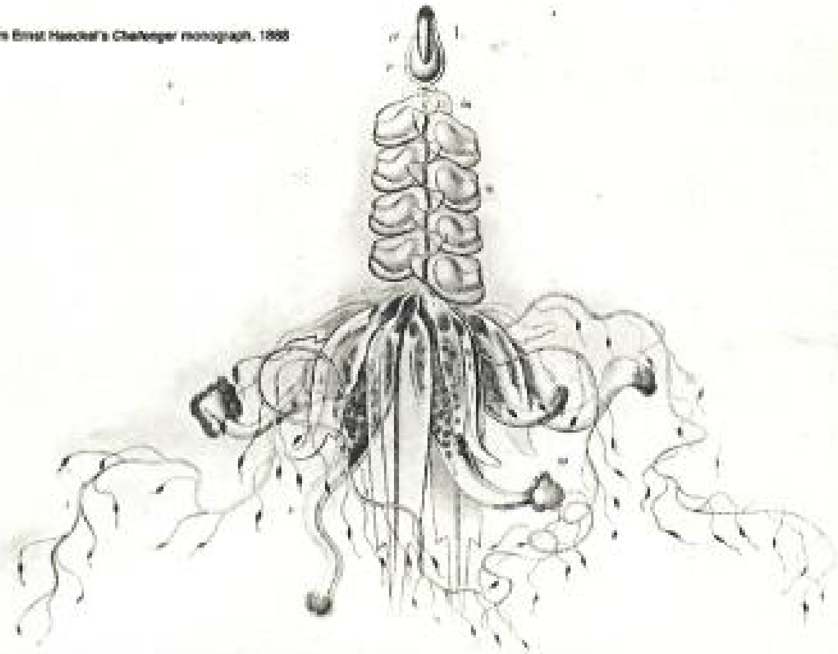
Is there any resolution to this ancient debate, any possible mediation between two legitimate criteria that seem to yield opposite results—the criterion of history supporting the poly-person theory (siphonophores are colonies and their parts are persons) and the criterion of current function upholding the poly-organ theory (siphonophores are organisms and their parts are organs). Could we tip the bal-

From Ernst Haeckel's Challenger monograph, 1888



The middle illustration (1) shows an entire siphonophore. The colony includes the following modified persons, from the top to the bottom: the single float, or pneumatophore (p); rows of swimming organs, or nectophores (n); fingerlike sensory projections, or palpons (q); clusters of reproductive parts (g); feeding siphons with trumpet-shaped mouths (s); and long, twisted strands of food-capturing filaments (t). Other figures are parts or early growth stages of the complex colony.

From Ernst Haeckel's Challenger monograph, 1888



This complex siphonophore colony includes a set of highly modified persons. From top to bottom: a single pneumatophore; two vertical rows of nectophores; protective leaflike bracts; feeding siphons with trumpet-shaped mouths; and finally, long food-capturing filaments.

ance in favor of one view or the other by invoking the third major criterion of natural history—growth and form?

Growth and form provides us with an *embarras de richesses* by presenting evidence for and against both theories. As strong support for the poly-organ theory, siphonophores develop from a single fertilized egg cell. A siphonophore begins life as an unambiguous person—should we not regard any later development as an elaboration of this one individual? Moreover, the adult siphonophore acts as a discrete object. Many species have definite and complex symmetry governing all parts considered together. Some Portuguese men-of-war, for example, come in right- and left-handed versions.

We may, however, cite equally good arguments for the poly-person theory. Admittedly, each colony begins life as a single ovum, but it then develops a series of entities—full persons in this view—by budding from a common stem. This is a familiar mode of growth for many aggregations conventionally regarded as colonies. A stand of bamboo or a field of dandelions may trace its origin to a single seed, yet we usually view each budded stem or flower as an individual.

Second, highly specialized structures sometimes bear vestigial parts that testify to their status as persons. In the poly-person theory, for example, nectophores are medusae that have lost all feeding and digestive parts, retaining only the jellyfish bell. But some nectophores grow rudimentary tentacles; in one species, the tentacles even retain eyespots. Protective bracts are the most modified and specialized of all siphonophore parts, but the covering organs of two species retain a vestigial mouth—an indication that bracts arose as full medusa persons.

It looks like a tossup again. We might resolve our paradox if growth occurred in either of two ways—but nature doesn't oblige. If all structures began growth as complete persons with a full set of parts, and then lost unneeded parts as they specialized for swimming, protecting, or eating, then the poly-person theory would gain a big boost. If buds from the main stem began as complete persons and then disarticulated—the bell parts becoming nectophores and the tentacle parts siphons, for example—then the poly-organ theory would be affirmed. But most specialized parts simply grow as we find them. Nectophores differentiate as nectophores, bracts as bracts. We are immersed in an unresolvable conflict among equally legitimate criteria: discrete buds grow like a person with a specialized set of parts like an organ. What shall we make of a gonophore, for example, the degenerate reproductive medusa budded from a polyp? If it separates from the colony, we may choose to regard it as an organism. But it has no mouth and cannot feed and must therefore die after releasing the sexual cells. Do we call such a limited breeding machine an individual? And if it remains attached to the colony, as it usually does, should we regard it as any more than a sexual organ?

When an inquiry becomes so convoluted, we must suspect that we are proceeding in the wrong way. We must return to go, change gears, and reformulate the problem, not pursue every new iota of information or nuance of argument in the old style, hoping all the time that our elusive solution simply awaits a crucial item, yet undiscovered.

Nature, in some respects, comes to us as continua, not as discrete objects with clear boundaries. One of nature's many continua runs from colonies at one end to organisms at the other. Even the words—organism and colony—have no precise and unambiguous separation. We may, however, use the two criteria of our vernacular as a guide. We tend to call a biological object an organism if it is spatially separated from others and if its parts are so well integrated that they work only in coordination with others and for the proper function of the whole.

Most creatures lie near one or the other end of this continuum, and we have no trouble defining them as organisms or colonies. People are organisms—even though all multicellular creatures probably arose as colonies about a billion years ago. This origin is so distant, and so much has happened since, that we detect no signs of coloniality in our current operation. Thus, we are organisms by any reasonable use of language. Reef-building corals are colonies because each polyp is a complete creature, fully functional in its own right, though attached to its fellows.

But since nature has built a continuum from colony to organism, we must encounter some ambiguity at the center. Some cases will be impossible to call—as a property of nature, not an imperfection of knowledge. Consider a progression from evident organisms toward the undefinable center. Human societies are made of organisms; each person is genetically distinct and spatially separate. What about ants? We still opt for organisms even though ants may so submerge their individuality in tightly knit societies that some naturalists refer to an anthill as a superorganism.

What about aphids? We begin to lose clarity. An aphid clone is all female; each mother grows her young within her own body, without benefit of fertilization. All members of the clone are genetically identical. Are they all separate individuals or one gigantic evolutionary body with many thousand separate parts, all identical (one prominent evolutionary biologist has recently urged this second view)?

What about dandelions? Harder still. All stems and flowers are members of a clone; they are genetically identical, and attached to a common underground stem. Is each plant above ground a person or a part? We still usually opt for persons (though many biologists demur) because each plant looks much the same and has a full set of structures.

Finally, then, what about siphonophores? We are now squarely in the middle of a continuum, and we cannot provide a clear answer. The parts of siphonophores are persons by history, organs by current function, and a bit of both by growth. Our criteria of separation and independent operation have failed, but we cannot deny a history that still stares us in the face.

Siphonophores do not convey the message—a favorite theme of unthinking romanticism—that nature is but one gigantic whole, all its parts intimately connected and interacting in some higher, ineffable harmony. Nature is full of boundaries and distinctions; we inhabit a universe of structure. But since our universe has evolved historically, it must present us with fuzzy boundaries, where one kind of thing grades into another. Objects at these boundaries will continue to confuse and frustrate us as long as we follow old habits of thought and insist that all parts of nature can be pigeonholed unambiguously to assuage our poor and overburdened intellects.

The siphonophore paradox does have an answer of sorts, and a profound one at that. The answer is that we asked the wrong question—a question that has no meaning because its assumptions violate the ways of nature. Are siphonophores organisms or colonies? Both and neither; they lie in the middle of a continuum where one grades into the other.

The siphonophore paradox is illuminating, not discouraging. It cannot be resolved, but when we understand why, we grasp a great truth about nature's structure. It embodies the same message as that old one about the lady who visits her butcher one Friday morning, seeking a large chicken for the Sabbath meal. The butcher looks in his bin and is chagrined to find that he has but one scrawny animal left. He takes it out with great fanfare and puts it on the scale. Two pounds. "Not big enough," the lady says. He puts it back in the bin, pretends to rummage amidst a large pile of nonexistent alternatives, finally pulls out the same chicken, puts it on the scale, and puts his thumb on the scale. Three pounds. "Fine," says the lady. "I'll take them both." Things that seem separate are often the different sides of a unity.

Stephen Jay Gould teaches biology, geology, and the history of science at Harvard University.

NATURAL HISTORY

Vol. 93, No. 12, December 1984

American Museum of Natural History
Robert G. Goelet, President
Thomas D. Nicholson, Director

Cover: *A pair of male polar bears play-fight at Cape Churchill, Canada. These ferocious-looking fights last about ten minutes and the bears are careful not to hurt each other. Photograph by Fred Bruemmer. Story on page 38.*

NATURAL HISTORY *(ISSN 0028-0712) is published monthly by the American Museum of Natural History, Central Park West at 79th Street, New York, N.Y. 10024. Subscriptions: $18.00 a year. In Canada and all other countries: $23.00 a year. Second-class postage paid at New York, N.Y. and at additional offices. In Canada second-class postage paid at Windsor, Ontario (permit no. 9579).*

Natural History *is indexed in* Reader's Guide to Periodical Literature.

Advertising Offices:
Natural History Sales
488 Madison Avenue
New York, N.Y. 10022
Representatives: Lew Galati, Dorothy Gough, Meg Lindsay, Annette Webb

Telephone Numbers:
Advertising Sales (212) 826-9467
Museum Information (212) 873-4225
Subscription Information (212) 690-0570

Subscription orders, change of address notices, undeliverable copies, and other mail items are to be sent to
Natural History Membership Services
Box 4300
Bergenfield, New Jersey 07621

JOHNSTON FILE

George Balazs
National Marine Fisheries Service
P.O. Box 3830
Honolulu, Hawaii 96812

February 15, 1986

Dear George,

The last sample you sent to me was not that difficult to identify, but took longer than expected. I'll be quicker next time. Winter quarter is often my busiest. Unfortunately there were no algae in the sample that are only known from South America. The ones in the sample were:

Polysiphonia scopulorum Harvey

Polysiphonia upolensis (Grunow) Hollenberg

Both of these are pantropical, occuring in Mexico, Miami, Australia, Hawaii and the South Pacific. The two species were about 50-50% in the sample. There was also an animal, perhaps a bryozoan or hydrozoan and some round worms. I made several slides from the sample and could not find anything else, but will look once more before sending the sample back to you.

Pacific Science 1950

The Sponges of Kaneohe Bay, Oahu[1]

M. W. de Laubenfels[2]

The Hawaiian Islands lie near the center of the north tropical Pacific Ocean. The island of Oahu is in the midst of these islands. Kaneohe Bay is near the middle of the windward side of Oahu, which side extends from northwest to southeast. The whole bay extends slightly over 11 kilometers along the coast, but is only some 3 kilometers (2 miles) deep. It is sheltered by extensive off-shore coral reefs, however, so that the water in it is much calmer than that of the open ocean. The southeast end of the bay is further sheltered by Mokapu peninsula so that it is here three-fourths landlocked; a roughly circular area some 3 kilometers in diameter is thus especially sheltered. The present study is based upon collections within this latter area which includes the junction of latitude 21° 26' N. and longitude 157° 48' W.

The deeper portions of Kaneohe Bay have a sand bottom; practically no sponges occur on sand. There are many patches of coral scattered throughout the bay, coming up to extreme low tide level, thus nearly but not quite 1 meter below the high tide surface. Such masses are often more than 100 meters in diameter, and have a vertical measurement above the floor of the bay of 10 to 15 meters. Much of the outer or fringing area of each is living coral, but the bulk of each mass is dead coral. There are innumerable interstices, and these are teeming with invertebrate life, including sponges. To collect and study this fauna, large armful-sized masses of coral were broken off, hauled to the surface, and placed on a boat where they were broken into small bits by means of hammers and crowbars. It is common to find that 5 to 10 per cent of the surface of the dead coral, down in these narrow crevices, is covered with living sponges. These are, however, always thin, often as thin as paper. Such incrustations are difficult to detach, or to study in any other way.

Much of the study of Kaneohe Bay was conducted at or near the island that has long been known by the Hawaiian name of Moku O Loe, but which has lately been termed Coconut Island. It is less than a kilometer in greatest dimension. Several man-made lagoons about 20 to 80 meters in length and connected to each other, and to the ocean, by channels that are 2 to 8 meters wide, have been constructed. In the channels sponges grow luxuriantly, and an individual sponge colony may quadruple its mass in 1 year's growth. In the calmer waters of the lagoons a few scattered sponges occur, some of rather large size (10 to 20 cm. high), but it is evident that there they grow very slowly; individual colonies showed so little growth in a year's time that it could not be measured. Doubtless there was some growth, but probably less than 10 per cent increase. These larger lagoon specimens are probably several years old, perhaps even 10 years old. Larger sponges in the channels may be only 10 months old.

Field investigation was carried out approximately once a month from September, 1947, to May, 1948 (9 months), and again in

---

[1] Research Paper No. 9, Cooperative Fisheries Research Staff, Territorial Board of Agriculture and Forestry and University of Hawaii; Contribution No. 1, Hawaii Marine Laboratory.

[2] Department of Zoology and Entomology, University of Hawaii. Manuscript received April 2, 1949.

FIG. 1. Map of the island of Oahu showing Kaneohe Bay and Moku O Loe.

October, 1948. About a dozen species of sponge were found to be fairly common or regular in occurrence in accessible locations, and a second dozen were found, but were rather rare and uncommon. It is certain that continued search would gradually but steadily build up this latter category to a total of at least 2 or 3 dozen. The same amount of effort and time expended on the Pacific coast of the United States, for areas of similar size and placement, would yield just about the same number and average size of specimens. The same may also be said for the coasts of England in particular and northwest Europe in general. In contrast, the Atlantic coast of the United States yields only half as many species, but typical regions in the Mediterranean and in the West Indies yield half again as many species, and the individual colonies are many times larger.

The possible faunal relationships of Hawaiian species to those of other parts of the world are interesting. Of the 23 species here discussed, 12 (or more than half) are new species. Of the 12, 7 (or more than half) are new genera. This is not unexpected in view of the insular location. Of the species that are here identified with previously named forms, four are circumtropical—almost to be called cosmopolitan—two are East Indian, two are from the Pacific coast of Panama, the others are from scattered localities. The two Panamanian forms conceivably may have been brought to Hawaii on ship bottoms; at least one of them is abundant on those that are dry-docked at Pearl Harbor. Conversely, they may have been taken to Panama from Hawaii.

The study of sponges in the field is complicated nearly everywhere by the occurrence of certain species of ascidians of the family Diademnidae which closely resemble encrusting sponges in all respects that are visible to the naked eye. Massive or branching sponges are easily discriminated, but such thin crusts as characterize the coral patches of Kaneohe Bay are perplexing. This locality furthermore contains especially numerous examples of the sponge-mimicking ascidians. The latter even contain spicules of the sort known as spherasters (a central ball, covered with outward projecting, conical, spines). Quite a few sponges contain spicules of just this shape, but these are always siliceous in sponges, always calcareous in the ascidians. Some sponges have calcareous spicules, but these are never spherasters.

A probable identification of the commoner sponges of Kaneohe Bay and vicinity may be made in the field by the key which is furnished below. Positive identification can only be made after microscopical study. Permanent mounts to show structure should be sectioned and preserved in balsam; but there are simpler methods available if permanent mounts are not required. Much structure can be ascertained by use of a dissecting-type stereoscopic microscope. One may slice the sponge in various directions and tease out small bits, using such a microscope. For spicule study one may take bits of the sponge, some from the surface and others from the interior, each bit about 3 mm. in diameter, put a few drops of concentrated fresh sodium

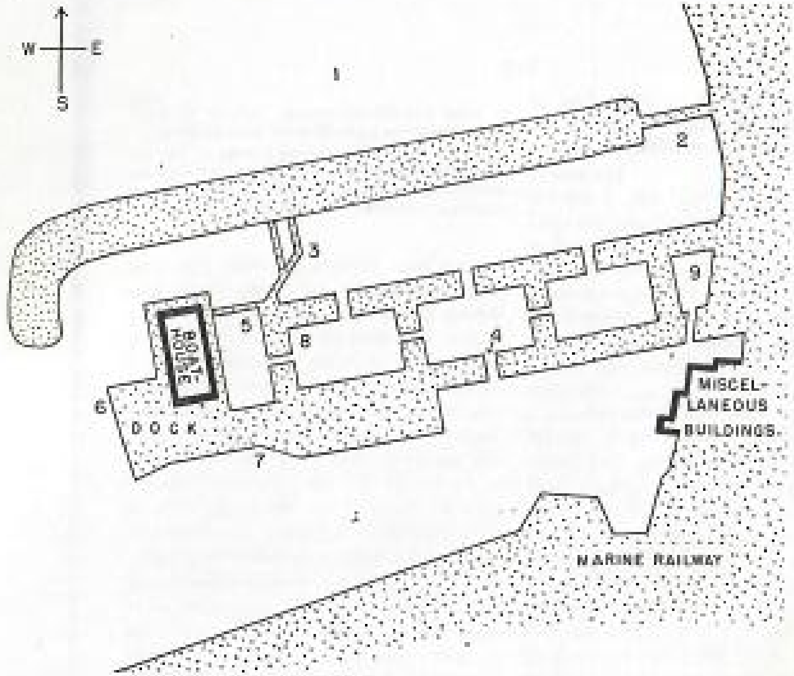


FIG. 2. Map of the vicinity of the Hawaii Marine Laboratory at Moku O Loe, showing by number six locations that are referred to, and three others for future reference.

hypochlorite solution on the sample, add a cover slip and study, pressing on the cover slip with a dissecting needle to move the gas bubbles. Commercial bleaching solutions such as Clorox and Purex will do, but a more concentrated solution is preferable. Such a solution destroys the protoplasm and leaves the spicules obscured only by the myriad bubbles. These latter may be moved about so that the isolated spicules are revealed. For permanent mounts one may boil out a sample (on a slide) with about six drops of fuming nitric acid, later adding balsam and cover slip.

A few words about spicule nomenclature may be in order. Megascleres typically make up the framework of the sponges in which they occur and are always comparatively large, sometimes even visible to the unaided eye. Microscleres never make up the framework of a sponge and are almost always minute. Some have a distinctive shape, and when such a shape is found to be large, that spicule is still regarded as being a microsclere in spite of its size. Megascleres may have three or more rays diverging from a central point (triaxon, tetraxon, etc.) or, instead, may be monaxon. The latter may be sharp at both ends (oxeas) or at only one end (style). If rounded at both ends they are called strongyles; if swollen at both ends they are called tylotes. A tylostyle is swollen at one end, pointed at the other. The prefix "acantho" means spiny. Microscleres may be very thin rods (raphides), S- or C-shaped (sigmas), or archer's-bow-shaped (toxas). Some are asters, covered with long rays. These are termed euasters if all radiate from a point, but are called streptasters if the rays radiate from a rod or bar. Amphidisks or birotulates have a circular pattern at each end of a rod. Related forms called chelas are so elaborate that they require illustration; some resemble anchors. If both ends are alike, it is an isochela, but if the ends differ it is an anisochela.

KEY TO GENERA

The commoner species occur in the genera marked with an asterisk.

1. No proper spicules present 2
   Proper spicules present 5
2. Spongin network present 3
   Spongin network absent 4
3. Fibers almost always clear . . . . **Spongia*** p. 7
   Fibers full of debris . . **Dysidea** p. 9
4. A few fibers present, no network . . . . **Pleraplysilla** p. 9
   No fibers present, dermal spongin present . . . . **Hexadella** p. 10
5. Spicules of silica present 6
   Spicules of calcium carbonate present 24
6. Spicules rare, skeleton chiefly sand . . . . **Kaneohea** p. 23
   Spicules common 7
7. Astrose spicules present 8
   Astrose spicules absent 9
8. Sponge spherical, no twice-bent oxeas . . . . . . **Tethya*** p. 30
   Sponge not spherical, twice-bent oxeas present . . **Zaplethea** p. 32
9. Some spicules triaxon . **Plakortis** p. 33
   No spicules triaxon 10
10. Ectosomal spicules the same as those of endosome 11
    Ectosomal spicules different from those of endosome 20
11. Larger spicules diactinal 12
    Larger spicules monactinal 15
12. Diacts are strongyles . . . . **Xytopsiphum** p. 11
    Diacts are oxeas 13
13. A fine-mesh dermal network present . . . . **Callyspongia*** p. 12
    No such dermal net present 14
14. Spicules oxeas and small toxas . . . . **Toxadocia*** p. 16
    Spicules oxeas and raphides . . . . **Neoadocia** p. 15

15. Monacts chiefly styles (a few may have a slight "head") 16
    Practically all monacts clear-cut tylostyles 18
16. No spicules except styles . . . . **Hymeniacidon*** p. 27
    Other spicules also present 17
17. Anisochelas and sigmas also present . . . . **Mycale*** p. 24
    Styles, isochelas, anisochelas, sigmas, toxas, and raphides present . . . . **Zygomycale*** p. 25
18. Spicules only tylostyles; sponge never boring into $CaCO_3$. **Terpios*** p. 28
19. Oxeas and acanthomicrostrongyles also present; sponge usually confined to galleries in $CaCO_3$ . . . . **Cliona*** p. 30
20. Dermal spicules spiny . **Naniupi** p. 18
    Dermal spicules smooth 21
21. Endosomal spicules spiny . . . . **Myxilla** p. 17
    Endosomal spicules smooth 22
22. Microscleres only raphides . . . . **Tedania*** p. 21
    Other microscleres present 23
23. Microscleres are isochelas . . . . **Damiriana*** p. 13
    Microscleres are amphidiscs . . . . **Hiattrochota** p. 19
24. Spicules chiefly calcareous triaxons . . . . **Leucetta*** p. 34

DESCRIPTIONS OF SPECIES

Spongia oceania new species

Figs. 3, 4

The holotype of this species is designated as a dried specimen, U. S. National Museum, Register Number 22755. It was collected February 14, 1948, just north of the entrance to Hanauma Bay, from a depth of 8 meters. Further data as to the abundance of this sponge are given after the description.

The shape of *Spongia oceania* is irregularly massive. Its size is often greater than 10 cm. in diameter. As is the rule in this genus, the

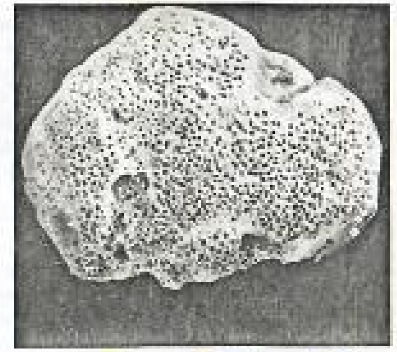


FIG. 3. Holotype of *Spongia oceania*, × 1/2.

exterior is normally jet black, the interior brown. Specimens that grow in the shade, however, fail to reveal the black color. The first ones that I found, from Moku O Loe, were dull brown externally, turning gray in alcohol. The consistency is very spongy as compared to other genera, but *oceania* is definitely less spongy than are most other species of the genus *Spongia*.

Its surface is most distinctive. Large areas are completely devoid of conules, and where these protrusions do occur they are only 0.1 to 0.2 mm. high, 4 to 6 mm. apart, and are vague. The oscules are 1 to 2 mm. in diameter. In a typical area of 10 square cm. I count 138 oscules; the average will certainly be close to 14 per square cm. on the upper surface of the sponge. There are, of course, very few on the sides, and none below. Many are only 2 mm. apart, center to center. These oscules in life are subject to at least partial sphincrate closure, as are also the pores. The pores in spirit-preserved specimens are abundant, 40 μ in diameter, but may have been slightly larger when fully opened in life.

The ectosome of *oceania* is a typical *Spongia* dermis about 15 μ thick, full of heavily pigmented cells. The endosome is the usual dense reticulation. The flagellate chambers are spherical, about 25 μ in diameter. The abundant fibers consist of nearly opaque, typically rather granular spongin without foreign inclusions. They are 15 to 30 μ in diameter and enclose meshes often about 50 by 200 μ. The scarce ascending fibers are about 60 μ in diameter, and contain a core of fragments of spicules from neighboring sponges.

FIG. 4. Fibers of *Spongia oceania* from a camera lucida drawing. × 100. A, principal or ascending fiber; B, common fibers.

No other species of *Spongia* has such numerous oscules of such small average size. A few such small ones may occur here and there in other species but as a rule the oscules are large, often nearly 10 mm. in diameter, and many centimeters apart. Only a few other *Spongia* specimens are as hard as *oceania*, and in each such case it appears decidedly possible that the hardness is due to some local environmental condition. The hardness of *oceania* may be a specific character. It would be interesting, however, to see if soft varieties, imported from elsewhere, would continue to grow soft in Hawaii. The commercial possibilities of *oceania* do not appear great, but they do exist.

The species name is given in respect to the location of this sponge near the center of the world's largest ocean.

The abundance of this species calls for special attention because it is almost, or perhaps could be, a commercial sponge. It is recorded that the ancient Hawaiians collected and used dried specimens, but to only a slight extent. Wet specimens feel somewhat like the usual commercial sponges, and I have used a locally collected sponge in a very practical way in my laboratory. Yet even when wet it is somewhat difficult to compress, and when dry it is almost as stiff as wood. The commercial sponge *Spongia officinalis* variety *dura* from the West Indian region, known in the market as "hardhead," is much like *oceania* in consistency. The best Hawaiian sponges are scarcely third-grade by market criteria, but their ability to absorb and hold water (which may then be readily squeezed out) is quite good. They have a fairly small ratio of gross cavities, so that their chief fault is the unpleasant stiffness.

I first collected this species in Kaneohe Bay (at Moku O Loe) on December 22, 1947, but the specimens from this vicinity were all small, thin encrusting forms, ill suited to reveal the typical characteristics. Mr. Vernon Brock collected the type specimen by "skin diving" and reported that at the type locality the bottom for perhaps as much as several acres was thick with spongias, scarcely a meter apart, and many of them were much larger than human head size. He brought up one specimen over 40 cm. in diameter. It is curious to note that there is probably a greater bulk of this species in the Hawaiian Archipelago than the total bulk of all other shallow-water Hawaiian sponges. Reports came to me of vast windrows of this sponge cast on the beach after storms. On January 24 to 26, 1947, an unusually severe gale struck Hawaii and on January 28, I went almost entirely around the island of Oahu, examining beaches along the south, east (windward), and north shores. I found only a few small fist-size spongias cast up. Almost nothing else was cast up, however, so presumably the wave action of this storm was of some peculiar nature so that it scoured material off the beach rather than depositing it. Extra big deposits of storm-dislodged sponges are

reported from the windward side of the island of Molokai, even masses 2 feet deep extending far along the beach. Reports came to me of large beds of *Spongia* north of the island of Maui and just north of, and also just south of, Kaneohe Bay. Dredging at the latter locality failed, however, to yield a single specimen. During May, 1948, I made a reconnaissance of the large island of Hawaii and found this species rather common along the south and west coasts, but did not similarly explore the turbulent, windward, northeast coast.

Dysidea avara (Schmidt) de Laubenfels

This species is represented to date by only a single specimen collected at Moku O Loe on January 10, 1948. This is now deposited in the U. S. National Museum, Register Number 22749. It was growing on the east side of the dock, near the concrete bridge which connects the dock with the island. It was at a depth of about 2 meters. This is location number 5 on the map.

This specimen is 6 by 7 by 9 cm., massive, and in life it was dull purple outside, brown inside. Its consistency is very spongy, but if dry it would doubtless, like others of the same species, become hard and brittle.

The surface is beset with conules about 2 mm. high and 1 to 8 mm. apart, usually 3 to 4 mm. apart. The oscules are 3 mm. in diameter and 2 to 3 cm. apart. The pores are 50 μ in diameter; about 10 or 14 such occur in each of numerous surface areas. Each such area is about 0.5 mm. in diameter, and represents a mesh in a subdermal reticulation of spongin fiber.

The ectosome consists of a thin dermis much perforated by pores as described. The endosome is fibro-reticulate. The flagellate chambers are 60 μ in diameter, sack-shaped (eurypylous). Both primary or ascending fibers and secondary fibers are loaded with foreign material, but a few fibers in the subdermal reticulation are free from detritus. These latter are 20 to 40 μ in diameter. In the main fibers a few short spaces that are free of inclusions are 100μ in diameter, but the abundant inclusions are often sand grains of 250 μ in diameter.

The species name *avara* was first used as *Spongelia avara* by Schmidt (1862: 29) for a Mediterranean species very much like this one from Hawaii. That *Spongelia* falls in synonymy to the earlier *Dysidea* is made clear by de Laubenfels (1932: 124) if not sooner; earlier authors had speculated that such might be the case. Very similar sponges are recorded from Australia by Lendenfeld (1889: 668) as *Spongelia distans* and are recorded from the Philippines, first by Wilson (1925: 476) as *Spongelia fragilis* and subsequently by de Laubenfels (1935: 327) as *Dysidea pallescens*. Burton (1934: 583) placed many species, including *pallescens*, *distans*, and *avara*, in synonymy with *fragilis*. In a monograph of the keratose sponges (de Laubenfels 1948: 142) I maintain the specific distinctness of *avara* as compared to *fragilis*, including *distans* with *avara*. The species *avara* is never as pale or grayish as *fragilis*, and consistently has a much coarser surface. In addition *fragilis* tends to have larger oscules, often at the distal ends of cylindrical branches. Occasional deformed specimens of *avara* may resemble equally rare deformed specimens of *fragilis*, thus leading to the belief that all are conspecific. *D. avara* appears to be common throughout the Old World, Europe to Australia, and is now recorded in mid-Pacific. *D. fragilis* is world-wide, being found even into the near Arctic.

Pleraplysilla hyalina new species

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22754. It was collected January 10, 1948, in Kaneohe Bay at a depth between 1 and 2 meters, growing on dead coral.

This species formed an extremely thin encrustation, barely 100 μ thick at the thickest unless measured directly at the conules. It spread laterally for distances of several centimeters on the exceedingly irregular surfaces of the coral. It was possible to dislodge postage-stamp-sized pieces with some difficulty. In life the color was blue-gray, and the transparency of the whole sponge was noteworthy. The consistency of the flesh was softly colloidal, scarcely more firm than raw egg white. The fibers were stiffly elastic.

The surface of this sponge was decidedly conulose, with conules 3 to 7 mm. apart and about 2 mm. high. Neither oscules nor pores could be found in the preserved specimen. Doubtless they were almost or quite microscopic in life, and completely contracted in the alcohol or while the encrustation was being scraped off. The whole is so thin that no distinction can be drawn between ectosome and endosome; specifically there was no evident dermis or dermal specialization, merely the surface of the protoplasm.

Doubtless there was a basal plate of spongin. Certainly at intervals spongin fibers rose upward, perpendicular to the base. These fibers are of clear amber-yellow spongin with a central region that is densely packed with spicule fragments and fine sand.

This appears to be the third time that anyone has found this genus, which is separated from the somewhat more common *Aplysilla* by the occurrence of a central region in the fiber filled with foreign detritus. The first was on the north coast of France, as recorded by Topsent (1905: clxxxiv). He described his discovery as *Pleraplysilla minchini*. It differed from the Hawaiian specimen in being opaque and chocolate-brown in color. The second occurrence of the genus was recorded by George and Wilson (1919: 165) at Beaufort, North Carolina. This species, *Pleraplysilla latens*, was described as colorless, conules less than 1 mm. high; the distance between conules was not given. In 1946, I spent the summer at Beaufort, but was unable to find a trace of *Pleraplysilla*. Of course it is an exceptionally inconspicuous sponge. The Hawaiian species is set off by color from *minchini* and in color and conule size from *latens*. The specific name selected refers to its transparency.

Hexadella pleochromata new species

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22748. It was collected January 10, 1948, in Kaneohe Bay at a depth of between 1 and 2 meters, growing on dead coral. It was also collected by dredging at 50 meters depth on the opposite side of Oahu, in the ocean south of Pearl Harbor, on February 19, 1948.

This species forms a thin encrustation not quite 1 mm. thick. In life the color is sulfur-yellow, but upon dying it turns purple. The consistency is fleshy, modified by the tough dermis.

The surface of this sponge was smooth, with scattered openings 25 to 60 μ in diameter. No distinction between exhalant and inhalant openings could be made.

The ectosome is a tough organic cuticle, giving no evidence of cellular nature but instead is almost certainly suitably called spongin. The endosome is completely askeletal, comprising only the protoplasmic sponge structures. The flagellate chambers are large, sack-shaped (eurypylous), 30 by 60 μ in size.

Hexadella was established by Topsent (1896: 119), like the preceding genus, for thin encrustations found on the north coast of France. He used two species names, *racovitzai* (the type) and *pruvoti*. Both were yellow, the only difference being that the former had rose-red tints. The two have long been regarded as conspecific but to clarify the literature, such reduction to synonymy is definitely made here. It is noteworthy that *racovitzai* does not turn purple on dying. The critical diagnosis of *Hexadella* concerns the lack of mineral or fibrous skeleton but the presence of a tough spongin dermis.

Dendy (1905: 61) established *Hexadella indica* from India. This was red when alive, lamellate and folded, with peculiar surface openings called "chones." Burton (1926: 2) described *Hexadella kirkpatricki* from South Africa. This was gray, with papillate oscules, and erect habitus. Burton (1937: 43) described *Hexadella purpurea* from India. This was purple in life, not at all folded like *indica*, and the endosome contained much foreign detritus.

Hexadella pleochromata is sharply set off from the other species in the genus by its change of color from yellow to purple upon dying. On the other hand, exactly such a change is exhibited by one species of *Aplysilla*, one or two species of *Ianthella*, one undescribed species of *Thorectopsamma*, one undescribed species of *Hippiospongia*, and several species in *Verongia*. Thus it is a trait that is widespread in the families of the order Keratosa. It is clearly based on the occurrence of a pigment that has the properties of an indicator. It may be regarded as practically certain that in a sufficiently acid medium this pigment is yellow, whereas in a sufficiently alkaline medium it is dark purple. The chemistry involved is being worked out at Yale University for the related pigments in *Aplysilla* and *Ianthella*.

XYTOPSIPHUM new genus

This genus is erected in the family Desmacidonidae with the following species, *Xytopsiphum kaneohe*, as genotype. It should be emphasized that this is a genus with strongyles as megascleres and arcuate chelas for microscleres. In the type, the latter are peculiar, with greatly reduced clads.

The genus *Xytopsibis* de Laubenfels (1936: 54) has a description essentially like this one, and there are some sound reasons for arguing that the species *kaneohe* should be put in it. On the other hand, the type of *Xytopsibis* was emphasized as being the sponge which Bowerbank (1875: 287) described as *Halichondria aspera*, from a specimen from the Malayan region. This might be considered fairly close to the Hawaiian faunal region, too. Were Bowerbank's description accurate, the matter would be simple. On May 26, 1948, however, Dr. Maurice Burton of the British Museum (Natural History) wrote me a personal letter stating that the type specimen of *aspera* was in his museum, a dried specimen, and that it is not at all as Bowerbank described it; instead it is a *Tedania*.

One might argue that because *aspera* does not fit the diagnosis of *Xytopsibis* it cannot go into that genus, is not and cannot be the type thereof, hence, that the following new species which does fit the diagnosis must become the type of *Xytopsibis*. Against this I will set the following considerations. The original generic designation said "*Xytopsibis* is established for genotype *Halichondria aspera* Bowerbank"; furthermore, the description mentioned chelas of two sizes, so that the Hawaiian sponge does not fit perfectly. It is here considered that *Xytopsibis* falls, with *aspera*, into synonymy to *Tedania*.

Xytopsiphum is not secure in its allocation to the Desmacidonidae. This family contains many genera that may be discovered, if adequate data about surface structure become available, to resemble more the Adociidae, or perhaps a new family between the older two. *Xytopsiphum* may go into this still hypothetical new family. Its closest relatives are now in the Desmacidonidae; these are *Plumocolumella* (megascleres oxea, microscleres perhaps really like those of *kaneohe*, but the surface structure hispid) and closer still, *Xytopsaga*, whose megascleres are hastate tornotes, and whose microscleres are arcuate chelas. They are rather commonplace chelas whereas those of *kaneohe* are peculiar, with minute clads, as in *Plumocolumella*. On the island of Hawaii there occurs an undescribed species of sponge which I regard as congeneric with *kaneohe*; it is definitely closely related. Yet this undescribed sponge has somewhat commonplace arcuate chelas as its chief point of separation from *kaneohe*, and therefore it approaches the genus *Xytopsaga*. On the other hand, *Xytopsaga* has much coarser structure and seems to be confined to the Antarctic region.

The generic name is based upon a modification of the older name *Xytopsibis*.

Xytopsiphum kaneohe new species
Fig. 5

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22742. It was collected January 10, 1948, at Moku O Loe, in the shadow of the walk along the south side of the series of small artificial lagoons, east of the dock, depth about 1 meter, location number 4 on the map. Another specimen was collected on September 27, 1947, in Waialua Bay, Oahu, at a depth of about 6 meters, on dead coral.

Both specimens were thin encrustations 1 to 5 mm. thick, covering areas of between 10 and 20 square cm. The type was very dark, almost black, but the color promptly dissolved out (and disappeared) in alcohol, leaving a pale grayish-pink specimen. Many sponges have a melanotic pigment, but it is quite resistant to alcohol. It may be that the dark hue of this specimen was due to some foreign material on the surface. The other specimen was reddish-brown, mottled. In alcohol it has become the same dull color as the type. The consistency is soft.

The surface of this species is relatively smooth, and the pores are not evident, probably due to rapid closing. On the Waialua specimen there is a surface hole, 0.5 mm. in diameter, with slightly raised rim, that may or may not be an oscule. Otherwise (and chiefly) the species is lipostomous, as are many thin encrusting sponges.

The ectosome is semidetachable, rendering family allocation of the genus difficult. There are many spicules tangentially placed in the dermis, but these are the same as the megascleres of the interior. The endosome is dense with spicule tracts that range up to 50μ in diameter, 150 spicules per cross section, spongin dubiously present.

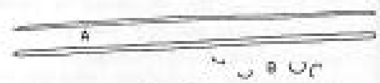


FIG. 5. *Xytopsiphum kaneohe*, spicules, from a camera lucida drawing, × 400. A, strongyles; B, sigmoid microsclera, probably reduced arcuate isochelas.

The megascleres are straight strongyles, 3 to 4 μ thick, 200 to 210 μ long. In one place in the Waialua specimen there are deformed but otherwise commonplace arcuate chelas; their absence from the rest of the specimen would indicate that they are foreign. In both specimens there are very abundant peculiar microscleres that are to be regarded as arcuate chelas, but the clads are so small that one obtains a first impression that these are sigmas. On the other hand, they are not at all contorted, as most sigmas are, but lie in one plane. These distinctive microscleres have a chord length of 15 μ in the Waialua specimen, but of only 10 μ in the type specimen.

The species name given refers to the type locality.

Callyspongia diffusa (Ridley) Burton
Fig. 6

This species was first studied in Hawaii on September 10, 1947, at the dock at Moku O Loe (location 6, Fig. 2). This specimen is deposited in the U. S. National Museum Register Number 22741. The species was found again on September 27, 1947, at Waialua Bay, and thereafter several times in various places in Kaneohe Bay, where it is moderately common. The shape is typically ramose, but juvenile specimens are temporarily encrusting. The branches are about 6 mm. in diameter, and often more than 12 cm. high. Three to five branches occur in the average mass. The color, in life, is dull drab with more or less lavender tinges; the more the sponge was exposed to light, the more lavender it shows. The consistency is very spongy.

The surface is superficially smooth. The pores in the protoplasmic dermis are often 40 μ in diameter. The oscules are 4 to 6 mm. in diameter, with raised rims often 3 mm. high.

The surface is covered by a network of fibers which are smaller than the fibers of the endosome and form smaller meshes. This is quite typical of *Callyspongia*. There is some ground for regarding the Hawaiian specimens as representing a new species, because unlike any other *Callyspongia* there is no coarser dermal net to include the finer one in its meshes; this is offset by the fact that there is such a net just below the surface. The endosome is a typical callyspongoid fibroreticulation.

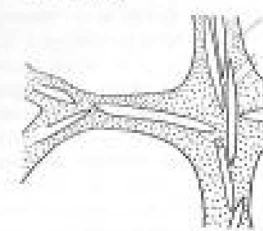


FIG. 6. *Callyspongia diffusa*, bit of the endoskeleton, × 320, showing spicules (oxeas) in spongin fibers. From a camera lucida drawing.

The dermal fibers are 10 to 15 μ in diameter, contain a single row of spicules, and form meshes that are 60 to 100 μ in diameter, usually about 75 μ. The protoplasmic dermis is in this same plane. The endosomal fibers are 25 to 35 μ in diameter in the Kaneohe specimen, about 40 μ in diameter in the one from Waialua Bay. In the latter there are several rows of spicules in some ascending fibers; in the Kaneohe specimen all the fibers have only the uniserial core of spicules. The endosomal meshes are 50 to 500 μ, often about 200 μ, in diameter, more or less rectangular. The spicules are oxeas, rather hastate; typical sizes are 4 by 100, 5 by 90, 6 by 75 μ. In one specimen I found one toxa 25 μ long. This is probably accidental, but is thought provoking in view of the similar color and shape of *Toxadocia* (p. 16) which has many toxas. *Toxadocia*, however, has a different sort of ectosome from *Callyspongia*.

Many species of *Callyspongia* are tubular in shape, with thin walls around the central hollow, which has a large distal opening. The type of the genus, *C. fallax*, is solid cylindrical, however. The species *diffusa* is perhaps best characterized by its relatively thick spicules. It was first described as *Cladochalina diffusa* by Ridley (1884: 183) from the Indian Ocean. It was subsequently recorded as *Cladochalina elegans* by Lendenfeld (1887: 770) from South Australia, as *Chalina palmata* by Lindgren (1897: 481) from the Malay region, as *Ceraochalina reticulata* by Dendy (1905: 152) from India. It is discussed, with synonymy, by Burton (1934: 541).

DAMIRIANA new genus

This genus is erected in the family Phorbasidae with the following species, *Damiriana hawaiiana*, as genotype. It should be emphasized that this is a genus with a special dermal skeleton of tylotes over an endosomal skeleton of oxeas, with arcuate chelas among the microscleres.

Within this family the genus *Damiriella* seems fairly close to *Damiriana*; all the other genera are widely different. None of the others has dermal tylotes, although such spiculation is common in the family Myxillidae.

All the others, with the dubious exception of *Iophonota*, do have echinating spicules. *Damiriella* has principal spicules that are strongyles whereas *Damiriana* has oxeas, otherwise the two are close. *Damiriella* is a rare genus, with only one species, itself rather rare, reported only from the Mediterranean coast of France.

The name *Damiriana* is selected to show plainly the resemblance to *Damiriella*.

Damiriana hawaiiana new species

Fig. 7

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22737. It was collected September 10, 1947, at Moku O Loe, in shallow water near the pier. It has been common at location 3 (Fig. 2), just inshore of the bridge over the long lagoon. It seems to grow very slowly. Several times during 1947 and 1948 bits were removed for study, and by just that much the total quantity present seems to be semipermanently reduced. In the fall of 1948 what might be a total of one or two handfuls remained.

In August, 1945, R. W. Hiatt carried out an extensive ecological survey on the south shore of the island of Hawaii, at a nearly inaccessible and therefore relatively natural and undisturbed region called Halape. He found at least one specimen of *Damiriana* growing on coral in a very exposed situation, quite in contrast to the quiet lagoon in Kaneohe Bay.

On May 19, 1948, at Kailua on the north Kona coast (west side) of the island of Hawaii I found a small, somewhat aberrant specimen of this species growing just barely below low tide.

Damiriana hawaiiana comprises first an amorphous basal region, often about the size of a hen's egg. From this, one or a few branches arise, little-finger size and shape. The color is a brilliant vermilion-red, and the consistency is soft, easily torn. The Kailua specimen was dull orange rather than flame-colored.

The surface is superficially smooth. The oscules may be terminal or lateral, may number six or more per specimen, and open as wide as 6 mm. They are conspicuously closable by a membrane which is pulled inward from all sides, maintaining the circular outline of the shrinking aperture. At least 5 minutes are required for complete oscular closure. The surface is perforate with gross pores, which in some places almost touch each other, elsewhere are far apart. Each of these, about 1 mm. in diameter, is in turn filled with a finer network, the meshes of which are barely 150 μ in diameter, 20 to 30 such openings per sieve. In places there are scattered pores, not so grouped, each about 40 μ in diameter.

The ectosome is a definite dermis, less than 100 μ thick, with its special spicules tangentially placed. The endosome is somewhat like "crumb of bread," with its special spicules chiefly in confusion, or in vague tracts about 100 μ in diameter. They often are placed so as to outline chambers, as in the genus *Myxilla*. The flagellate chambers are spherical, 25 to 40 μ in diameter. There is abundant colloidal material present.

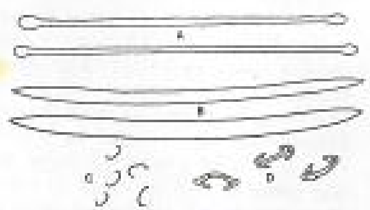


FIG. 7. *Damiriana hawaiiana*, spicules, from a camera lucida drawing, × 333. A, dermal tylotes. B, endosomal oxeas. C, sigmas. D, arcuate isochelas.

The ectosomal megascleres are tylotes, usually about 5 by 200 μ, although in one specimen, otherwise typical, they were only 4 by 170 μ. This is a minor difference. The endosomal megascleres are oxeas, usually about 8 by 200 μ, but sometimes 9 by 230. A few thicker, shorter ones, 12 by 180 μ, may be found, for example. The microscleres are of two sorts. There are abundant, commonplace, arcuate isochelas, 27 μ long. In the aberrant Kailua specimen there were also some only 15 μ long. A second category of microscleres appears to be a sort of sigma. It is C-shaped rather than S-shaped, is in one plane, not contorted. This suggests that it might be a reduced chela, and accordingly a search was made with immersion microscopy for traces of clads. At least one inward pointing clad is certainly present, perhaps three. The difficulty of being sure is due to the size of this spicule. Its chord length is 13 μ, its diameter 1 μ, the clad or clads are less than 1 μ in length, and at the widest about a third or a fourth of a micron in diameter, tapering to a point.

The species name is given in honor of Hawaii.

NEOADOCIA new genus

This genus is here erected in the family Adociidae, with the following species, *Neoadocia mokuoloea*, as genotype. It should be emphasized that this is a genus with an ectosomal skeleton of tangentially placed oxeas overlying an endosomal skeleton of oxeas, with raphides as microscleres. This is like *Adocia* except for the addition of raphides; it is set off from all other genera in the family by the possession of these microscleres.

The generic name is selected to show the close relationship to the genus *Adocia*.

Neoadocia mokuoloea new species

Fig. 8

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22745. It was collected September 10, 1947, at a depth of about 2 meters, near the dock at Moku O Loe (location 6, Fig. 2). Only the single specimen was found. I have repeatedly searched for others but without success.

The specimen is a mass 2 by 3 by 3 cm. Two holes go right through it, perhaps caused by foreign objects about which it grew; one of these is 3 mm. and the other is 9 mm. in diameter. The color in life was golden-yellow for all the interior and much of the exterior, but externally there were rosy-red patches. The consistency is very soft.

The surface is exceptionally punctiform. It is liberally perforated by apertures 1 mm. in diameter, more than 20 per square cm. of surface, on all surfaces except the surface of attachment. It is not clear which of these apertures are inhalant and which exhalant, unless it may be that all are pores, and the two large openings mentioned above may be the oscules. It would be interesting to have additional specimens and so be able to ascertain more of the structure of this species.

FIG. 8. *Neoadocia mokuoloea*, spicules, from a camera lucida drawing, × 444. A, megasclere (oxea). B, microscleres (microxeas), or raphides.

The ectosome contains a tangent dermal skeleton of smooth diacts, over subdermal spaces. The endosome is cavernous, with an isodictyal reticulation of smooth diacts and few or no spicule tracts at all. The megascleres are all smooth oxeas, 6 by 120 to 6 by 135 μ. The microscleres are commonplace raphides, about 0.5 μ thick, but upwards of 100 μ long.

Adocia baeri occurs in the Philippine Islands. It was first described as *Reniera implexa* variety *baeri* by Wilson (1925: 398) and made a species by de Laubenfels (1936: 328). This *Adocia* is very different from *mokuoloea* in appearance, being nearly black. It contains a few very thin spicules, but these may merely have been juvenile forms of the megascleres, inasmuch as they are uncommon. There seems to be no way to discriminate between such immature forms and clear-cut raphides, unless the latter are so numerous that it is unlikely that they are juveniles. If it should happen, as I believe unlikely, that *baeri* has genuine raphides, then it should be transferred from *Adocia* to *Neoadocia*. This transfer is not here made.

The name of this new species is derived from its type locality, the island of Moku O Loe.

Toxadocia violacea new species

Fig. 9

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22752. It was collected November 3, 1947, at Moku O Loe, at a depth of 1 meter, in the long pool near location number 3 in Figure 2. This species was also found growing in numerous places on dead coral throughout Kaneohe Bay, but not on the leeward side of Oahu. On the island of Hawaii I found it in at least two places near Hilo, which is on the windward side of that island.

This species is basically encrusting, but the numerous oscules are raised on little hillocks about 1 cm. high. Some projections are so long (15 mm.) but so narrow (3 mm.) as to resemble fistules. Few colonies reach the size of the palm of the hand or a basic thickness of as much as 1 cm. The color is a vivid violet and the consistency is soft and fragile.

The surface of *Toxadocia violacea* is smooth, provided with a translucent dermis over extensive subdermal cavities. The pores in this dermis are abundant, contractile, about 30 μ in diameter. The openings that lead down from the floor of the subdermal cavity are rather more conspicuous than those in the dermis, being readily visible through it. They are less numerous and are about 150 μ in diameter. The oscules are about 3 mm. in diameter, and are often raised 8 to 16 mm. above the surface on rounded projections.

The dermal membrane is full of spicules tangentially arranged, but in little more than one single layer. The endosome is micro-cavernous, permeated by an isodictyal reticulation of spicules.

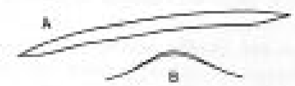


FIG. 9. *Toxadocia violacea*, spicules, from a camera lucida drawing, × 444. A, oxea. B, toxa.

All the megascleres are smooth oxeas, about 4 by 120 μ. A few are larger, especially in the specimens from Hilo, where a size of 7 by 140 μ is sometimes reached. The microscleres are toxas, 1 by 60 μ. Some thin, straight spicules may be raphides, or juvenile megascleres, or merely edgewise views of toxas; they are not regarded as worthy of emphasis.

There are seven other species which have been assigned to the genus *Toxadocia*. Two, *toxius* and *toxophorus*, are East Indian, and one might expect them to be the most like this Hawaiian species, but such is not the case. Each has, for example, a very peculiar type of toxa which differs from those of all others in the genus. Two species from the tropical Atlantic, *abbreviatus* and *tener*, have megascleres that are many times larger than those of the Pacific species. One from Great Britain, *fallax*, has large spicules, but not nearly so large as those from farther south. There are two Arctic species, *primitivus* and *proximus*, and these have still smaller megascleres, and approach closest of all to the Hawaiian *Toxadocia*. Their toxas are much larger, however, and they and all other hitherto described members of this genus are recorded as yellow in color. Emphasis is laid here on the spicule differences and, particularly, on the color. The species name

violacea is derived from the violet hue of this sponge.

Myxilla rosacea (Lieberkühn) Schmidt

Fig. 10

This species is represented in the fauna of Hawaii by only two known specimens; both were collected at Moku O Loe in Kaneohe Bay. The first specimen was taken September 10, 1947, at a depth of 1 or 2 meters, on pilings at the dock (location 6, Fig. 2). This is deposited in the U. S. National Museum, Register Number 22734. A second was found January 10, 1948, in the sluice-way from one of the small lagoons (location 4, Fig. 2).

This sponge is massive. Our specimens are each fist-size, but much of the bulk is due to contained lumps of dead coral. The color in life is bright orange-red, paler in the interior. The consistency is slightly spongy, not especially remarkable. The surface is slightly and irregularly lumpy. There is a conspicuous translucent dermis pierced by microscopic contractile pores; through it the larger canals that lead into the sponge from the floor of the subdermal space are easily seen. These openings are about 0.3 mm. in diameter and 1.2 mm. apart. The oscules are few and scattered, about 6 mm. in diameter, and closable by very thin membranes.

The ectosome is packed with special dermal spicules arranged tangentially. The endosome is cavernous, "crumb of bread" type, with the skeleton in "log cabin" or modified isodictyal arrangement about small gross chambers.

The ectosomal spicules are smooth-shafted tornotes; their ends are just faintly micro-spined, their size about 3 by 160 μ. The endosomal spicules are acanthostyles, 8 by 140 μ. The microscleres include anchorate isochelas, approaching the unguiferate type but only 15 μ in total length, and also commonplace sigmas, 18 to 30 μ in chord length.

This species was first described from Europe, as *Halichondria rosacea*, by Lieberkühn (1859: 521). It was transferred to *Myxilla* (genotype) by Schmidt (1862: 71). It is abundant throughout Europe, on both the Mediterranean and Atlantic coasts, but appears to be absent from the Americas.

The European specimens and these from Hawaii agree rather closely. The former have isochelas that are often nearly twice as large as those of the latter, but this is scarcely a specific difference in view of the other similarities.

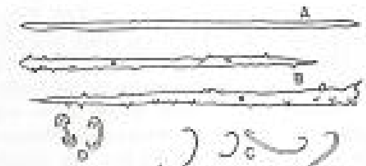


FIG. 10. *Myxilla rosacea*, spicules, from a camera lucida drawing, × 444. A, dermal tornotes. B, endosomal acanthostyles. C, sigmas. D, anchorate isochelas.

In reviewing the very numerous species of the genus *Myxilla* with a view to identifying the Hawaiian specimen, various items become noteworthy. The genus *Burtonanchora* de Laubenfels (1936: 94) was established for certain species formerly in *Myxilla* but differing chiefly in that they have only smooth spicules, and thus passing over into the family Tedaniidae. Perplexing intermediate forms, having spicules that are only very slightly spined, exist; yet for convenience, if nothing else, the division is worth maintaining. The following additional species are now taken out of *Myxilla* to go into *Burtonanchora*: *M. acribria* de Laubenfels, *M. cribrigera* Ridley and Dendy, *M. mollis* Ridley and Dendy, and *M. novaezealandiae* Dendy. Two species, *D. inaequalis* and *D. simplex*, first put in *Dendoryx* by Baer, are also placed in *Burtonanchora*.

Four others appear to require transfer from *Myxilla* into the related genus *Lissodendoryx*. They are *M. behringensis* Lambe, *M. cratera* Row, *M. firma* Lambe, and *M. pygmaea* Burton.

Topsent (1893: xxiv) described a sponge from the Mediterranean coast of France as *Myxilla arciteneus*. The megascleres and chelas are like *Myxilla*, but unlike this genus there are not (as usual) sigmas, and there are (as never in *Myxilla*) raphides and toxas. This is clearly not *Myxilla*. If there were no chelas it would fit *Acheliderma*. Because there is no genus now set up for this sponge, a new one is required, and is established as:

Quintoxilla new genus

This genus is assigned to the family Myxillidae, genotype *Myxilla arciteneus* Topsent. The holotype location is unknown to me; Professor Topsent told me personally that he rarely kept or deposited specimens. This is a genus with smooth dermal diactinal or sometimes inequiended spicules, and a principal skeleton of acanthostyles. The microscleres are isochelas (presumably, but not certainly, anchorate) and toxas. Raphides may be among the microscleres, but this is not emphasized here. The name is arbitrary, not descriptive, suggested however by the emphasis upon the toxas of the spiculation.

Naniupi new genus

This genus is erected in the family Myxillidae, subfamily Grayellinae, with the new species *Naniupi ula* as genotype. It should be emphasized that this is a genus with ectosomal acanthoxeas, endosomal smooth styles, and echinating acanthostyles. The microscleres include arcuate chelas. The genotype also has peculiar sigmoid microscleres. The genus name is derived from the native Hawaiian language, "nani" meaning beautiful and "upi" meaning sponge.

The subfamily Grayellinae is characterized by spiny diacts over smooth monacts. The type genus, *Grayella*, has similar ectosomal acanthoxeas to those of *Naniupi*, as very few sponges do, but the endosomal spicules of *Grayella* are smooth tylostyles with no echinating spicules or microscleres. Brøndsted (1932: 14) described a sponge from east of Iceland as *Grayella akraleitae*. This has a spiculation of lumpy styles echinated by acanthostyles, with arcuate chelas as microsclere. This cannot be a *Grayella*, but belongs in the family Microcionidae in which, however, a new genus is required for its reception, and is here established as:

Ramosichela new genus

This genus is assigned to the family Microcionidae, genotype *Grayella akraleitae* Brøndsted. The location of the holotype is not known to me. This is a genus for sponges with a principal spiculation of styles not smooth, in tracts that are echinated by acanthostyles; there are also arcuate isochelas. Within this family all the other genera have one or more categories of smooth megascleres except the genus *Ramoses*, which has no microscleres but is otherwise much like *Ramosichela*. *Ramoses* is exclusively Antarctic and sub-Antarctic whereas *Ramosichela* is Arctic or sub-Arctic. The genus name is derived from that of this related genus, *Ramoses*.

To continue with an analysis of the subfamily Grayellinae, de Laubenfels (1936: 88) puts *Crellomyxilla* here, but upon further consideration it is thought preferable to transfer this genus to the family Microcionidae, subfamily Yvesiinae. *Tethyspira* has been put in the Grayellinae with some doubt, and is, still doubtfully, left there. It has small acanthostrongyles that may be regarded as dermal; its main spicules are large smooth styles. A fourth genus belongs in this subfamily, on the basis of published descriptions, but as it too is unnamed it is here named as follows:

Quindesmia new genus

This genus is assigned to the family Myxillidae, subfamily Grayellinae, genotype *Hymedesmia inflata* Bowerbank (1874: 245, pl. 79). The holotype is probably in the British Museum of Natural History. This is a genus for sponges with special ectosomal acanthoxeas and endosomal smooth monaxons echinated by acanthostyles, but without microscleres. It is reported only from Great Britain and is evidently quite rare. The name is arbitrary rather than descriptive.

Thus it appears that there are now four genera in the Grayellinae, of which *Naniupi* is the only one to have microscleres.

Naniupi ula new species

Fig. 11

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22740. It was collected January 10, 1948, in Kaneohe Bay, at a depth of about 2 meters, growing on dead coral. On February 19, 1948, a similar specimen was dredged from a depth of about 50 meters, in the open ocean about 3 kilometers south of Pearl Harbor, on the opposite side of Oahu from Kaneohe Bay.

This rather uncommon sponge is a paper-thin encrustation, spreading indefinitely laterally. The type specimen came from a colony that covered an area about as large as a human hand, of very irregular outline due to the deeply sculptured mass of dead coral on which it grew. The color in life is a distinctive vivid carmine-red. The consistency is obscured by the extremely thin habitus.

The surface of *Naniupi ula* is smooth and lipostomous. The ectosome is a well-marked dermis, packed with a felted mass of tangentially arranged acanthoxeas. The endosome is dense, with its spicules in some confusion.

The special dermal acanthoxeas are about 4 by 110 μ. The endosomal megascleres are chiefly smooth styles about 4 by 190 μ. A few of these are pseudoxeas. In the deepest portions are a few echinate spicules, acanthostyles 7 by 130 μ. The principal or only microscleres are abundant, rather typical arcuate isochelas, 21 μ in total length. At least in the type specimen a few other spicules occur that seem, at first glimpse, to be microscleres. They are only about 1.5 μ thick, 80 μ long, very faintly microspined, and four times curved like two S-shaped sigmas end to end. There are, however, other similar spicules that are nearly straight, and these

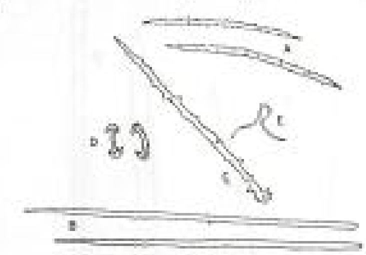


FIG. 11. *Naniupi ula*, spicules, from a camera lucida drawing, × 333. A, dermal acanthoxea. B, endosomal styles. C, echinating acanthostyle. D, arcuate isochelas. E, peculiar contort microsclere.

latter give evidence of being juvenile forms of the dermal acanthoxeas. The much curved spicules may be malformed examples of the same juvenile sort, but their occurrence is noteworthy. As additional specimens are found, this type of spicule should be looked for. I do not find them in the specimen collected south of Oahu.

The species name is derived from the native Hawaiian word for red, because of the brilliant color of this species.

Hiattrochota new genus

This genus is erected in the family Tedaniidae with the following species, *Hiattrochota protea*, as genotype. It should be emphasized that this is a genus with smooth strongyles as special ectosomal spicules, smooth styles as endosomal megascleres, and birotulates or amphidiscs among the microscleres, without chelas.

The genus *Iotrochota* may be regarded as a sort of nomenclatorial parent for all the marine Demospongiae having amphidiscs. Such spicules are common in the fresh water sponges (subfamily Meyeninae) and in the order Amphidiscophora of the Hyalospongiae. As more and more species were put in *Iotrochota* for this reason, it became evident from their other characteristics that they actually belonged to several families. The type of *Iotrochota* (*birotulata*) is in the Desmacidonidae. In 1936 de Laubenfels took out many species, establishing from them the genera *Hymetrochota* and *Iotroata* in the Myxillidae, and *Iotanta* in the Tedaniidae. *Hiattrochota* is also in this latter family. The two myxillids have megascleres typical of that family; *Hymetrochota* has only amphidiscs for microscleres, *Iotroata* also has unguiferate chelas. Of the tedaniids, *Iotanta* matches the latter, with both amphidiscs and unguiferate chelas as well as megascleres typical of the family. *Hiattrochota* matches *Hymetrochota*, with only amphidiscs as microscleres, but megascleres typical of Tedaniidae.

The terminus of the new generic name follows the pattern as used for the comparable genera, but the distinctive prefix is given in honor of the eminent zoologist, Robert W. Hiatt.

Hiattrochota protea new species

Fig. 12

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22750. It was collected December 22, 1947, at Moku O Loe, at a depth of about 1 meter, in a sluiceway (location number 4, Fig. 2). Another specimen was collected May 16, 1948, at Kaalualu, near the south end of the island of Hawaii. Yet a third slightly different specimen was collected May 17, 1948, at Honaunau on the Kona coast of the island of Hawaii.

This species is massive, about fist-size, and in life is velvety black. The spirits in which it is preserved are stained dark brown, but the sponge retains its hue. The consistency is somewhat elastic, not remarkable.

The surface is rather smooth, most of the pores having quickly contracted. A few openings about 1 mm. in diameter are dubiously regarded as unclosed pores. The oscules are 1 to 3 mm. in diameter and characteristically each is situated at the summit of a rounded dome or lobe, more than 1 cm. in diameter, but only about half as high.

The ectosome consists of a definite dermis over subdermal spaces, but is much less flesh-

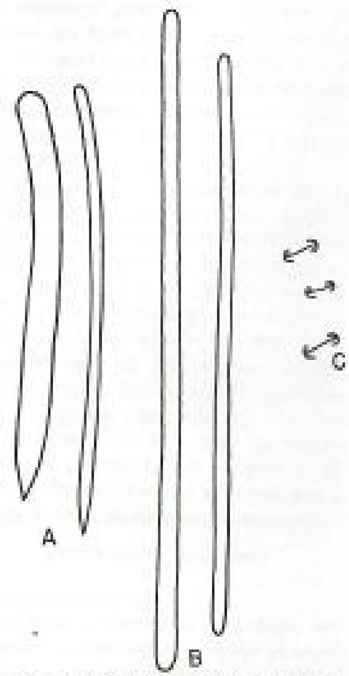


FIG. 12. *Hiattrochota protea*, spicules, from a camera lucida drawing. × 666. A, endosomal styles. B, ectosomal strongyles. C, amphidisc or birotulate microscleres.

like than that of *Iotrochota*. The endosome is microcavernous with a skeleton that approaches the isodictyal condition, very much as in *Tedania*. There are a few vague spicular tracts, about 50 μ in diameter in the type specimen but somewhat more than twice as thick in the second specimen. The latter grew on the beach of the open ocean, whereas the type was in calm water; this probably accounts for the difference.

The ectosomal spicules are smooth strongyles 3 by 140 to 6 by 205 μ in size. The endosomal spicules are smooth styles 7 by 135 to 10 by 180 μ in size. Both sorts are consistently a little larger in the Kaalualu specimen. Both sorts are somewhat thicker, up to 12 μ, in the Honaunau specimen. The microscleres are amphidiscs. Their length is 12 to 13 μ in the type specimen, 15 μ in both others. There are often only four clads at each end in those of the type specimen, usually more clads in the corresponding spicules of the other two specimens. In the type specimen the clads are less strongly recurved. In the Honaunau specimen, as in many hyalospongoid amphidiscs, the shaft is visibly spiny.

The species name is given because this is the first of the genus.

Tedania ignis (Duchassaing and Michelotti) Verrill

Fig. 13

This species is very common throughout the shallow waters of Hawaii including Kaneohe Bay. It is represented by a specimen collected at Moku O Loe from coral, near the pier (location number 6, Fig. 2). This specimen is deposited in the U. S. National Museum, Register Number 22744.

This species is basically encrusting, with the oscules often so elevated that chimneys as tall as 4 to 7 cm. result, yet these chimneys are usually less than 1 cm. in diameter, hollow, and thin-walled. Specimens are sometimes as large as a hand, more often somewhat smaller. The color is bright vermilion where the sponge tissue grew in brilliant illumination, but more orange, even to yellow, in proportion to the amount of shade in which the sponge grew. The consistency is soft and the sponge easily torn or compressed.

The surface is smooth, with abundant, very contractile pores. The oscules are from 2 to 7 mm. in diameter, often raised in the form of tubes. The ectosome is a definite dermis, over subdermal spaces, and is packed with special spicules, not always horizontal but instead in many orientations; some clusters are actually perpendicular to the surface. The endosome is finely cavernous, somewhat "crumb of bread" style, with its spicules in quite confused arrangement.

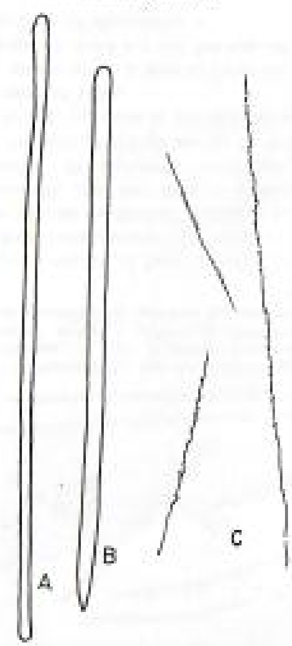


FIG. 13. *Tedania ignis* (?), spicules, from a camera lucida drawing. × 666. A, dermal tornote. B, endosomal style. C, microspined raphides.

The special dermal spicules are usually regarded as tylotes, but the ends are so minutely enlarged that the spicule at first seems to be a strongyle and often really is a strongyle. It is rather that there is a very slight constriction near the end of each spicule than that the end is actually swollen. On each extreme tip of these spicules there are a number of very fine spines. These spicules nearly all range in size between 3 by 180 and 4 by 210 μ. The principal spicules are smooth styles, often curved a little, and range from 6 by 160 to 8 by 210 μ. The abundant microscleres are peculiar microspined raphides, usually less than 1 μ in diameter, but occasionally as thick as 2 μ with total lengths up to at least 200 μ.

Within the genus *Tedania* there are some 45 names, besides others that have been transferred to other genera. Some of the 45 are clearly synonyms, but others arouse serious questioning. There are some well-marked differences. One group of three or four species has two distinct categories of microscleres. On the west coast of North America two species (or is it all one?) have tylostyles instead of styles for principal spicules. Some deep-water species have enormous spicules and distinctive, symmetrical habitus. There remain about 20 species that differ in color and in having spicules a little larger or smaller. Burton (1932: 344) and also Burton and Rao (1932: 353 and following) argue that all these are conspecific and call them all *Tedania nigrescens*, which then would become an amazingly cosmopolitan species. Perhaps some further analysis is in order, and, in particular, color may be quite significant.

The genus *Tedania* was established by Gray (1867: 52) for *Reniera digitata* Schmidt (1862: 75) and *Reniera ambigua* Schmidt (1864: 39). The former was shown to be a synonym of *Reniera nigrescens* Schmidt (1862: 74) and the type is assumed by Burton and others to be called *nigrescens*. This designation was made official by de Laubenfels (1936: 89). Topsent (1939: 5) pointed out, however, that *digitata* and *nigrescens* both fall to the earlier *Halichondria anhelans* Lieberkühn (1859: 522). This species, under various names, is well known from the Mediterranean, where it seems to be the only *Tedania*. It is regularly and consistently described by the various authors as being black or nearly so; some say very dark blue, some say very dark green. I have not found these colors in the field or in the literature from other parts of the world. It may be that the Mediterranean form is well characterized by color. Burton and Rao have implied, but without actual data, that it has similar spiculation to West Indian *Tedania*. On the other hand, published descriptions show that the Mediterranean *Tedania* has the endosomal styles two to seven times as thick as the ectosomal tornotes. I find, in very numerous specimens, no such difference in West Indian *Tedania*, in which the thickness varies from the same to one and one-half times that of the tornotes.

The West Indian form, which I am convinced is specifically distinct from *anhelans*, was first named *Thalysias ignis* by Duchassaing and Michelotti (1864: 83) and transferred to *Tedania* by Verrill (1907: 339). It is regularly brilliant red, almost spectral red, but tending a little toward vermilion. I have examined thousands of specimens, and found extreme uniformity.

Numerous species names for *Tedania* have been established for forms occurring in the East Indian region. These all have spicules thicker than those of *ignis*; they vary from slightly longer to one and one-half times as long. The colors are usually cited as yellow, in a few cases tending toward red.

The allocation of the Hawaiian *Tedania* must be regarded as provisional; I do not feel that its position can be settled at present. If the attitude of Burton and Rao is adopted, it is *Tedania anhelans*, and so are a score of other forms. In color it is like the East Indian species, unlike typical *Tedania ignis*; but in spiculation it is indistinguishable from *ignis*.

Tedania ignis gives a pronounced irritation to most people who touch it (those with very calloused hands are safe). This irritation includes a reddening of the skin, swelling, extreme tenderness to the touch, and lasts 3 to 7 days. I obtained such an irritation from the Hawaiian *Tedania*, and this has influenced me in making my provisional identification.

The correct name of the East Indian species is doubtful too—an additional reason for hesitating to synonymize on the basis of a dubious resemblance. The oldest name that may possibly be available is *Spongia macrodactyla* Lamarck (1814: 458), but its use is beset with difficulties. Its locality is not certainly known; Lamarck himself was not sure, but thought it might be East Indian. Topsent (1933: 13) redescribes Lamarck's material, showing a spiculation like *Tedania*, but he adds that the skeleton is mostly keratose, and his photograph shows a general appearance that might well be that of a keratose sponge. Such forms often contain foreign spicules. If this one had no spiculiferous neighbors except *Tedania*, it might contain only *Tedania* spicules. If the spicules are proper, this is a peculiar *Tedania* because of its large spongin content.

Thiele in 1903 described four species of *Tedania* from the East Indies (Ternate, in the Molucca Sea). These are *reticulata* (p. 946), *coralliophila* (p. 946), *meandrica* (p. 947), and *brevispiculata* (p. 947). The differences in spicule size which Thiele emphasizes are within the range of individual variation and we may be confident that these, all from the one locality, are conspecific, to be known as *Tedania reticulata*. I wish to record at this time, that further studies in the East Indian region may bring about a decision to include the Hawaiian *Tedania* with *reticulata*, rather than with *ignis*. Undoubtedly some authors would designate the Hawaiian form

as a new species and perhaps this may ultimately prove to be necessary.

KANEOHEA new genus

This genus is erected in the family Psammascidae with the following species, *Kaneohea poni*, as genotype. It should be emphasized that this is a genus (like all in the family) with a principal skeleton of foreign material, to which are added strongyles, oxeas, styles, and raphides. The genus which is most similar is *Holopsamma*, which has strongyles and styles but not the oxeas and raphides. Oxeas and raphides are each quite unusual in this family.

The generic name is given in honor of Kaneohe Bay.

Kaneohea poni new species

Fig. 14

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22751. It was collected January 10, 1948, at a depth of 1 meter, growing on dead coral in Kaneohe Bay. Only the one small specimen has so far been found, but it might be sought in the future with some interest.

This specimen is a thin encrustation, about the size and thickness of a shilling or quarter-dollar. The color in life was a brilliant, gaudy purple, one of the most conspicuous color notes one may hope to find. The consistency is mediocre. The surface is smooth, and, as might be expected, the specimen is lipostomous.

There is just the thinnest of fleshy ectosomes, less than 10 μ thick, which is very easily destroyed by handling. The endosome is packed with sand grains that are about 30 to 60 μ in diameter—so small that they would easily be swept about and carried in water currents. In among these grains there is an isodictyal proper skeleton, with some uniserial spicule tracts.

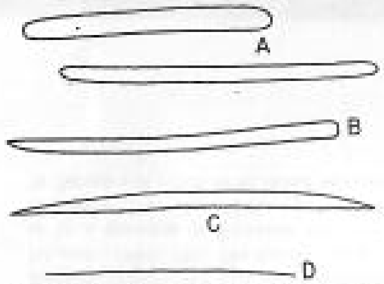


FIG. 14. *Kaneohea poni*, spicules, from a camera lucida drawing, × 666. A, strongyles. B, styles. C, oxea. D, raphide.

The spicules show little or no localization, but all three kinds of megascleres make up the reticulation, well mixed. The strongyles are about 5 by 90 μ, the styles 4 or 5 by 120 μ, the oxeas also 5 by 120 μ. The raphides are about 0.5 by 90 μ.

The species name is derived from the Hawaiian word for purple.

Mycale cecilia de Laubenfels

Fig. 15

This species is very common in Hawaii, widely scattered in shallow water locations. Its greatest abundance, however, seems to be in Honolulu Harbor and in Pearl Harbor. The first specimen that I found in Kaneohe Bay was at Moku O Loe, November 3, 1947; this is deposited in the U. S. National Museum, Register Number 22747. It occurred as a large encrustation on a mangrove shoot at location 2 in Figure 2. By December 22, 1947, the whole sponge had disappeared, although I had carefully left most of it *in situ*, and the location was one that would be most easily kept track of and found again. Nor have I been able to find it in that vicinity since. This may have some connection with a reproductive cycle.

This species is encrusting, often about 0.5 to 1 cm. thick. The above mentioned Moku O Loe specimen covered a mangrove shoot that was some 40 cm. long. The multitude of colors of this species requires further discussion below. The consistency is softly spongy.

The surface is fairly smooth, with many minute, contractile pores. The oscules are about 200 μ in diameter, but they too are difficult to measure because of their contractility and small size at greatest opening.

The ectosome is a definite dermis over extensive subdermal cavities. The endosome is a reticulation of spicular tracts 30 to 120 μ in diameter, often about 65 μ in diameter. Each is packed with spicules, and may possibly, but not certainly, contain spongin. Distally, each ends in a tuft or brush. There are astonishingly few interstitial megascleres.

FIG. 15. *Mycale cecilia*, spicules, from a camera lucida drawing, × 333. A, style. B, sigmas. C, palmate anisochelas.

The megascleres are tylostyles with long rather than wide heads; their sizes are 4 by 250 to 6 by 240 μ. The microscleres include commonplace sigmas 30 to 42 μ in chord length, and palmate anisochelas. These latter are very narrow, so that in boiled-out spicule preparations all lie on their sides. Profile views are thus common but what one may call "face views" are rare and difficult to find. In most specimens these spicules are only 15 μ long, but in some specimens they range to at least 24 μ. I found none in rosettes.

There are close to a hundred species names left in *Mycale*, even after the partitioning of the genus undertaken previously (de Laubenfels, 1936: 118). Only about 25 of these, however, have tylostyles rather than the usual styles as megascleres. The additional factor of very narrow anisochelas reduces the number still further.

Duchassaing and Michelotti (1864: 89) described *Pandaros angulosa*, and de Laubenfels (1936: 116) shows that it is a *Mycale*. This is a common West Indian species, and its spiculation is practically identical with that of the specimens which are now under consideration. It is, however, one of the fairly numerous species of *Mycale* that have the following distinctive characteristics: they are extremely coarse with gross chambers upwards of a centimeter in diameter; the flesh and skeleton are largely restricted to the trabeculate partitions. Upon handling a specimen, there is copious production of colloidal slime. I have observed a head-size specimen literally fill a tub with its exudate within 12 hours. *Mycale angulosa* itself has a pronounced tendency to assume a hollow or vasiform habitus.

In a study of the sponges of Panama, de Laubenfels (1936: 447) reported from the Pacific side, at Panama City, intertidal, the new species *cecilia*. This has a spiculation like that of *angulosa* and like our Hawaiian *Mycale*, but this species is encrusting, fine-grained, with few or no gross cavities even as much as 1 mm. in diameter, and scarcely a bit of colloidal exudate upon handling. But for the spicules, one would not consider *cecilia* and *angulosa* to be even in the same family.

The identification of the *Mycale* from Hawaii is complicated by the peculiar color situation. The Panama specimens of *cecilia* were all green, one of the few colors never shown by the Hawaiian specimens. Furthermore, in July and August, 1933 (when I studied it in the field), it was thickly beset with bright red embryos about 200 μ in diameter. These showed plainly in a specimen held 2 meters away—a bright green but red-speckled and thus curiously conspicuous sponge. In contrast, the Kaneohe specimen above described was a mottled patchwork of pink and lavender. In November, 1947, it was loaded with yellow embryos, 600 μ in diameter, and these did not show at all from the surface, but were all in a layer at the base of the sponge and adjacent to the mangrove tissue upon which it was growing. May not such differences in size and color of embryo and color of adult tissue indicate specific difference? Yet this is further complicated by the finding in October and also in March of yellow to orange colored specimens devoid of embryos.

Just as a surmise, a hypothesis to be checked by later field observation, one may wonder if the young embryos are red, changing to orange and then yellow as they enlarge, and if perhaps the young sponge is yellow, then pale orange, then pink, and at last lavender just when reproducing. It may die after giving off a large number of embryos, at an age between 1 and 2 years. This is not groundless surmise, as it is also partially confirmed by some observations of mine upon related species at Bermuda. The green color found at Panama might well be due to the presence of algal symbionts.

Zygomycale parishii (Bowerbank) Topsent

Fig. 16

This species was first collected from Kaneohe Bay at Moku O Loe, on the shore of the harbor, north of location 6 (Fig. 2) at a depth of 2 meters. This specimen is deposited in the U. S. National Museum, Register Number 22735. It is one of the commonest species at Moku O Loe, but rare or absent elsewhere in Kaneohe Bay. It is extremely abundant as a growth on vessels that remain for a year or so at harbor on the lee side of Oahu, as revealed by study of ship bottoms in the dry-docks at Pearl Harbor.

This is a somewhat ramose sponge; there is an amorphous basal mass from which long processes arise. These processes are extremely irregular in cross section and in long section, too. This is another species of many colors. Probably the commonest is a dull reddish or brownish-purple. Individual specimens are often polychrome, gradually shading into different hues here and there without apparent relationship to ecological factors or anything else. A few specimens are bluish-violet to gray. The first collected was definitely orange. I found no green, yellow, black, white, or any brilliantly colored specimens of this sponge. One might say that the color ranged from dull orange through mahogany-brown to dull lavender. The consistency is spongy. If any considerable quantity is available, say a good handful, one may discover that this species has a definite odor. I have never found a similar fragrance in any other sponge, nor failed to find it in *Zygomycale*—some half a dozen times that a large quantity was at hand. This odor is strongly reminiscent of linseed oil, also faintly suggestive of fresh-cut grass, not like phosgene, but much more like old, oxidizing linseed oil.

The surface of this species is rather smooth but not level, and has a very characteristic speckled or punctiform appearance by which one soon comes to recognize it. This is due to a dermal network of fibers. The latter are minute, only about 5 to 10 μ thick, and the meshes are 65 to 100 μ in size. However, even when the unaided eye cannot resolve the individual pores or fibers, the over-all appearance can be recognized. The oscules are about 2 or 3 mm. in diameter, often provided with thin, raised rims. They are uncommon and rather difficult to find among obviously accidental surface openings.

The ectosome is a definite dermis over extremely widespread, nearly omnipresent subdermal spaces which may be as much as 0.5 mm. high. It contains the special network already mentioned. The endosome contains a coarser, but still rather fine-grained, network of fibers; these fibers are upwards of 50 μ in diameter and contain about 15 spicules per transverse section. At their distal terminations they splay out into dermal brushes or tufts.

The megascleres of *Zygomycale* are of one kind only, a subtylostyle with such a vague neck constriction that it is barely perceptible; therefore they often give a first impression of being styles. The microscleres are extremely diversified. Only the genus *Acarnus* can match this one for diversity of small spicules. There are large palmate anisochelas, 46 to (more usually) 48 μ long, and often grouped in rosettes, small ends together in the center of a spherical arrangement of the larger ends. There are medium-sized palmate anisochelas, 18 to 20 μ long. There are minute palmate isochelas only 10 μ long. There are two sizes of sigmas—the larger, 5 μ in diameter and from 75 to as much as 90 μ in chord length; the smaller, 25 to 30 μ in chord length, and only 1 or 2 μ thick like most sigmas. There are toxas 30 μ long, and, rarely, also raphides barely 10 to 15 μ long. They may be more common than first appears, but often overlooked because of their minute size—they are hardly as much as 1 light-wave in diameter.

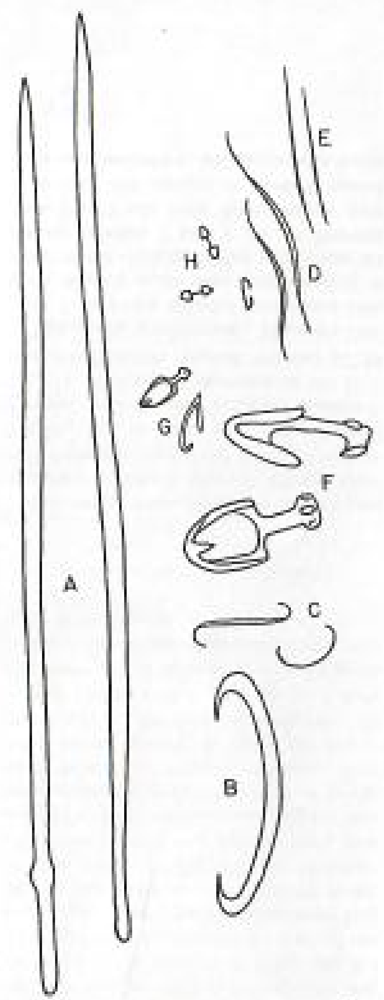


FIG. 16. *Zygomycale parishii*, spicules, from a camera lucida drawing, × 666. A, styles. B, larger sigma. C, smaller sigmas. D, toxas. E, raphides. F, larger palmate anisochelas. G, smaller palmate anisochelas. H, palmate isochelas.

The genus *Zygomycale* was established by Topsent (1930: 431). The genotype is here designated as the sponge which was first described as *Raphiodesma parishii* by Bowerbank (1875: 283), the name here selected with some misgivings for the Hawaiian *Zygomycale*. Topsent transferred three other species names to his new genus, but two additional ones still require such transfer. They are the species first described as *Esperella ridleyi* by Lendenfeld (1888: 211) and that described as *Esperella crassissima* by Dendy (1905: 160). The original description of *parishii* by Bowerbank is utterly inadequate, and its use here rests entirely upon this circumstance. Burton and Rao (1932: 328) state that it is their opinion that *parishii* and several others now in *Zygomycale* are all conspecific. It is probable that Bowerbank's specimen of *parishii* is in the British Museum; therefore it is probable that Dr. Burton examined it. It is further probable that he really did find it to be conspecific with the others because of his treatment thereof, above mentioned. If so, *Zygomycale* is monospecific. All the records have been from the eastern part of the Indian Ocean, the East Indies, and Australia; therefore the possibility of conspecificity is great. Thus there may be a link between the East Indian fauna and that of Hawaii, evidenced by the occurrence here of *Zygomycale parishii*.

Hymeniacidon chloris new species

Fig. 17

The holotype of this species is here designated as spirit-preserved specimen, U. S. National Museum, Register Number 22738. It was collected September 11, 1947, at Moku O Loe, from a depth of 1 meter (location number 1, Fig. 2). It is fairly common at that one locality but has not been found anywhere else as yet.

This species forms masses ranging from the size of a hen's egg to that of a small fist. Numerous tapering projections 1 to 2 cm. high and 6 to 14 mm. thick occur. The color is a medium dark green; the consistency is soft, somewhat spongy, but also rather fragile.

The surface is minutely tuberculate. The oscules are 1 to 2 mm. in diameter, usually at the summit of one of the above-described processes, and are readily closed by the sponge within less than 5 minutes after removal from the water. The pores are even more rapidly closed. They are often in groups of 8 to 12, separated by only very thin strands; these groups are about 200 μ in total diameter.

The ectosome is fleshy, contractile, a true dermis, perhaps 15 μ thick. The endosome is rather dense, and is packed with spicules. The latter are sometimes loosely organized into strands; more have their points toward

FIG. 17. *Hymeniacidon chloris*, spicules (styles), from a camera lucida drawing, × 296.

the surface than any other orientation, but many are strewn in confusion.

The spicules are exclusively styles, chiefly 5 by 300 to 7 by 400 μ in size. A few that are much smaller may be immature.

One hesitates to erect a new species in a genus that, like this one, has fifty names in it already, especially since these are all so much alike in description. On the other hand, this genus has only a few of those traits to which we look for specific separation; were we to consider others, such as chemical composition, serological reaction, and physiological processes, we might find that there really are more diverse species within it than are now suspected. The emphasis is here laid on the green color. Bowerbank (1874: 191) established the name *Hymeniacidon plumiger* for two British specimens that he said were green in preservative; what they were in life is unknown. He may have overlooked microscleres; therefore we are not sure that these specimens were even of the genus *Hymeniacidon*. Their styles were only 4 by 234 μ. Since Bowerbank's report, no one seems to have found any further specimens to match his description; therefore *plumiger* is not an important species name, and, except for this dubious record, the color is unique in the group. Except for the color, *chloris* is much like *Hymeniacidon heliophila*, which is abundant on the Atlantic coast of North America. It must be realized that green color may be due to contained algal symbionts; even so, that a species should specialize in symbiosis may be a valid criterion.

It appears that there are the following valid species of *Hymeniacidon* in the world: a yellow one, *caruncula*, in the Mediterranean and north to England; a deep red one, *sanguinea*, from England on north (some experts would synonymize these, but I found them both at Plymouth, England, and definitely decided they were not conspecific); an orange species, *heliophila*, from the Arctic to the West Indies in the West Atlantic; a yellow species, *sinapeum*, which is practically undistinguishable from *caruncula*, on the west coast of North America; in the same locality also occurs *ungodon* with a peculiar mahogany-colored ectosome. In the West Indies *amphilecta* has a curious brown color and corky consistency. Five species names occur in the Indian Ocean and East Indies; all have extremely thick spicules (20 to 40 μ) and may all be conspecific. A yellow species, *fernandezi*, from both coasts of South America, is also close to *caruncula*, but *pauciespiculus* from Argentina is not certainly of this genus; it is a fan with few spicules and those are of two size ranges. Three species names have been used in this group for New Zealand forms; all three are much alike and may be conspecific; minute differences separate them from *caruncula*. Four Antarctic species each have some distinctive peculiarity, such as centrostyle spicules, or verrucose surface. Many other named species are unrecognizable or are already known to fall in synonymy. Assuming *chloris* to be a good species, I opine that there are 14 valid species in the genus.

The species name *chloris* refers to the green color of this sponge.

Terpios zeteki (de Laubenfels)

Fig. 18

This species is one of the two or three most abundant sponges in Hawaii. My first specimen from this region was collected September 10, 1947, at Moku O Loe at a depth of 1 meter, near the pier (location number 6, Fig. 2). This one is deposited in the U. S. National Museum, Register Number 22739.

This species is sub-ramose. There is a basal mass from which rounded projections arise, often scarcely more than hemispherical, at other places digitate. These projections are usually between 1 and 2 cm. in diameter, from 0 to 5 cm. long. Some masses reach head size. The interior of *zeteki* is consistently an ochre-yellow, but the exterior is contrastingly colored. In the type of the genus, *fugax*, the yellow shows over more or less of the surface, the rest being a dark prussian blue. In *zeteki* the yellow never shows and the whole exterior is of one uniform color. This color in nearly 50 per cent of all specimens is a turquoise or robin's-egg blue, in as many other specimens it is rosy-red. This was the color of the above-mentioned U. S. National Museum specimen. After a long search, out of scores of specimens, I began finding an occasional one that was violet—clearly a hybrid of the other two colors. I never found a parti-colored colony but always the entire sponge of the same hue. The consistency is spongy.

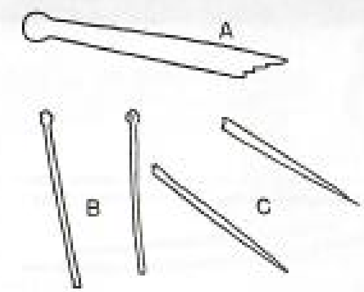


FIG. 18. *Terpios zeteki*, spicules, from a camera lucida drawing, × 666. A, the head of one of the common spicules, which are tylostyles. The pointed end, not shown, is commonplace. B, heads of some smaller (juvenile?) tylostyles, which show the hexactinellid pattern. C, pointed ends of the spicules shown at "B"; the mid-regions of them are not shown.

The surface of *Terpios zeteki* is tuberculate, almost like the skin condition called "goose pimples." The elevations are less than 1 mm. high and about 3 or 4 mm. apart. The pores are extremely contractile, and so are the oscules, but in life the latter certainly open to as much as 2 mm. in diameter. Their closure is by a sphinctrate contraction involving rather typical muscle cells instead of by the pulling of a membrane across the opening as in some sponges. This muscular closing is quite typical, however, of the order Hadromerina, in which this genus belongs.

The ectosome of this species is very thin, not the usual thick cortex of this order; in fact, it is usually less than 50 μ thick, and chiefly organic. The endosome is so densely organic as to resemble cheese; the gross chambers carry out the similarity. There is no segregation of spicule sorts nor any conspicuous tracts. Most of the spicules are in confusion but more have their points toward the surface than with any other one orientation. There are vague ascending tracts, and these end in relatively large, very definite dermal tufts or brushes; in these tufts the spicules bristle, all the points being directed toward the surface or slightly divergent.

The spicules are exclusively tylostyles, of great variation in size. Many are about 4 by 300 μ, but 14 by 700 may be expected; many are only 2 (or less) by 200 μ. An interesting shape is often found in the slender, unfinished spicules of this species, especially if the whole colony be small and evidently young. In such spicules it can be seen that the head is not just one single swelling, but is due to the existence of four short arms at right angles to each other and to the rhabd or shaft. Such a spicule could be called an orthotetraene; in the Hyalospongiae it is called a pentact. These four arms in *Terpios* do not continue to grow; they stop when only about 1 μ long and are then buried by successive layers of the opaline silica. When the mass of the head reaches a diameter of about 4 or 5 μ, the arms are so thoroughly covered that they can no longer be observed. The genus *Terpios* was based upon the occurrence of these pentactinal spicules; the larger, older specimens were put in a later genus *Laxosuberites*. In a manuscript on the sponge fauna of Bermuda I show the synonymy of the two, and review the genus *Terpios*; that manuscript may be published before this one.

The present species was first described as *Laxosuberites zeteki* by de Laubenfels (1936:

450) from the vicinity of the Panama Canal, especially the Pacific end. The amazing color situation was evident there, half of all the specimens being red, the remaining ones blue-green. In Panama I found no intermediates. Dickinson (1943: 37) records the species from the Pacific coast of Mexico. This species and *Mycale cecilia* afford links between the Hawaiian fauna and that of the tropical Americas.

Cliona vastifica Hancock

Fig. 19

This species was first studied in Hawaii on September 27, 1947, in Waialua Bay (northwest of Kaneohe Bay), at a depth of about 3 meters. This specimen is deposited in the U. S. National Museum, Register Number 22743. The species is common throughout the shallow waters of Hawaii, but is always inconspicuous. If one breaks up almost any long-submerged calcareous material, such as shells or dead coral, one will find this boring sponge. It is very common throughout Kaneohe Bay.

Cliona vastifica excavates galleries in calcium carbonate. These are roughly circular in cross section and about 1 mm. in diameter. Each gallery meanders rather than extends in a straight line, and may reach a total length of 5 to 10 cm. Old coral may be so riddled by *Cliona* that it crumbles as one handles it, but this is not common experience in Kaneohe Bay, where usually a crowbar or hammer is required to break up the coral. The sponge is orange in color, and of mediocre consistency. The pores and oscules are minute, and are located at the small inconspicuous openings to the galleries (1 mm. in diameter). Obviously one can say little about ectosome as compared to endosome as long as the sponge lives thus buried. *Cliona* specimens may grow out of their burrows into plain view, but I have not yet found any such in Hawaii. The principal skeleton of *Cliona vastifica* consists of tylostyles 4 by 300 to 7 by 240 μ in size. Fairly numerous microspined oxeas, 4 by 85 to 5 by 75 μ, are also present. There are distinctive microscleres, heavily microspined and probably to be regarded as microstrongyles, but the ends are cut off so sharply that they are more like little cylinders. Some are as small as 2 by 8 μ, others as large as 3 by 18 μ, with 10 μ as a common length.

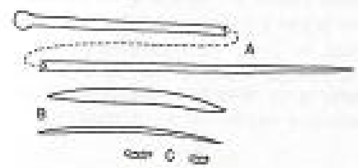


FIG. 19. *Cliona vastifica*, spicules, from a camera lucida drawing, × 444. A, tylostyles. B, oxeas. C, microacanthostrongyles.

This species was first described by Hancock (1849: 342) from Great Britain. It is an abundant species throughout the Old World, but quite uncommon (although present) in the New World. In the Americas the boring sponges are nearly always *Cliona celata*; this species is also common in the Old World, but from Norway, to Turkey, to Ceylon, to New Zealand, *vastifica* is a close rival to *celata*. Is *vastifica* perhaps a recent immigrant to North America, carried by barnacles on ship bottoms? Did it reach Hawaii in that same way too?

Tethya diploderma Schmidt

Fig. 20

This species is very common throughout the shallow waters of Hawaii, including Kaneohe Bay. It is represented by some specimens collected November 22, 1947, at Moku O Loe, at a depth of 1 meter, in the long lagoon (location number 3, Fig. 2). These are deposited in the U. S. National Museum, Register Number 22751.

This species is nearly spherical in shape and may become as large as a hen's egg; more

often it is about half this size. The interior is regularly ochre-yellow. The exterior is extremely pale, almost white for specimens that grow in the shade, but a mahogany-brown for specimens which grow in relatively bright illumination. This was true of most of the Moku O Loe specimens. Among the brown tethyas, however, were a few that in life appeared black. In alcohol these promptly bleached to about the brown color that the others had in life, but the brown ones in alcohol bleached very pale indeed. The black specimens had identical spiculation, and in all respects, save for color, appeared to be identical with the brown ones. No difference in their ecological placement could be found to account for the difference in hue. The hypothesis here favored is that the black ones had a symbiont of some sort in or on their dermis, which symbiont was lacking from the brown tethyas. The consistency of this sponge is cartilagineus.

The surface of *Tethya* changes with the reproductive cycle, but is always more or less verrucose. The protrusions are at the distal terminations of spicular fascicles, and are about 2 mm. in diameter. Their height varies during the reproductive cycle from nearly 0 to more than 3 mm. so that they may actually depart from the parent as slowly motile buds. The pores and oscules are very contractile but the latter may open to as much as 2 mm. in diameter. There is seldom more than one oscule per sponge, and it is usually apical.

Schmidt's name *diploderma* is well deserved by the remarkable ectosome of this sponge. The outer cortex is about 650 μ thick, and may contain symbionts, reproductive tissue, and protective tissue including microscleres. The inner cortex is about as thick or a little thicker, is pale, full of strong smooth muscle tissue, and very contractile. Not only may the pores and oscules be closed promptly, but the whole sponge seems to grow smaller when these muscle fibers contract.

The endosome is rather dense, and is permeated by radiating columns or tracts of megascleres; each tract is about 200 μ in diameter. There is one column for each dermal protrusion.

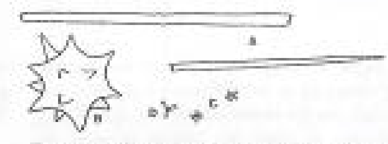


FIG. 20. *Tethya diploderma*, spicules, from a camera lucida drawing, × 333. A, style or fusiform strongyle. B, spheraster. C, small tylasters, common shape. D, euaster, less common shape.

The megascleres are inequiended, fusiform strongyles. The small end is usually pointed toward the surface of the sponge and is so small that the spicule almost becomes a style. Indeed, some actually appear to be genuine styles. They range in size from 8 by 500 μ up to at least 20 by 1500 and 25 by 1250 μ. There are two sorts of microscleres. First, there are large spherasters, 25 to 75 μ in diameter, more often near the larger size. These are chiefly localized just under the cortex. Second, there are myriads of small tylasters with microspined rays. The total diameter of the asters is only 5 to 11 μ. They are abundant both in the outer cortex and throughout the endosome.

This species was first described by Schmidt (1870: 52) from the West Indies, but has since been shown, especially by Burton (1924: 1039), to be practically cosmopolitan. A very interesting article by Edmondson (1946: 271 and following) discusses the asexual reproduction of this species as it occurs in Hawaii, but uses the name *Donatia deformis*. The name *Donatia* is a later synonym for *Tethya* but was used for a while on the unwarranted assumption that the still earlier name *Tethys* (for a mollusk) preoccupied Lamarck's (1814: 69) establishment of *Tethya*. The two names are, of course, quite different. The species *deformis* is much like *diploderma* but less elaborate as to dermis, and its microsters each have a centrum. It is a western Pacific species, from Japan through the East Indies to New Zealand. The species *diploderma* is circum-equatorial. If the two should be determined to be conspecific, as is possible, the name *diploderma* has a 28-year priority.

ZAPLETHEA new genus

This genus is erected with the following species, *Zaplethea digonoxea*, as genotype. It is placed provisionally in the family Halinidae, subfamily Corticiinae. It should be emphasized that this is a genus of sponges with extremely abundant microscleres, but very few megascleres, those that are present being oxeas. The microscleres are of two sorts, euasters and twice-bent microxeas.

Twice-bent spicules are exceedingly rare in the phylum Porifera. There is at least one other case, however. This is the record by de Laubenfels (1930: 26; or better, 1932: 35) of *Penares cortius*, a sponge with two kinds of microscleres: euasters and twice-bent microstrongyles. It had a few oxeate megascleres, so that if the twice-bent spicules were oxeate, there would be agreement to this extent. However *Penares* has a principal spiculation of large tetraxons; thus it goes in the order Choristida. *Penares cortius*, from California, was a large sponge with a conspicuous leathery dermis, very different in appearance from *Zaplethea digonoxea*.

In the order Choristida there is a family Jaspidae. Its type genus, *Jaspis*, has a spiculation of oxeas and euasters, but no twice-bent microscleres; the oxeas are the principal spicules, and are radiately arranged. These are large, significant differences from *Zaplethea*.

The order Carnosa is established especially to receive sponges that have few or no megascleres, and has even been called "Microsclerophora." Thus it seems clearly to be the best order to receive the genus *Zaplethea*. Yet the family situation in this order is still perplexing; there are now four families in the Carnosa, and none quite fits *Zaplethea*. The Chondrosiidae have no spicules at all. The Chondrillidae have only euasters.

The Plakinastrellidae have a few megascleres, as no others in the order do, and thus are intermediate. But the megascleres that are present are tetraxons, so that the intermediate condition obtains as between the Carnosa and the Choristida. For lack of tetraxons, *Zaplethea* seems utterly out of place in the Plakinastrellidae.

The fourth family is the Halinidae, here selected by elimination. Yet all the genera of this family (there are about a dozen) have a peculiar microsclere known as calthrops. Other than this, these genera are divided into two subfamilies; the Halininae have asters that are streptasters, while the Corticiinae have asters that are euasters.

If we focus attention on the above-mentioned fact that every other genus in this family has calthrops, and regard this as a reason for excluding *Zaplethea*, we are thrown into the embarrassing situation of needing a new family to receive this genus. I do not want to erect any more families in the Porifera, because I believe there is a large enough number already.

The genus name is derived from the Greek "zaplethes," meaning very full, because the sponge is so packed with spicules. The exact Greek is not available, having been used in 1868 in Hymenoptera, also in 1920 in Pisces.

Zaplethea digonoxea new species

Fig. 21

The holotype of this species is designated as spirit-preserved specimen, U. S. National Museum, Register Number 22746. It was collected September 27, 1947, in Waialua Bay, at a depth of between 4 and 8 meters, growing on dead coral. A second specimen was collected in Kaneohe Bay on January 10, 1948, at a depth of 2 meters, also on dead coral.

This species is encrusting, about 3 to 5 mm. thick. The color is pale, dull, and may be termed drab, or yellowish-gray. The consistency is firm, somewhat like cartilage. The surface is smooth and lipostomous. There is no sharply defined cortical region. The interior is exceedingly dense, with few cavities larger than 40 μ in diameter. The flagellar chambers are about 25 μ in diameter.

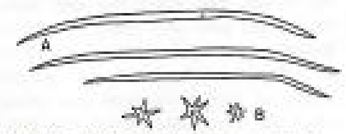


FIG. 21. *Zaplethea digonoxea*, spicules, from a camera lucida drawing, × 444. A, microxeas. B, euasters. The larger oxeas are not shown.

There are a few scattered oxeas, 7 by 400 to 12 by 520 μ in size. They are so rare that while I had only the one specimen I considered them accidental, foreign inclusions. But they were not only present in the second specimen, they were a little more nearly common in it. The whole sponge is densely packed with millions of microscleres. They are of two sorts, about equally abundant. One kind is an oxyeuaster, usually 10 μ, but ranging on up to 20 μ, in diameter. The other very distinctive kind is a twice-bent microxea. The three straight regions make obtuse angles and are not quite equal in length; instead the middle piece is a little longer than the others. The over-all length is about 105 μ and the thickness 3 μ or less.

The species name stresses the twice-bent microxea; in fact, this novel sort of spicule itself may suitably be named digonoxea.

Plakortis simplex Schulze

Fig. 22

This species was found in Hawaii on January 10, 1948, in Kaneohe Bay, at a depth of about 2 meters, growing on dead coral. Another specimen was found on May 15, 1948, at Keaukaha near Hilo on the island of Hawaii, just below low tide mark.

This is a thin, encrusting sponge, seldom much more than 2 mm. thick. The two specimens covered about 10 square cm. each. The first was dull olive-brown, the second dull gray—this species is usually brown, but dull or drab. The consistency is rather like that of cheese.

The surface is smooth but not level, being often elevated into low tubercles. As usual in such thin sponges, it is lipostomous. There is a paper-thin fleshy dermis; the rest of the sponge is also very dense. It is astonishingly full of flagellate chambers which are round and are 30 to 40 μ in diameter. The spicules are crowded throughout the flesh in confusion. Much of the skeleton is merely the usual interstitial jelly.

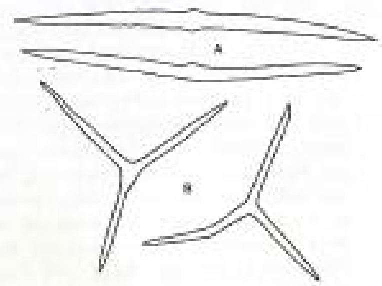


FIG. 22. *Plakortis simplex*, spicules, from a camera lucida drawing, × 380. A, oxeas (?). B, triaxons.

The spicules of *Plakortis* are chiefly to be regarded as triacts, and about one in twenty is indeed a neat, symmetrical triact as in calcareous sponges. The rays are often about 5 to 7 by 100 μ. More common are spicules that show signs of being a triact with one ray missing, so that the result is V-shaped. Very much the commonest of all are spicules that seem at a casual glance to be oxeas, but which have a central swelling or series of kinks, so that they are probably triacts with one ray lost and the other two brought into nearly the same line.

This species was first discovered by Schulze in the Mediterranean (1880: 450). Someone (Dendy, I believe) found it again in an East Indian collection. I have found it in the West Indies (Tortugas) and in Bermuda, and now in two places here. It is probable that it is not so rare as it is simply overlooked because of being dull, drab, and thin; one might say it is camouflaged on the rocks that it normally inhabits.

Leucetta solida (Schmidt) Dendy and Row

Fig. 23

In Kaneohe Bay in particular, and throughout the Hawaiian Archipelago in general, small fragmentary calcareous sponges are very commonly found, usually growing on dead coral in shallow water, but also down to at least 50 meters depth (in my experience). These fragments are chiefly of a species that is clearly a *Leucetta*. A few calcareous sponges that are of other genera have been found in the Archipelago, but not yet in Kaneohe Bay.

The genus *Leucetta* is outstanding in the class Calcispongiae for its morphological resemblance to those sponges that are typical of the class Demospongiae. Most calcareous sponges have symmetrical, cylindrical shapes, with large central cloacal hollows, so that they are somewhat like the sponges of the class Hyalospongiae. It is common to find *Leucetta* species that are taken for Demospongiae until the acid test is applied to the (calcareous) spicules.

The genus *Leucetta* is cosmopolitan, especially common in the Antarctic and also in equatorial waters around the world. Some 18 species are commonly recognized. Of these, a few are unique; a new genus may indeed be needed for *Leucetta trigona*. Many others are separated by very small differences and may eventually prove to be conspecific.

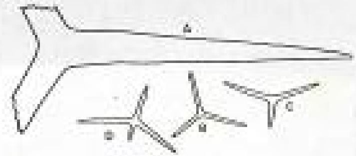


FIG. 23. *Leucetta solida* (?), spicules, from a camera lucida drawing, × 333. A, portion of one of the larger triaxons. B, common triaxons of smaller size. C, slate triaxon. D, tetraxon.

I do not yet have material adequate for a proper evaluation of the Hawaiian *Leucetta*, unless it be a specific characteristic that it should always seem to be just a fragment of a sponge. These specimens are usually amorphous, about as large as beans, white, fragile, and full of triaxon spicules of two size ranges. These traits are true of practically all species in the genus. The larger spicules have rays 100 to 120 μ thick and 660 to 960 μ long and thus are visible to the unaided eye. The smaller ones have rays 6 to 10 μ thick and 70 to 110 μ long. A few intermediates are probably developmental forms of the larger size range. I found one lone tetraxon, of the smaller size range. This may have been an accidental malformation, or an accidental (foreign) inclusion. Again, one must note that many calcispongias have such spicules in the lining of a cloaca, but not elsewhere. I have not yet found a cloaca in a specimen which is for certain one that occurs in Kaneohe Bay; however, it may be that a cloaca is part of this sponge's full complement of traits, and will be discovered later. On March 29, 1948, I found a calcisponge on the bottom of a barge in dry dock at Pearl Harbor. It had a cloaca lined with small tetraxons. It may or may not be the *Leucetta* that is locally widespread; more study is required.

Of all the species names available in the genus *Leucetta*, the oldest is *solida*. Schmidt (1862: 18) described *Grantia solida* from the Mediterranean. Dendy and Row (1913: 734) correctly transferred this to *Leucetta*. Schmidt's description is so generalized that many other *Leucetta* species could be put with it, and thus our Hawaiian *Leucetta* may be tentatively identified. It is here left an open question whether or not several later species names should be dropped in synonymy to *solida*.

Needless to say, this Hawaiian calcisponge does not help in determining faunal relationships to others parts of the world.

REFERENCES

BOWERBANK, J. S. 1874. *A monograph of the British Spongiadae.* Vol. III. 360 pp. Ray Society, London.

——— 1875. Contributions to a general history of the Spongiadae. Part VII. *Zool. Soc. London, Proc. 1875:* 281–296.

BRØNDSTED, H. V. 1932. Marine Spongia. In: *Zoology of the Faroes.* [1–34; from reprint.] Copenhagen.

BURTON, M. 1924. A revision of the sponge family Donatiidae. *Zool. Soc. London, Proc. 1924:* 1033–1045.

——— 1926. Descriptions of South African sponges collected in the South African Marine Survey. *Union So. Africa Fish and Marine Biol. Survey.* Rept. 4 (1925): 1–29.

——— 1932. Sponges. *Cambridge Univ., Discovery Reports* 6: 237–392.

——— 1934. Sponges. *Great Barrier Reef Expedition 1928–29, Scientific Reports* [Brit. Mus. (Nat. Hist.)] 4(14): 513–621, 2 pls.

——— 1937. The littoral fauna of Krusadai Island. *Madras Govt. Mus., Bul.* 1(2) (4): 1–58.

——— and H. SRINIVASA RAO. 1932. Reports on the shallow-water marine sponges in the collection of the Indian Museum. *Indian Mus., Rec.* 34(3): 299–356.

DE LAUBENFELS, M. W. 1930. The sponges of California. *Stanford Univ. Bul.* V, 5(98): 24–29.

——— 1932. The marine and fresh-water sponges of California. *U. S. Natl. Mus., Proc.* 81(4): 1–40.

——— 1935. A collection of sponges from Puerto Galera, Mindoro, Philippine Islands. *Philippine Jour. Sci.* 56(3): 327–336.

——— 1936. A comparison of the shallow-water sponges near the Pacific end of the Panama Canal with those at the Caribbean end. *U. S. Natl. Mus., Proc.* 83(2993): 441–464.

——— 1936. *A discussion of the sponge fauna of the Dry Tortugas in particular, and the West Indies in general, with material for a revision of the families and orders of the Porifera.* Carnegie Inst. Wash., Pub. 467: 1–225.

——— 1948. *The order Keratosa of the phylum Porifera—a monographic study.* Allan Hancock Foundation Publ., Occas. Paper 3: 1–217.

DENDY, A. 1905. *Report on the sponges collected by Professor Herdman, at Ceylon, in 1902.* Suppl. 18, pp. 57–246 in vol. 3 of W. A. Herdman's Report on the Pearl Oyster Fisheries of the Gulf of Manaar. Royal Society, London.

——— and R. W. H. ROW. 1913. The classification and phylogeny of the calcareous sponges. . . . *Zool. Soc. London, Proc. 1913:* 704–813.

DICKINSON, M. G. 1945. Sponges of the Gulf of California. *Allan Hancock Pac. Exped.* 2(1): 1–55.

DUCHASSAING, DE FONBRESSIN, P. and G. MICHELOTTI. 1864. Spongiaires de la mer caraïbe. Mémoire publié par la Societé hollandaise des sciences à Harlem. *Natuurk Verh. Mij. Haarlem* 21: 1–124.

EDMONDSON, C. H. 1946. *Reproduction in Donatia deformis (Thiele).* Bernice P. Bishop Mus., Occas. Papers 18(18): 271–282.

GEORGE, W. C., and H. V. WILSON. 1919. *Sponges of Beaufort (N. C.) Harbour and vicinity.* U. S. Bur. Fisheries, Bul. 36: 129–179.

GRAY, J. E. 1867. Notes on the arrangement of sponges, with the description of some new genera. *Zool. Soc. London, Proc. 1867:* 492–558.

HANCOCK, A. 1849. On the excavating powers of certain sponges belonging to the genus *Cliona*; with descriptions of several new species, and an allied generic form. *Ann. and Mag. Nat. Hist.* II, 3: 321–348.

LAMARCK, J. B. P. DE MONET. 1814*a*. Sur les Polypiers empâtés. *Paris Mus. d'Hist. Nat., Ann.* 20: 370–386, 432–458.

——— 1814*b*. Suite des Polypiers empâtés. *Paris Mus. d'Hist. Nat., Mem.* 1: 69–80.

LENDENFELD, R. VON. 1887. Die Chalineen des australischen Gebietes. *Zool. Jahrb.* 2: 723–828.

——— 1888. *Descriptive catalogue of the sponges in the Australian Museum, Sydney.* 260 pp. Australian Museum, London.

——— 1889. *A monograph of the horny sponges.* 936 pp. Trübner & Co., London.

LIEBERKÜHN, N. 1859. Neue Beiträge zur Anatomie der Spongien. *Arch. f. Anat. u. Physiol.* 1859: 353–382, 515–529.

LINDGREN, N. G. 1897. Beitrag zur Kenntniss der Spongien-Fauna des Malaiischen Archipels und der Chinesischen Meere. *Zool. Anz.* 20: 480–487.

RIDLEY, S. O. 1884. Notes on sponges, with description of a new species. *Ann. and Mag. Nat. Hist.* V, 14: 183–187.

SCHMIDT, O. 1862. *Die Spongien des adriatischen Meeres.* 88 pp. Wilhelm Engleman, Leipzig.

——— 1864. *Supplement der Spongien des adriatischen Meeres.* 48 pp. Wilhelm Engleman, Leipzig.

——— 1870. *Grundzüge einer Spongien-Fauna des atlantischen Gebietes.* 88 pp. Wilhelm Engleman, Leipzig.

SCHULTZE, F. E. 1880. Untersuchungen über den Bau und die Entwicklung der Spongien. IX: Die Plakiniden. *Ztschr. f. Wiss. Zool.* 34: 407–451.

THIELE, J. 1903. Kieselschwamme von Ternate. *Senckenb. Naturf. Gesell., Abhandl.* 25: 933–968.

TOPSENT, E. 1892. Diagnoses d'éponges nouvelles de la Mediterranée et plus particulièrement de Banyuls. *Arch. de Zool. Expt. et Gén.* 10(1893): Notes et revue xvii–xxviii.

——— 1896. Matériaux pour servir à l'étude de la faune des spongiaires de France. *Soc. Zool. de France, Mém.* 9: 113–133.

——— 1905. Étude sur les Dendroceratida. *Arch. de Zool. Expt. et Gén.* 4(3): clxxi–cxcii.

——— 1930. *Chondrocladia yatsui* n. sp. de la baie de Sagami. *Annot. Zool. Jap.* 12(2): 421–432.

——— 1933. Éponges de Lamarck, conservées au Muséum de Paris. *Paris Mus. d'Hist. Nat., Arch.* 10(6): 1–60.

——— 1939. Interprétation des Myxilla d'O. Schmidt. *L'Inst. Océanog.* [Monaco]. *Bul.* 762: 1–8.

WILSON, H. V. 1925. Siliceous and horny sponges collected by the U. S. Fisheries Steamer Albatross during the Philippine Expedition, 1907–10. *U. S. Natl. Mus. Bul.* 100. 2(4): 273–506.

Chromosome Numbers of Some Species of *Passiflora* Occurring in Hawaii[1]

W. B. STOREY[2]

INTRODUCTION

PASSIFLORA IS A GENUS of approximately 400 species of plants, mostly woody or herbaceous vines. About 360 species are native to tropical and subtropical North and South America and adjacent islands. The remainder are indigenous to southeastern Asia, a number of south Pacific islands, and Madagascar (Killip, 1938: 9). Man has been instrumental in disseminating many of the species with edible fruits or with highly colored, attractive flowers, and representatives of the genus are now to be found in most tropical lands throughout the world.

Several species of *Passiflora* have been introduced into the Hawaiian Islands for cultivation for their edible fruits (Pope, 1935). Additional species have been introduced for growing as garden ornamentals. A number of species, both edible and ornamental, have escaped from cultivation and are now to be found in a naturalized wild state along waysides, on waste lands, and in lower forest regions (Pope, 1929: 149). A total of 22 species has recently been reported as occurring in Hawaii (Neal, 1948: 522–525).

A number of edible species, of which *P. edulis* is the most important, are cultivated as commercial crops in Australia, New Zealand, and South Africa, where extensive use is made of the fruit. Their culture is practiced to a lesser degree in various other tropical countries, and in Florida, California, and Hawaii. Numerous ornamental species and species-hybrids constitute an important item in the plant nursery business in the United States and elsewhere.

Nurserymen have enjoyed some success in producing interspecific hybrid varieties for the floricultural trade. Fruit breeders, on the other hand, have had little or no success in attempts to improve upon existing edible types through interspecific hybridization, largely because of hybrid sterility.

Cytological studies of plants often serve as a useful adjunct to plant breeding problems. Chromosome numbers and chromosome behavior frequently indicate origins of species and relationships between species, and provide clues as to which species are most likely to be compatible upon crossing. Despite the amount of breeding which has been done among species of *Passiflora*, in Hawaii and elsewhere, the genus is but poorly understood from the standpoint of cytology. The recently published *Chromosome Atlas of Cultivated Plants* lists the chromosome numbers of only seven species (Darlington and Janaki Ammal, 1945: 114).

This paper deals principally with reporting the chromosome numbers of additional species of *Passiflora* as well as of a number of botanical varieties and forms, interspecific hybrids, and an intraspecific chromosomal race. Notes on cytological behavior have been added where they might be helpful in clarifying origins or relationships.

MATERIALS AND METHODS

Chromosome numbers were determined for all species of *Passiflora* of which material for study could be obtained in Hawaii. Counts were made from root tips of seedling plants

[1] Published with the approval of the Director of the University of Hawaii Agricultural Experiment Station as Technical Paper No. 180.

[2] Department of Horticulture, University of Hawaii Agricultural Experiment Station. Manuscript received May 24, 1949.

STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES

Florida Marine Research Institute
Division of Marine Resources
100 Eighth Avenue S.E. • St. Petersburg, Florida 33701-5095
Phone: (813) 896-8626 • Suncom: 523-1011 • FAX: (813) 823-0166

4/13/90

Dear George:

Thanks for sending these for me to see. I am waiting for my order to arrive, and I'll let you know when we get back how they worked out.

Enclosed are some taxonomic notes on Chondrosia + Chondrilla. Their close relationship does not seem to be disputed, but rather their placement within the Tetractinomorpha. I'm anxious to hear more about the hawksbill you got, and would be glad to see a sample.

We are departing for Panama on ~20 May and returning 30 June. We have Big Plans this year...

Thanks, again, for the t-tags.

Regards,

Anne

Tom Gardner, Executive Director

Administration Beaches and Shores Law Enforcement Marine Resources Recreation and Parks Resource Management State Lands

Bob Martinez, Governor • Jim Smith, Secretary of State • Bob Butterworth, Attorney General • Gerald Lewis, State Comptroller • Tom Gallagher, State Treasurer • Doyle Conner, Commissioner of Agriculture • Betty Castor, Commissioner of Education

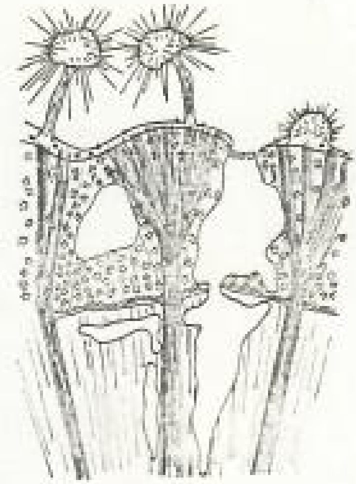


Fig. 5.14 Section of *Tethya* at right angles to the surface. The strong tissue cortex is reinforced by cortical megascleres in brushes, and dispersed microscleres (spherasters). The radiating tracts of endosmal megascleres grade into the cortical brushes. *Tethya* produces stalked surface buds as one means of asexual reproduction. (Redrawn from Brien 1973.)

Family **Tethyidae** Gray

Massive, usually spherical Hadromerida with a perfect radial megasclere skeleton and a marked cortical region (Fig. 1.7*d*, *e*, p. 44). Megascleres are never tylostyles, but are a special type of subtylostyle known as a strongyloxea. This is a spicule in which the two ends are different, usually rounded at the broad end and tapering to a point distally. Both ends are more asymmetric than those of typical styles and the spicule diameter is frequently increased or decreased in abrupt steps. Microscleres, where present, are spherasters and micrasters.

Tethya (Pls. 6*a*, 10*a*; Figs. 1.7*d*, *e* (p. 44) 5.14), *Aaptos*.

Family **Chondrosiidae** Schulze

Massive or encrusting Hadromerida in which the megasclere skeleton has been lost and in which the microscleres, when present, are euasters. Some forms lack spicules entirely. The surface is often smooth and a marked cortex, enriched strongly with fibrillar collagen, is present. This family is placed in the Hadromerida largely on the evidence of biochemical studies and microsclere morphology.

Chondrilla, *Chondrosia*.

Sponges

Patricia R. Bergquist

University of California
Berkeley and Los Angeles

Their cladomes are frequently asymmetrical, the clads occasionally slightly crooked. The lengths of two entire rhabds were measured as 3,480 and 3,920 μ, respectively. Diameters 6–12 μ; chord of cladomes 35–45 μ; clads 30–65 by 3–7 μ. (b) Abundant large oxeas, straight to slightly bent; thinner ones fusiform to hastate, thicker ones usually hastate, with more or less distinctly telescoped ends. Some are strongyloxeas, strongyles, anisoxeas, or styles. The axial canal frequently shows several abrupt swellings, at every step of the telescoped ends. Dimensions: 1,320–4,320 by 3–40 μ. (c) Small fusiform oxeas, slightly curved, occasionally straight, somewhat roughened or slightly crenulate, abundant. Dimensions: 47–100 by 1.5–2 μ. (d) Rare curved oxeas of intermediate size, smooth, fusiform, hastate, or strongyloxeate. Some subtylostyles and tylostyles of the same size range occur, with smooth or slightly crenulate heads. Dimensions: 285–370 by 5–10 μ. (e) Sigmaspires, similar in shape and size range to those of *Cinachyra alloclada*.

Remarks. – Uliczka mentioned only one size range of small oxeas, 55–65 by 2.5–3 μ, and did not indicate crenulation. Small crenulate oxeas have been hitherto reported only in the Indo-Pacific *Cinachyra cavernosa* (Lamarck). The presence of an intermediate size range of oxeas, with transitions to tylostyles, is unique for the genus and the order.

Material. – One specimen in alcohol, B 894, a meridional slice comprising one-eight of a sponge, 17.5 cm in diameter and 16 cm high (pl. 41, fig. 3, 4), collected near the underwater television camera, west of the Laboratory, 1 km offshore, in 20 m depth.

Occurrence. – Several specimens of this species were observed where B 894 was collected, but nowhere else. This may indicate a preference for deeper water.

Suborder Chondrosiina Lévi, 1956a

[nomen correctum Wiedenmayer, herein (ex Chondrosides Lévi, 1956a).]

Family Chondrillidae Gray, 1872

[nomen correctum, Lendenfeld, 1887a (pro Chondrilladae Gray, 1872, nomen imperfectum.]

Genus *Chondrilla* Schmidt, 1862

Chondrilla Schmidt, 1862, p. 38; Schulze, 1877, p. 108 (topotypes of type species described), 115; Keller, 1891, p. 327; Topsent, 1896b, p. 512–513, 514, 515; Lendenfeld, 1897, p. 214; Dendy, 1916, p. 267; Topsent, 1918, p. 603; Burton, 1924a, p. 206–209; Wilson, 1925, p. 353; Topsent, 1928c, p. 34; Burton & Rao, 1932, p. 324; Vosmaer, 1932–5, vol. 1, p. 293; de Laubenfels, 1936a, p. 182.

Magog Sollas, 1888, p. 422 [fide Dendy, 1916, p. 245, 268. Type: *Chondrilla sacciformis* Carter, 1879a, by monotypy (type and topotypes redescribed by Dendy, 1916]; Burton, 1924a, p. 209.

Chondrillastra Topsent, 1918, p. 603 (fide Burton, 1924a. Type: *Chondrilla australiensis* Carter, 1873, p. 23, by subsequent designation in de Laubenfels, 1936a, p. 182); Burton, 1924a, p. 206, 208, 209; Wilson, 1925, p. 353; Topsent, 1928c, p. 34.

Type species. – *Chondrilla nucula* Schmidt (1862, p. 39), subsequent designation by de Laubenfels (1936, p. 182).

Chondrilla nucula Schmidt

Plate 41, figures 5–7; plate 42, figures 1, 2; textfigure 178

Chondrilla nucula Schmidt, 1862, p. 39, pl. 3, fig. 22, 22a; Tabb & Manning, 1961, p. 564 (Florida Bay, Cape Sable area); McNulty et al., 1962, p. 229 (Florida: Biscayne Bay); Sarà & Melone, 1963, p. 358 (southern Adriatic Sea); Sarà, 1964, p. 223, fig. 9 (Ligurian Sea); Storr, 1964a, p. 43 (Florida west coast); Hechtel, 1965, p. 74 (with additional synonyms and distribution); Randall & Hartman, 1968, p. 218–222 [in fish stomachs, Virgin Islands and (?) Puerto Rico]; Hechtel, 1969, p. 34 (Barbados).

Type material. – An unspecified number of syntypes. Repositories for the most part unknown. Two schizosyntypes in London: BMNH 1867.7.26.1, in alcohol; BMNH 1867.7.26.30, dry. Also one type slide (spicule preparation) by Schmidt, BMNH 1867.3.11.67.

Type locality: Quarnero (Kvarner Gulf, Yugoslavia).

Description. – Two distinct habits occur, which are also separated by color and habitat: (a) Amorphous, with globular lobes attached to vegetation, or thickly incrusting, up to about 1 cm thick, spreading horizontally over rocky substrate or large sponges, with pronounced, deeply incised and lacunose, meandering lobes, never covering large areas (pl. 41, fig. 5). The color of the upper surface is dark-brown to walnut-brown or beige; often mottled. Base and choanosome are light beige to buff. Specimens growing in dark areas, as hidden under dense vegetation, may be pale. The oscules are inconspicuous. (b) Thinly incrusting on rocky substrate, 1–2 mm thick, with incised margins and lacunae, but covering larger, more continuous areas than habit *a* (pl. 41, fig. 6). The color is commonly yellowish-brown, fulvous, with dark brown rims and conspicuous oscules surrounded by paler areas.

The consistency is soft, elastic, tough, reminiscent of fresh liver (hence the vernacular name 'chicken-liver sponge'); somewhat tougher, more cartilagenous in habit *b*. The surface is smooth, glabrous, shiny. The oscules in habit *a* are inconspicuous, few, 0.5–1.5 mm in diameter, flush; in habit *b*, more numerous, up to 3 mm wide, usually slightly elevated.

The ectosome is a strongly pigmented cortex, detachable with some difficulty, 0.5–1 mm thick in habit *a*, 150–200 μ thick in habit *b*. In the latter, it is further differentiated by a concentration of spherasters (pl. 41, fig. 7). These are packed around crowded ostia, which are 50–100 μ in diameter, with equal or slightly narrower intervals (pl. 42, fig. 2).

The choanosome is dense, fleshy, with long, narrow canals, 10–50 μ in diameter. The spicules are irregularly scattered.

The spiculation consists entirely of oxyspherasters with centra occupying 50–80% of the diameter. The rays are conical, short and blunt in smaller spherasters (grading into pycnasters), longer and often terminally slightly constricted in larger spicules. The diameter is 10–40 μ. The rays are 2.5–10 μ long, 3–5 μ wide at the base.

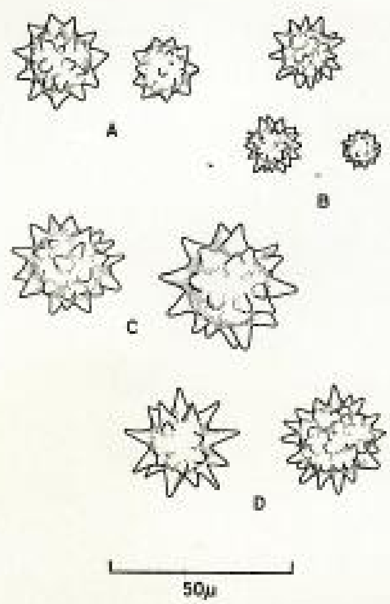


Fig. 178. *Chondrilla nucula*. Spicules. A: B138. B B673. C: B801. D: O710.

Material. – Four dry specimens: B608, O673, O686, habit *a;* B801, habit *b*. B608 was collected near Tokas Cay, O673 and O686 came from stations 7 and 8, respectively, on the cruise of the R/V 'Oliver'. B801 (pl. 42, fig. 1) was taken just west of the northern tip of the third islet from the north of Turtle Rocks. One specimen of habit *a*, B928, is preserved in alcohol. It was incrusting the large individual of *Jaspis pudica* shown in pl. 36, fig. 5, which was collected at locality 62.

Occurrence. – Specimens of the habit *a* are among the most common sponges in the lagoon and show the least degree of environmental selectivity of any sponge in the area. The greatest abundance was found in rocky patches having a dense population of other sponges in the central part of the lagoon, between Big Mangrove Cay, Alec Cay and Tokas Cay. Abundance and size range are shown in table 39.

Specimens of the habit *b* seem to be restricted to the *Millepora* terrace and vertical cliffs, to the rock pavement and reef habitats on the outer platform of the Bimini Group. Several pale greenish-grey, incrusting, small specimens were observed at station 12 on the cruise of the R/V 'Oliver', i.e. on the wall of the 'ocean hole' on Gibson Cay.

During the cruise of the R/V 'Oliver', specimens of *Chondrilla nucula* were noted at stations 6 (habit *b*), 7, 8, 11 (habit *a*), 12 (habit *b*), 14, 19, and 21 (habit *a*).

Family Chondrosiidae Schulze, 1877

[nomen correctum Sollas, 1887 (pro Chondrosidae Schulze, 1877, nomen imperfectum).]

Genus *Chondrosia* Nardo, 1847b

Chondrosia Nardo, 1847b p. 267; Schulze, 1877, p. 97 (topotypes of type species redescribed), 114; Topsent, 1896b, p. 513–515, 568; Lendenfeld, 1897, p. 215; Dendy, 1905, p. 133; Kirkpatrick, 1910, p. 130; Topsent, 1918, p. 609–611; Wilson, 1925, p. 353; Topsent, 1928c, p. 34, 69, 143; Burton & Rao, 1932, p. 323; Vosmaer, 1932–5, vol. 1, p. 285; de Laubenfels, 1936a, p. 183; de Laubenfels, 1950a, p. 135.

Gummina Schmidt, 1862, p. 38.

Cellulophana Schmidt, 1862, p. 41, sensu Schmidt, 1870, p. 25 (type: *C. pileata* Schmidt, 1862, by monotypy. A composite tunicate, fide Schulze, 1877, p. 119–121. *C. collectrix* Schmidt, 1870, is a *Chondrosia*).

Table 39
Abundance and size range of *Chondrilla nucula*, habit *a*, in the Bimini Lagoon (for explanation, see table 1).

Locality	No. of specimens	Min. size in cm^2	Max. size in cm^2	Average size in cm^2	Cumul. area in cm^2	Density (cumul. area/ total area) in ‰
6	2	50	50	50	100	0.1
8 (66.7 m^2)	2	25	30	27.5	55	0.08
30	39	25	250	80	3,100	3.1
33	115	25	150	35	4,250	4.25
37	16	25	75	30	475	0.48
38	2	50	50	50	100	0.1
45	1	-	-	10	-	-
46	8	10	25	20	140	0.14
47	6	25	25	25	150	0.15
48	6	10	25	22.5	135	0.14
50	3	10	25	15	45	0.05
51	2	25	25	25	50	0.05
52	57	25	250	75	4,380	4.38
54	7	10	175	50	335	0.34
55	4	10	25	20	85	0.09
57	66	10	75	20	1,430	1.43
58	23	10	50	20	480	0.48
59	1	-	-	10	-	-
60	332	7	1,805	116	38,590	38.59
61	57	15	130	50	2,740	2.74
62	481	5	150	20	9,670	9.67

Type species. – *Chondrosia reniformis* Nardo (1847b), by monotypy.

Remarks. – Vosmaer (1932–5, vol. 1, p. 285) and Burton & Rao (1932, p. 324) synonymized all species described in *Chondrosia* with *C. reniformis*. Burton & Rao assigned all species of previous authors to two ecophenotypic forms, compared to the 'metamps' of Bidder (1902) or 'tropi' of Vosmaer (1911a). *C. reniformis* forma *typica* thus included *C. corticata*, *C. debilis*, *C. plebeja*, and *C. ramsayi* of authors; *C. reniformis* forma *spurca* was reserved for *C. spurca* Carter (with its synonym *C. collectrix* Lendenfeld). Forma *typica* was characterized as massive, corticate, leathery, and tough, its surface usually reticulate, its vents raised. Forma *spurca* was said to be incrusting, with level vents, and smooth, reticulated surface. Both forms were noted to accumulate foreign bodies on the surface.

Synonymies within the genus are not completely clarified. There are definitely two species of *Chondrosia* at Bimini.

Chondrosia reniformis Nardo

Plate 42, figures 3–6

Chondrosia reniformis Nardo, 1847b, p. 267; Schmidt, 1862, p. 40 (translation of original description); Schulze, 1877, p. 87 (previous descriptions), 95–96 (classification, material, distribution), 97–108 (detailed description, anatomy), 114 (synonymy), 121 (distribution), pl. 8, fig. 1–19; Lendenfeld, 1889b, p. 458–462 (detailed description), 462–470 (experiments in nutrition), 470–492 (experiments in poisoning), 572–671 (discussion of experiments; cf. Jones, 1962, p. 32), pl. 28, fig. 89, 90, 93; pl. 29, fig. 94; pl. 33, fig. 187; Topsent, 1896b, p. 512–518 (classification, synonyms, distribution), 521, 522, 524, 525 (comparative anatomy), 526 (reproduction), 527 (key), 533, 546 (comparison with other species), 568–573 (description), pl. 22, fig. 12b; pl. 23, fig. 1–5; Lendenfeld, 1897, p. 38–43, pl. 1, fig. 7, 11, 12; pl. 9, fig. 118, 119; Stephens, 1915, p. 437 (Cape Verde Islands); Topsent, 1918, p. 609 (West Africa: São Tomé); Babić, 1922, p. 269 (Adriatic Sea); Topsent, 1925b, p. 630 (Bay of Naples); Topsent, 1928c, p. 143 (Mediterranean: Monaco, 123 m; Toulon, 20–50 m); Topsent, 1929b, file card (with distribution); Burton & Rao, 1932, p. 324 (in part ? Ceylon: Tuticorin); Vosmaer, 1932–5, vol. 1, p. 285 (in part ? List of synonyms up to 1906, and distribution), pl. 2, fig. 12; pl. 4, fig. 4, 9, 11; pl. 16, fig. 9–12; pl. 41, fig. 1–3; pl. 42, fig. 1; Lévi, 1952, p. 44 (West Africa: Senegal); Sarà, 1958, p. 216, pl. 7 (Ligurian Sea); Sarà, 1963, p. 206 (Tyrrhenian Sea); Sarà & Melone, 1963, p. 359 (southern Adriatic Sea); Sarà, 1964, p. 225 (Ligurian Sea).

Type material. – Repository unknown. Type locality: Adriatic Sea near Venice.

Description. – The sponge is massive, depressed-ellipsoidal, or grossly lobate, up to 24 cm in greatest dimension observed. The few single lobes are often contorted, and reach fist size. The surface is typically strongly convoluted into irregular, corrugated folds, 1–5 mm high 2–5 mm wide, outlining polygonal or elongate, meandering depressions. These primary folds may be blunt or ridge-shaped, and are commonly provided with secondary, transverse folds on their sides.

The color in life is sepia brown to deep orange-brown externally, on parts exposed to light. The color is deeper in the depressions and lighter on the elevations. The area around the base is white with orange-pink tinges. Transitional areas, on the sides, where the superficial relief is low, display a peculiar, dendritic-stellate pattern, reminiscent of scleractinians with large, polygonal, contiguous calyces. The septate pattern within these polygons, which are about 2–12 mm wide, is caused by the secondary, transverse folds combined with the deeper pigmentation in the interstitial depressions.

The consistency in life is cartilaginous, firm, and tough. Dry specimens are shriveled, hard as plastic or horn, and difficult to cut.

The surface is smooth, glabrous, but matte under water. There may be one to five usually contorted pseudoscules provided with a thick, elevated collar. The largest ones observed had a width of 26 mm. The ostia are regularly distributed over most of the surface, except for the top of the primary folds. They are about 50 μ wide, equidistant.

The ectosome is a thick white cortex, dense, cartilaginous, 3–10 mm thick. Its periphery, about 300–500 μ thick, is pigmented like the surface, but is otherwise undifferentiated. Many radial, narrow canals traverse the white cortex, branching and diverging below the superficial depressions.

The choanosome, distinct from the cortex, is buff-colored and softer, reminiscent of marrow in texture. It is riddled by meandering canals (exochetes) about 100–300 μ wide having linings of the same texture and color as the cortex. In the center, there may be a system of larger exochetes (pseudatria), 1–3 mm wide, with a white, dense lining about 1 mm thick. Their walls contain irregularly scattered, elongated oscules leading to the smaller exochetes in the choanosome.

Remarks. – This is the first record of this species for the western Atlantic. Prof. M. Sarà (Genoa) and Dr. K. Rützler (US National Museum) have expressed doubts about the identity of this West Indian sponge with the well-known Mediterranean species (personal communication). The latter is smaller, has a smooth surface and a thinner cortex which is pigmented throughout (cf. Topsent, 1929b). The West Indian sponge shows a better agreement with *Chondrosia plebeja* Schmidt (1868, p. 1), from the coast of Algeria, which has been regarded as a synonym of *C. reniformis* by several authors. *Chondrosia plebeja* was originally distinguished on the basis of strong, polygonally disposed folds on the surface. Schmidt's name was later applied to a West African sponge (*C. plebeja* sensu Kirkpatrick, 1910, p. 128, pl. 7, fig. 4–8; Stephens, 1915, p. 437; Topsent, 1918, p. 610), which is distinct from *C. reniformis*, and may be conspecific with *C. collectrix* (Schmidt; see below, under Remarks on *C. collectrix*).

Reconsideration of the identity of this West Indian *Chondrosia* must await revision of the genus.

Material. – Two specimens in alcohol: B 872 and B 875. B 872 (pl. 42, fig. 4, 6) was collected west of northern Turtle Rock, about 50 m offshore, in 6–9 m depth. It is ellipsoidal, 11 by 13 cm wide, 6 cm high. B 875 (pl. 42, fig. 3, 5) was collected west of the second islet from the north of Turtle Rocks, same depth as for B 872. It

consisted of three adjoining, fist-sized lobes, and is now cut into three parts.
One dry specimen, O 659, collected at station 1 during the cruise of the R/V 'Oliver'.

Occurrence. – The species seems to be rather rare. In the Bimini area, it was seen only in the reef habitat west of Turtle Rocks. O 659 was the only specimen seen during the cruise of the R/V 'Oliver'.

Chondrosia collectrix (Schmidt)

Plate 42, figure 7

Cellulophana collectrix Schmidt, 1870, p. 25.
Chondrosia collectrix (Schmidt) de Laubenfels, 1936a, p. 130, pl. 20, fig. 1 (Dry Tortugas); de Laubenfels, 1950a, p. 135, fig. 40 (Bermuda).
[?] *Chondrosia collectrix* (Schmidt) Randall & Hartman, 1968, p. 219–222 [in fish stomachs, Virgin Islands and (?) Puerto Rico].
[non] *Chondrosia collectrix* Lendenfeld, 1888, p. 74 [= *Chondrosia chucalla* de Laubenfels, 1936a, p. 183, nomen substitutum; *Chondrosia spurca* Carter, 1887, fide Topsent, 1896b, p. 513].

Type material. – Repository of holotype unknown (Museum of Comparative Zoology, Cambridge ?). Type locality: Dry Tortugas, Florida, 42 fathoms.

Description. – The sponge is cushion-shaped, with a lobate contour and rounded margins; 1–1.5 cm thick, up to 10–15 cm wide. The color is externally dark purplish brown, almost black; the base may be blueish. The basic color is obscured by large quantities of sand in the body. The consistency is firm, rubbery, but easily torn. The surface is smooth, glabrous in specimens with little sand in the periphery, otherwise roughened by the agglutinated sand grains. The oscules are conspicuous in live specimens, flush or with slightly elevated rims, 3–8 mm in diameter. The atria are shallow, only 1–3 mm deep. Soon after removal of specimens, and in preserved material, the atria collapse completely, their floors becoming flush with the surface and the rims barely visible. The ostia are represented by scarce round orifices, 100–300 μ in diameter.
The ectosome is a thin, semitransparent, gelatinous, detachable skin. The choanosome is firmly gelatinous, often packed with sand grains. Its periphery, 2–3 mm thick, has the same dark color as the surface, and grades into the purplish or brownish grey deeper parts, which contain scattered pigment cells. The choanosome is cavernous, riddled by meandering canals and cavities 100 μ to 2 mm wide. In some specimens, the periphery contains less abundant, finer sand grains.

Remarks. – *Chondrosia plebeja* Schmidt (1868, p. 1) is generally accepted as a synonym of *C. reniformis*, the only difference being that the surface of the former has polygonal folds. *Chondrosia plebeja* sensu Kirkpatrick, 1910, from St. Helena, appears to be specifically distinct from *C. reniformis*, judging from the description. It is softer, has flush oscules with membranous sphincters, and a thin, delicate skin instead of a cortex. Stephens (1915, p. 437) described specimens from the same locality, which were full of sand. Similar specimens from São Tomé were described under the same name by Topsent (1918, p. 610). I might regard this form as conspecific with *C. collectrix*, except for the peculiar anatomical features of the canal system described and illustrated by Kirkpatrick, especially the radial 'bristle canals' surrounding the larger incurrent canals. I could not detect such features in the Bimini material, but it must be noted that I could not obtain wholly satisfactory sections because of the large amount of sediment grains.
When these sponges were observed and counted in situ, a very remarkable physiological feature was noted, which seems to be rare among sponges: upon the slightest touch, the oscules, including the atria, and the whole surface would contract quite suddenly, within a fraction of a second. Previously reported contraction times to outside stimuli of all kinds, to my knowledge, were always in the order of several seconds (1–5 seconds according to Prosser et al., 1962). Reaction to external stimuli is commonly localized in most sponges (cf. Jones, 1962); coordinated contraction of the whole surface has been recorded and described for *Tethya aurantium* (cf. Topsent, 1929c; Pavans de Ceccatty et al., 1960), but seems to be considerably slower than in *Chondrosia collectrix*.

Material. – One dry specimen, B 818, locality 54. Two specimens in alcohol: B 849, locality 54, consisting of two individuals and two fragments of a third individual; B 852 (pl. 42, fig. 7), a large specimen, containing relatively little sand in the periphery. The latter was collected north of locality 54, at the northern end of the rocky strip north of Mosquito Point.

Occurrence. – The only specimens were seen on the rocky strip along the shore between Mosquito Point and a point about 600 m north of locality 54. The census for this locality is reported in table 40.

Class Calcarea Bowerbank, 1864

Subclass Calcinea Bidder, 1898

Order Clathrinida Hartman, 1958b

Table 40
Abundance and size range of *Chondrosia collectrix* at locality 54 (for explanation, see table 1).

Locality	No. of specimens	Min. size in cm²	Max. size in cm²	Average size in cm²	Cumul. area in cm²	Density (cumul. area/ total area) in ‰
54	18	25	100	60	1,050	1.05

Shallow-water sponges of the western Bahamas

Felix Wiedenmayer
Naturhistorisches Museum, Basel, Switzerland

With 180 textfigures, 43 plates, and 52 tables

1977 Birkhäuser Verlag, Basel und Stuttgart

Limnol. Oceanogr., 29(6), 1984, 1335–1337

Predation on jellyfish and their associates by seabirds

Abstract—Scyphozoan jellyfish are preyed on by 11 species of birds in the Bering Sea: *Fulmarus glacialis, Puffinus griseus, Puffinus tenuirostris, Oceanodroma furcata, Larus hyperboreus, Rissa tridactyla, Rissa brevirostris, Uria aalge, Uria lomvia, Cyclorrhynchus psittacula*, and *Aethia cristatella*. Parasitic amphipods on scyphomedusae also contribute to avian diets.

Predation by birds on gelatinous zooplankton has been documented anecdotally (Anthony 1895; Foxton 1966; Madin 1974; Murie 1979), but has not been suggested as a significant trophic pathway. Gelatinous organisms are abundant in the pelagic environment and are important in creating spatial heterogeneity, acting as "floating substrates" for a suite of other organisms (Hamner et al. 1975). Medusae, salps, and siphonophores, with their parasitic or symbiotic amphipods (Laval 1980), may constitute easily captured patches of prey for marine birds. I here report 11 species of arctic birds feeding on scyphozoan jellyfish and their associated amphipods. For only one of the eleven, the northern fulmar (*Fulmarus glacialis*), has feeding on medusae been previously described (Anthony 1895; Murie 1979).

The stomachs of 17 species of birds were examined for evidence of predation on jellyfish: *F. glacialis*; *Puffinus griseus* (sooty shearwater); *Puffinus tenuirostris* (short-tailed shearwater); *Oceanodroma furcata* (fork-tailed storm-petrel); *Larus hyperboreus* (glaucous gull); *Larus glaucescens* (glaucous-winged gull); *Rissa tridactyla* (black-legged kittiwake); *Rissa brevirostris* (red-legged kittiwake); *Uria aalge* (common murre); *Uria lomvia* (thick-billed murre); *Cepphus columba* (pigeon guillemot); *Ptychoramphus aleuticus* (Cassin's auklet); *Cyclorrhynchus psittacula* (parakeet auklet); *Aethia pusilla* (least auklet); *Aethia cristatella* (crested auklet); *Fratercula cirrhata* (tufted puffin); and *Fratercula corniculata* (horned puffin). Nine species of birds (215 individuals) were collected in the southeastern Bering Sea in August 1982 by D. Schneider and N. Harrison. Additional collections were made in October 1982 near St. Matthew Island (7 species, 25 individuals) and in July 1983 in the northern Bering Sea, St. Matthew Island, and the Pribilof Islands (9 species, 86 individuals) by G. Hunt, Z. Eppley, and N. Harrison. All birds were killed with a 12-gauge shotgun. The digestive tracts of the birds were removed immediately after collection, opened, and preserved in 80% ethanol. Reference samples of scyphomedusae were collected and identified by J. Morin and W. Hamner. These samples were preserved in both Formalin and 80% ethanol, the latter for comparison with preserved avian stomach contents. The study was completed as part of the multidisciplinary investigation of the southeastern Bering Sea (PROBES).

Jellyfish have probably been overlooked in the analysis of avian stomach contents in earlier studies because of the rapid breakdown of their tissue. I observed the deterioration of the medusae preserved in ethanol through time and learned how to identify the shreds of dehydrated tissues. Their appearance is unmistakable under low magnification and permits accurate identification of medusa tissues from ethanol-preserved stomach contents. Under high magnification nematocysts can be seen in the tissues, confirming the identification. Comparisons with the reference samples confirm that *Chrysaora* and *Cyanea* are ingested by the birds, as well as other unidentified medusae. Specific identification of the stomach contents is often impossible because digestion is too far advanced.

Of the 17 bird species collected, 11 had eaten scyphozoan jellyfish (Table 1). The tabulation presumably represents a conservative estimate of the frequency of occurrence of jellyfish in these birds. Many more of the collected birds had remnants of tissue which I could not identify with certainty as jellyfish. Another indication that my estimates of jellyfish ingestion are conservative is that fulmars frequently contained hyperiid amphipods, in the absence of confirmed jellyfish, mostly of the genus *Hyperia* which

Table 1. Percentage of birds containing jellyfish for each of three collections. Total number of individual birds collected on each occasion is in parentheses.

	Aug 82	Oct 82	Jul 83
Fulmarus glacialis	41(116)	50(2)	44(18)
Puffinus griseus	(0)	(0)	50(2)
Puffinus tenuirostris	23(26)	(0)	(0)
Oceanodroma furcata	25(51)	(0)	50(4)
Larus hyperboreus	(0)	(0)	50(2)
Rissa tridactyla	46(13)	0(4)	40(15)
Rissa brevirostris	50(2)	(0)	(0)
Uria aalge	0(1)	(0)	20(20)
Uria lomvia	(0)	0(1)	20(10)
Cyclorrhynchus psittacula	(0)	(0)	50(8)
Aethia cristatella	(0)	50(2)	(0)
Larus glaucescens	0(1)	(0)	(0)
Cepphus columba	(0)	0(1)	(0)
Ptychoramphus aleuticus	0(2)	(0)	(0)
Aethia pusilla	(0)	0(3)	0(7)
Fratercula cirrhata	0(2)	(0)	(0)
Fratercula corniculata	(0)	0(3)	(0)

are known to live on medusae (Bowman and Gruner 1973; Laval 1980). The best specimens of *Hyperia* found in the stomachs were intact individuals enveloped in gelatinous tissue.

As can be seen in Table 2, scyphomedusae provide only a portion of the diet for any of these birds, which also feed on squid, crustacea, fish, and a few polychaetes. It is likely that in the winter when jellyfish are less abundant, the birds feed more on other organisms. The fact that several birds were found to have eaten jellyfish near St. Matthew Island in October suggests that they are a prey as well at times of year when they are less abundant.

Table 3. Mean number of prey genera per individual bird, comparing birds which fed on jellyfish to conspecifics that had not fed on jellyfish (August 1982). The number of individual birds in each sample is in parentheses.

	With jellyfish	Without jellyfish
Fulmarus glacialis	3.20±0.99(48)	1.98±1.01(68)
Puffinus tenuirostris	2.00±0.58(6)	1.70±0.78(20)
Oceanodroma furcata	2.14±0.99(14)	1.57±0.82(37)
Rissa tridactyla	1.57±0.73(7)	1.00±0.82(6)
Rissa brevirostris	3.00(1)	2.00(1)

Harbison et al. (1977) noted the abundance of parasitic organisms on gelatinous zooplankton. If the host were eaten, the birds also would ingest its associates. It might be predicted that birds eating jellyfish would have a greater diversity of prey per bird than birds not eating jellyfish, and indeed this is so (Table 3).

The trend toward higher diversity of prey in the jellyfish-feeding birds supports the idea that gelatinous zooplankton are important in structuring the Bering Sea food chain. When numerous, jellyfish associates are likely to be of higher food value than the jellyfish itself. From the predator's perspective, medusae along with their various

Table 2. Percentage of collected birds (sample size in parentheses) containing prey (August 1982).

	Fulmarus glacialis (116)	*Oceanodroma furcata* (51)	*Puffinus tenuirostris* (26)	*Rissa tridactyla* (13)	*Rissa brevirostris* (2)
Scyphomedusae	41	25	23	46	50
Nereids	4				
Squid	97	47	23	15	50
Hyperiids	36	8			50
Gammerids	1	6	4		
Unident. amph.		6			
Copepods	1	10			
Euphausiids	5	4	54		
Crab larvae	6	2	8	8	
Unident. crust.	22	35	31	15	
Myctophids	6	4		8	100
Gadids	2	2	15	15	
Unident. fish	28	22	19	31	

associated organisms represent a highly localized food patch.

Nancy M. Harrison

Department of Ecology and
Evolutionary Biology
University of California
Irvine 92717

References

ANTHONY, A. W. 1895. The fulmars of southern California. Auk 12: 100.

BOWMAN, T. E., AND H.-E. GRUNER. 1973. The families and genera of Hyperiidae (Crustacea: Amphipoda). Smithson. Contrib. Zool. 146: 1–64.

FOXTON, P. 1966. The distribution and life-history of *Salpa thompsoni* Foxton with observations on a related species, *Salpa gerlanchei* Foxton. Discovery Rep. 34: 1–116.

HAMNER, W. M., L. P. MADIN, A. L. ALLDREDGE, R. W. GILMER, AND P. P. HAMNER. 1975. Underwater observations of gelatinous zooplankton: Sampling problems, feeding biology, and behavior. Limnol. Oceanogr. 20: 907–917.

HARBISON, B. R., D. C. BIGGS, AND L. P. MADIN. 1977. The associations of Amphipoda Hyperiidae with gelatinous zooplankton—2. Associations with Cnidaria, Ctenophora, and Radiolaria. Deep-Sea Res. 24: 465–488.

LAVAL, P. 1980. Hyperiid amphipods as crustacean parasitoids associated with gelatinous zooplankton. Oceanogr. Mar. Biol. Annu. Rev. 18: 11–56.

MADIN, L. P. 1974. Field observations on the feeding behavior of salps (Tunicata: Thaliacea). Mar. Biol. 25: 143–147.

MURIE, M. E. 1979. The Alaska bird sketches of Olaus Murie. Alaska Northwest.

Submitted: 14 October 1983
Accepted: 7 May 1984

from Reef and Shore Fauna of Hawaii
Section 1: Protozoa through Ctenophora
B.P. Bishop Museum Special Publication 64(1)
1977
Bishop Museum Press
Honolulu
edited by
Dennis M. Devaney
and
Lucius G. Eldredge

OTHER HYDROZOANS

L. G. ELDREDGE and DENNIS M. DEVANEY

University of Guam and B. P. Bishop Museum

Order SIPHONOPHORA

SIPHONOPHORES are colonial coelenterates composed of both medusae and polyps budded from a common stem. The polypoid portions or individuals are the feeding gastrozooids, tactile dactylozooids, and reproductive gonozooids. The medusoid individuals are responsible for locomotion (swimming bells or nectophores), and reproduction (gonophores). A float or pneumatophore, once considered to be medusoid in origin, is also present in many forms and is composed of a double-walled chamber provided at the bottom with a gas gland. Some species have a float which serves as a hydrostatic organ, keeping the animal at a particular depth, while other species lack the pneumatophore altogether. *Physalia* floats on the surface and has its pneumatophore elevated (Fig. 1*a*). The nematocysts are particularly toxic in siphonophores. Only one species has been reported from shallow Hawaiian waters, although smaller forms are common in the oceanic plankton, including small colorless species sometimes observed in near-shore waters.

Physalia physalis (Linnaeus 1758) [as *Physalia utriculus* Eschscholtz in Edmondson, 1946]. Commonly known as the Portuguese man-of-war, this wind-blown wanderer frequently reaches the Hawaiian Islands, especially the windward coasts. While lacking a nectophore, it floats at the surface, with its pneumatophore forming an oval having a turgid crest which allows the animal to maneuver in the wind. When stimulated, powerful nematocysts, mainly in the tentacles of the dactylozooids, discharge a noxious and severely painful toxin. The float, in iridescent and bluish purple color, may be as long as 5 cm while the extended tentacles, of the same color, may reach well over 10 m. Beach-washed individuals are frequently eaten by the mole crab, *Hippa pacifica* (Bonnet, 1946; Matthews, 1955), and, when available, constitute one of this crab's more important sources of food. The ghost crabs, *Ocypode laevis* and *O. ceratophthalmus*, also scavenge on it (Fellows, 1966). While Totton (1960) maintained that *Physalia physalis* was the only species to be recognized worldwide, Cleland and Southcott (1965), following earlier workers, considered *P. utriculus* La Martinière to be an Indo-Pacific species having a single main tentacle, and *P. physalis* an Atlantic species with several main tentacles.

Order CHONDROPHORA

The chondrophores are also colonial hydrozoans. They lack an elongated stem and have the shape of a round or oval disk consisting of a multichambered float, from which hangs a single gastrozooid, surrounded by gonozooids that give

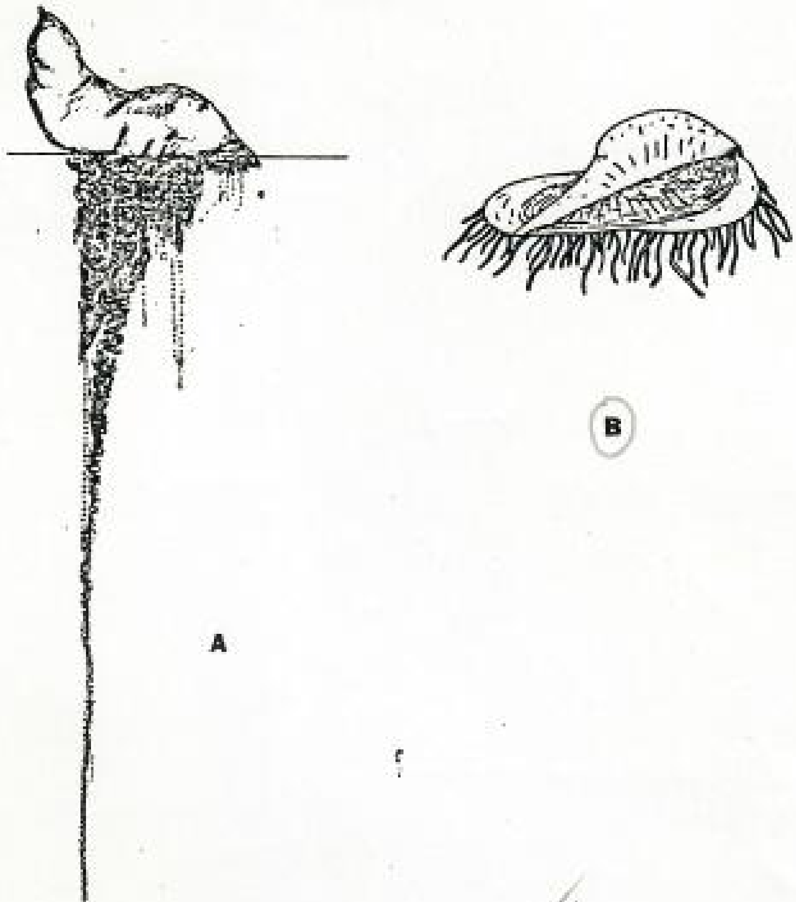


Figure 1.—OTHER HYDROZOANS: *a*, *Physalia physalis*, Portuguese man-of-war, floating on the water surface; note the single main tentacle (from Cleland and Southcott, 1965). *b*, *Velella velella* (from Hyman, 1940).

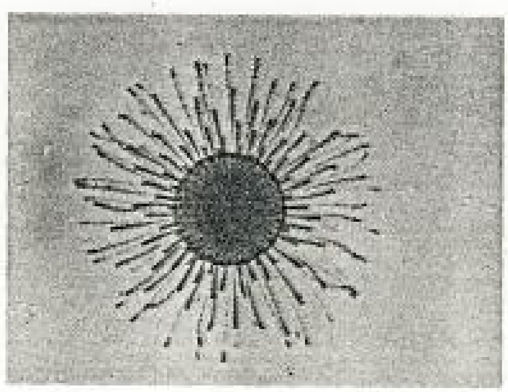


Figure 2.—OTHER HYDROZOANS: *Porpita pacifica* (C. E. Cutress photo).

rise to free-swimming medusae. Dactylozooids fringe the margin of the animal. Two members of this group of free-floating hydrozoans have been observed in Hawaiian waters. Neither has been reported to sting humans, in contrast to *Physalia*.

Velella velella Linneaus 1758 [as *V. pacifica* Eschscholtz in Edmondson, 1946]. This form has a flattened, elliptical float with a thin triangular sail (Fig. 1*b*). At the margin of the thin float is a series of short dactylozooids directed downward. Its nematocysts are less virulent than those of the man-of-war. The color of the animal is vivid blue. A review of this wide-ranging tropical species was given by Edwards (1966).

Porpita pacifica Lesson 1826. These small, discoidal forms, without a sail (Fig. 2), have been collected off the windward coast of Oahu. Specimens in Hawaiian waters seldom exceed a diameter of 1 cm to 2 cm. The marginally placed dactylozooids are quite evident, standing out horizontally at the side of the disk. Like *Velella*, this form is normally a blue color.

GLOSSARY (OTHER HYDROZOANS)

dactylozooid: tactile polyp which serves in defense and captures food.
gastrozooid: feeding polyp with mouth, tentacles, and gastric cavity.
gonozooid: reproductive polyp which buds medusae.
nectophore: swimming bell, a modified medusa with bell, velum, radial canals, and ring canal.
pneumatophore: float, an inverted medusoidlike bell.

REFERENCES (OTHER HYDROZOANS)

Bonnet, D. D.
1946. The Portuguese Man-of-War as a Food Source for the Sand Crab *(Emerita pacifica). Science* 103: 148–149.

Cleland, J. B., and R. V. Southcott
1965. *Injuries to Man from Marine Invertebrates in the Australian Region*. Canberra: Commonwealth of Australia.

Edmondson, C. H.
1946. *Reef and Shore Fauna of Hawaii*. B. P. Bishop Mus. Spec. Publ. 22. Honolulu.

Edwards, C.
1966. *Velella velella* (L.): The Distribution of Its Dimorphic Forms in the Atlantic Ocean and the Mediterranean, with Comments on Its Nature and Affinities. In H. Barnes (ed.), *Some Contemporary Studies in Marine Science*. pp. 283–296. London: Allen and Unwin.

Fellows, D. P.
1966. Zonation and Burrowing Behavior of the Ghost Crabs *Ocypode ceratophthalmus* (Pallas) and *Ocypode laevis* Dana in Hawaii. M.S. Thesis, Univ. Hawaii.

Hyman, L. H.
1940. *The Invertebrates: Protozoa through Ctenophora*. New York: McGraw Hill.

Matthews, D. C.
1955. Feeding Habits of the Sand Crab *Hippa pacifica* (Dana). *Pacific Science* 9: 382–386.

Totton, A. K.
1960. Studies on *Physalia physalis* (L.). Part 1, Natural History and Morphology. *Discovery Rep.* 30: 301–367. Pls. vii–xxv, 31 figs.

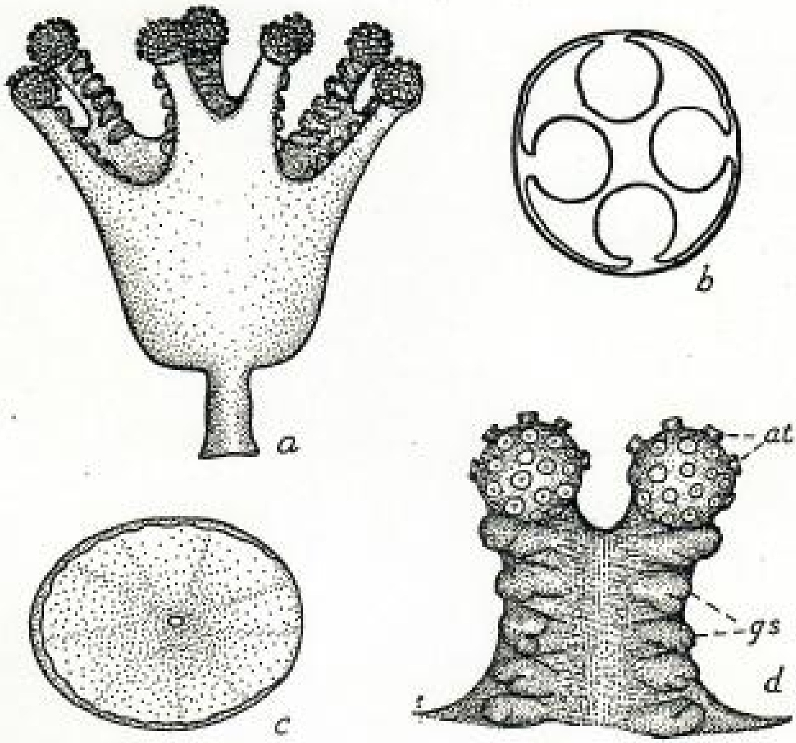


Figure 1.—SCYPHOZOA. *Kishinouyea hawaiiensis: a*, lateral view of the medusa; *b*, cross section of peduncle showing four chambers; *c*, basal end of peduncle showing central pore opening of a canal of the peduncle; *d*, medial surface of a lobe showing gonads and adhesive tentacles; *at*, adhesive tentacles; *gs*, gonads (from Edmondson, 1930).

Charybdea alata Reynaud 1830 [as *C. moseri* Mayer 1906]. In Hawaiian waters this species has been recorded up to 80 mm in height by 47 mm in width. Gonads are not developed until the bell reaches 30 mm to 60 mm in height. Four radially situated, club shaped sense organs, each with a wide cleftlike niche, occur about 15 mm above the margin of the velarium in large specimens (Fig. 2*a*). This species, like the next, is nearly transparent in water and difficult to see, but preserved specimens have shown the flexible shafts of the tentacles to be slightly pink, the eye spots dark reddish brown, and the gonads milky yellow (Mayer, 1906). Nearly all of the collected specimens have been found near the surface at various locations around the Hawaiian Islands. According to Edmondson (1952, p. 5), swarms of this jellyfish rather suddenly appeared on Waikiki Beach during June, 1951. The severity of the sting of this jellyfish is said to equal or exceed that of the Portuguese man-of-war *(Physalia)*. *C. alata* is known from the tropical parts of the Atlantic, Pacific, and Indian Oceans. Life history studies at Puerto Rico were presented recently (Arneson and Cutress, 1977).

Charybdea rastoni Haacke 1886 [as *C. arborifera* Maas 1897]. In contrast to *C. alata*, the bell of *C. rastoni* is nearly as wide as high (maximum 30 mm by 35 mm). Gonads appear when the medusa bell is only 11 mm high and attain their maximum size when the bell height reaches 15 mm. The four club-shaped sense organs are found within a niche about 5 mm above the level of the velarium (Fig. 2*b*). Maas

CLASS ANTHOZOA

THE ANTHOZOANS are exclusively marine cnidarians which exist only as polyps. The oral area is expanded into a disk, and the body is, for the most part, relatively short. The body cavity is divided by septa into a number of chambers. The animal is either solitary or colonial and may or may not secrete a hard internal or external skeleton. The class is divided into two subclasses—the Octocorallia (or Alcyonaria) and the Zoantharia (or Hexacorallia)—primarily on the basis of symmetry.

Subclass OCTOCORALLIA

DENNIS M. DEVANEY
B. P. Bishop Museum

Polyps of this subclass possess eight pinnate (branched) tentacles and eight septa (membranes) which divide the body cavity into compartments. When present, the skeleton consists of individual sclerites or of a network of these fused together with either a calcareous or hornlike substance. Of the six recognized orders, five are found in Hawaiian waters, three in depths less than 100 m. No blue corals (order Coenothecalia) are present, while the orders Stolonifera and Pennatulacea (sea pens) are known only at depths exceeding 100 fm. Most of the other representatives of this subclass are deep-water forms (Bayer, 1952, 1956).

Order ALCYONACEA

Six families of this order, collectively referred to as "soft corals" are known, but only two are represented in Hawaiian waters. The predominant reef-dwelling alcyonaceans in the tropical Pacific are members of the family Alcyoniidae. However, until recently, this family was unreported in shallow Hawaiian waters. Alcyonaceans generally form massive or lobate colonies, occasionally arborescent, in which there is no solid axis, and in which the gastric cavities of many polyps reach to the base of the colony.

Family **Alcyoniidae**

Sinularia abrupta Tixier-Durivault 1970. Colonies of this true "soft coral" have been found at several locations in recent years around the island of Oahu. It has been observed off Moku Manu islet at a depth of 17 m to 37 m and off Sandy Beach and Rabbit Island (Manana) at depths less than 10 m. Verseveldt (1977) made the initial identification of these specimens and gave a redescription of this species. The colonies encrust hard substrata, either basalt or limestone. A single colony may extend nearly 1 m in greatest breadth. The general surface of the colony is lobose

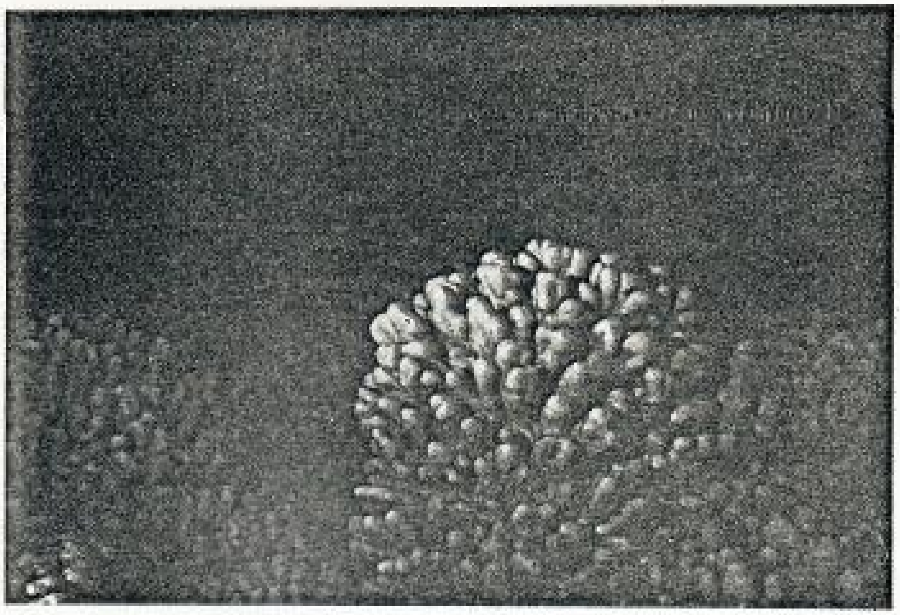


Figure 1.—OCTOCORALLIA. *Sinularia abrupta* colony at Halona Blowhole, Oahu (courtesy of Michael Missakian).

with lobes from 1 cm to 5 cm high (Fig. 1), somewhat resembling poritid stony corals but being flexible to the touch. Each lobe consists of many polyps approximately 1 mm in diameter. Retracted, the polyps give the lobes a pitted appearance. The living color ranges from greenish to yellowish brown. Very well-developed rough elongate tuberculate sclerites are present as well as fusiform spindles (Figs. 2, 3). Besides Hawaii, *S. abrupta* is recorded from Nha-Trang, Vietnam, and Fanning Atoll.

Family **Xeniidae**

Anthelia edmondsoni (Verrill 1928) [as *Sarcothelia edmondsoni* Verrill]. This "soft coral" is occasionally found in shallow waters. The soft-bodied polyps, while close together, are only connected basally by a stolon and are 5 mm to 7 mm high when expanded. No sclerites are present. The tentacles are pale lilac to purple in reflected light, and the polyp body is light tan or buff (Figs. 4, 5). Recent studies have demonstrated the presence of zooxanthellae in the tissues of *A. edmondsoni* (Robert Kinzie, pers. comm.). Colonies reach a diameter of 8 cm or more and have been collected from various locations around the islands, generally in quiet waters or embayments. Utinomi (1950, 1958) brought attention to the fact that Verrill's *Sarcothelia* was synonymous with *Anthelia*. *A. edmondsoni* is known only from Hawaii.

Order TELESTACEA

This group is recognized by having erect, branching colonies which, in the family Telestidae, are produced by monopodial growth and in which each tall axial

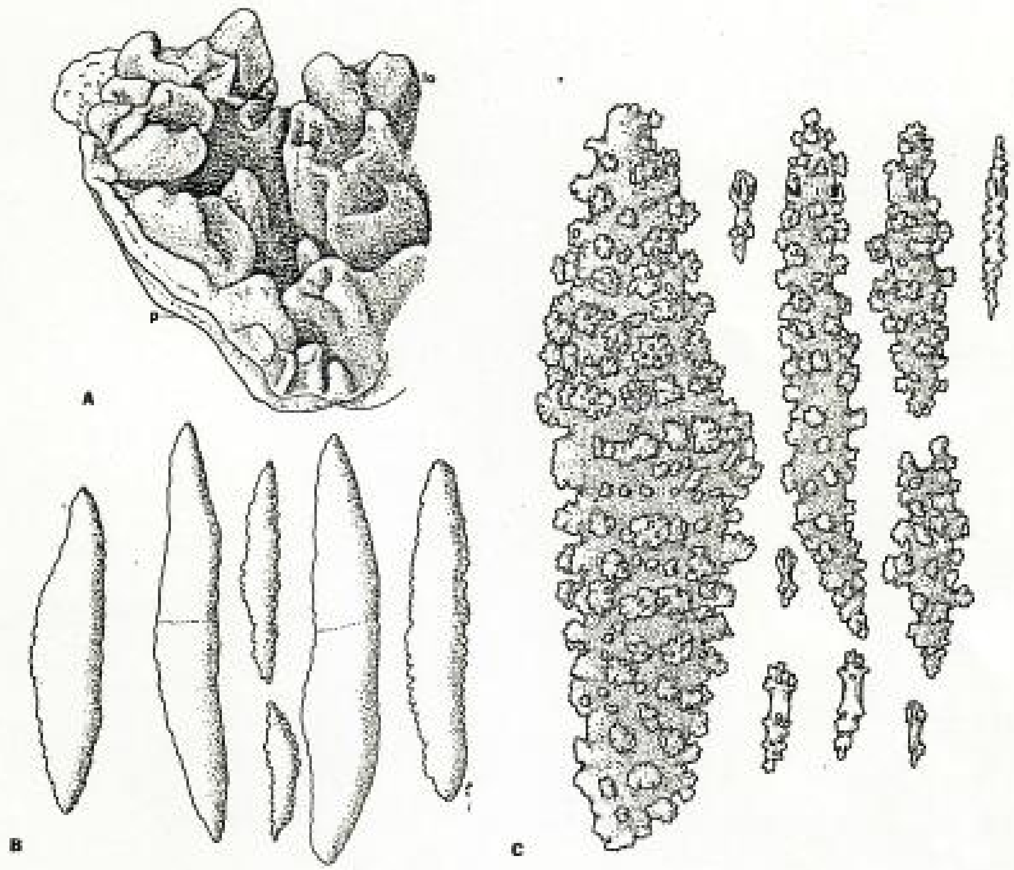


Figure 3.—OCTOCORALLIA. *Sinularia abrupta*. *a*, Portion of a colony (*lo*, lobe; *p*, base); *b*, fusiform sclerites from base; *c*, tuberculate sclerites from base (after Tixier-Durivault, 1970).

polyp has many short lateral polyps. In the genus *Telesto*, the polyps lack sclerites in the tissues of the lower part of the gastric cavities.

Telesto riisei (Duchassaing and Michelotti 1860). In the anthocodial region of the polyps of *T. riisei*, sclerites are longitudinally arranged in 16 narrow rows—8 on the tentacle basis and 8 along septal insertions below the tentacles (Fig. 6*a*). Two types of sclerites occur in the body wall (Figs. 6*b*-*g*). Colonies of this species (Fig. 7) are commonly red or orange and have white tentacles. In Hawaiian waters they were first noted in Pearl Harbor, Oahu (Naval Undersea Center, 1974). It occurs as a part of the fouling community, but was not noted by Edmondson in the 1940's during his studies in this location. Subsequent investigation has shown it to be present in Honolulu Harbor and several other areas along the leeward Oahu coast. The species has previously been reported from Florida to Brazil in the West Atlantic (Bayer, 1961) and it has quite likely been introduced to Hawaii.

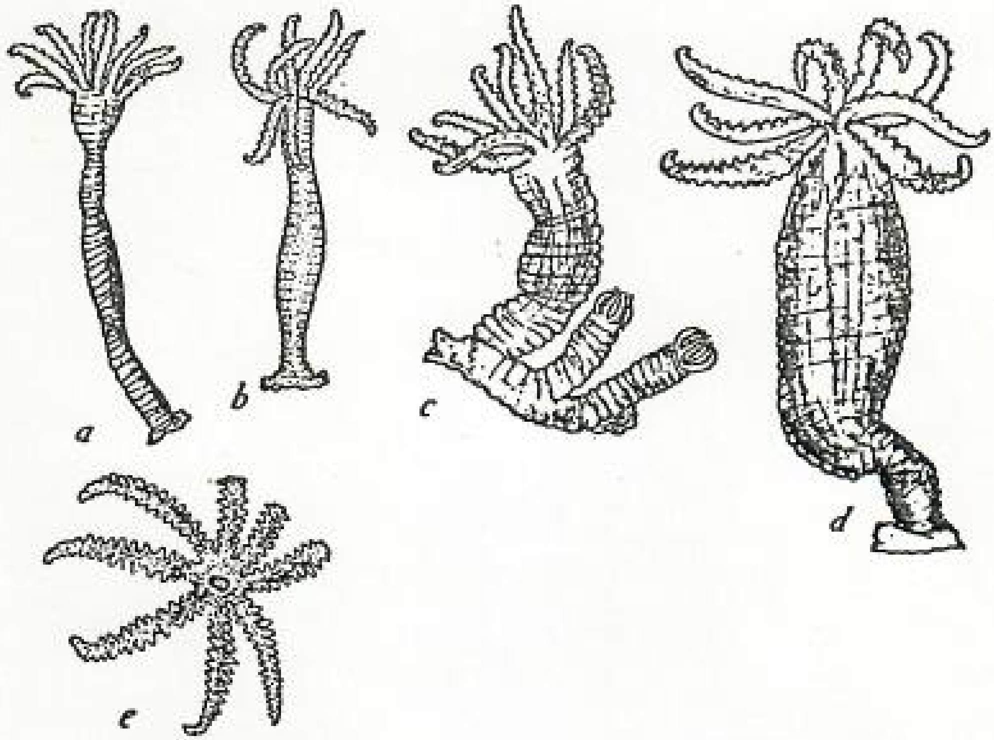


Figure 4.—OCTOCORALLIA. *Anthelia edmondsoni. a, b,* Expanded polyps (× 10); *c,* group of partially contracted polyps (× 15); *d,* partially contracted polyp (× 25); *e,* oral view of polyp (× 10) (from Verrill, 1928).

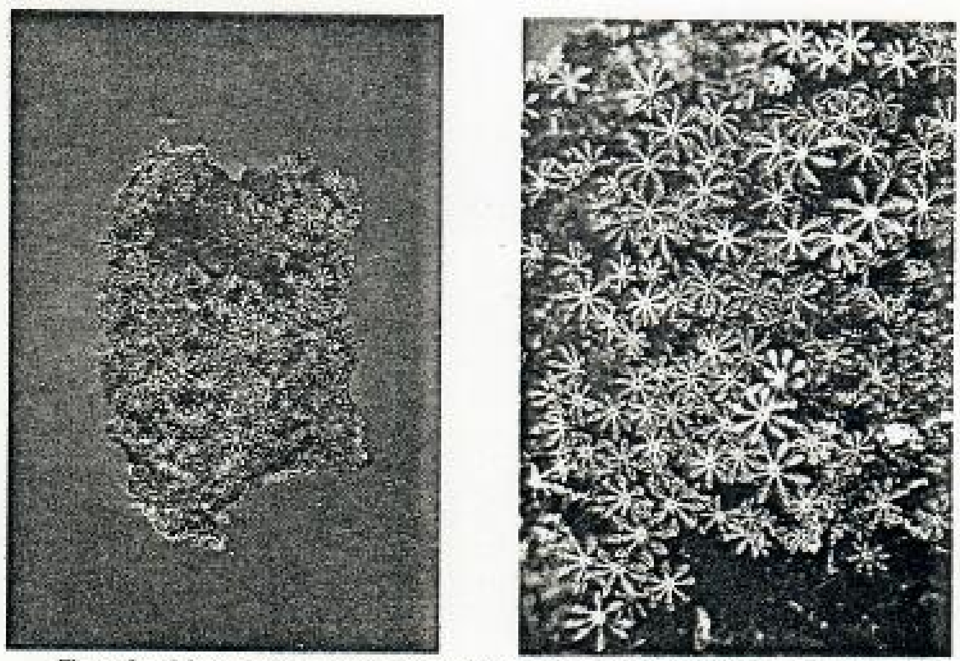


Figure 5.—OCTOCORALLIA. *Anthelia edmondsoni. a* (left), Colony from Sharks Cove, Oahu; *b* (right), same, close-up of polyps (courtesy S. A. Reed).

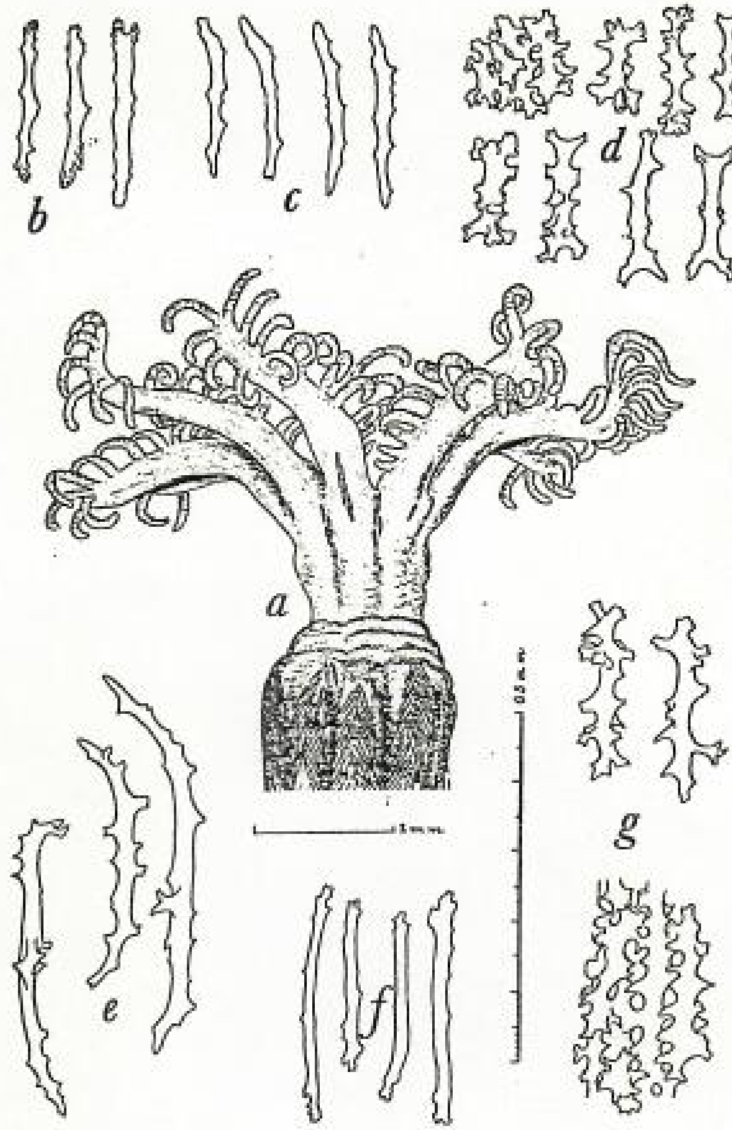


Figure 6.—OCTOCORALLIA. *Telesto riisei. a,* Polyp; *b–g,* sclerites from two different specimens (*b, f,* anthocodial sclerites; *c, e,* nonfusing sclerites from body wall; *d, g,* partially fused sclerites from body wall) (from Bayer, 1961).

Order GORGONACEA

Members of this order, known as gorgonaceans, are characterized by having a skeleton composed of two parts: an outer cortex containing loosely arranged sclerites, and an inner medulla which, when present, has a solid axis of either calcareous or horny material. While there is but one shallow-water representative verified in Hawaii, over 90 deep-water species are recorded (Grigg and Bayer, in press).

The deep-water forms include six species of *Corallium* (family Coralliidae) known as precious or pink corals. Jewelry made from the hard skeleton of *Corallium* is an economic resource for the State of Hawaii (Poh, 1971). However, beds of precious coral must be carefully harvested to avoid overexploitation (Grigg, Bartko, and Brancart, 1973). In addition to pink coral, several genera of the family Primnoidae from deep water are used to make gold coral jewelry, although the most abundant gold coral of the Hawaiian jewelry industry is a species of the zoanthidlike genus *Gerardia* (R.W. Grigg, pers. comm.). In addition, members of the segmented family Isididae, the bamboo corals, are used for jewelry and occur below 100 fathoms.

Gorgonaceans include the sea fans (gorgonians), best known from the tropical Atlantic shallow waters, although many members occur in the western Indo-Pacific region as well. These forms, representing several families of gorgonaceans, are often confused with black corals (order Antipatharia, subclass Zoantharia). However, the skeleton of gorgonians is smooth and the polyps have 8 pinnate tentacles while the skeleton of antipatharians has short spines and the polyps have 6 simple tentacles. The only gorgonian reported from shallow waters in Hawaii is *Acabaria bicolor* in the family Melithaeidae.

Acabaria bicolor (Nutting 1908). This small form (seldom exceeding 40 mm broad by 35 mm high) is branched dichotomously in more than one plane (Fig. 9). The polyps originate from nodes, most often on one side of a branch (Bayer, 1956). Its color is quite variable, from white to yellow (Fig. 8) or pink to red. Specimens are seldom fully exposed, being found under ledges or in rocky crevices at depths from 2 m to 40 m. This species, noted as prevalent on shallow lava flows off the island of Hawaii (R. W. Grigg, pers. comm.), is also known from Oahu, and was first dredged at a depth between 40 and 233 fathoms off Kauai.

ORDER ZOANTHINIARIA

GERALD E. WALSH and RALPH L. BOWERS

University of Hawaii

THE ZOANTHINIARIA (Zoanthidea) is a small group of sessile (attached) and mostly colonial anemonelike anthozoans. In shallow water these organisms, sometimes referred to as soft corals, may form extensive colonies that encrust hard surfaces or live buried in sand up to the level of their oral disks. Although skeletons are not formed, sand grains are found embedded in the tissues of some species, giving support and firmness to the polyps (Edmondson, 1946). The polyps arise from platelike (lamellate) or branching (stolonate) extensions of the body wall called the coenenchyme. This tissue contains gastrodermal canals continuous with the digestive (gastrovascular) cavity of each polyp in the colony. New polyps are budded from extensions of the gastrodermal canals rather than from old polyps. Numerous mesenteries (septa) are arranged in a pattern unlike other anthozoan orders. Muscle tissues borne on the mesenteries produce rather sluggish column and weak retractile movements (Bayer and Owre, 1968).

One shallow-water family (Zoanthidae) is represented in Hawaii by seven species in three genera—*Isaurus*, *Palythoa*, and *Zoanthus* (Walsh and Bowers, 1971). There is extensive intraspecific variation of the external morphology in *Palythoa* and *Zoanthus* in relation to habitat, and it is necessary to examine microscopic sections of the column for proper identification. For all three genera, the cnidom (description of types, sizes, and distribution of nematocysts) is of great help in identifying species. For this technical information, see Walsh and Bowers (1971). Two of the Hawaiian zoanthids have been studied in connection with their feeding responses (Reimer, 1971). A chemical component (palytoxin) from Hawaiian zoanthids has demonstrated antitumor activity in mice (Quinn and others, 1974).

Isaurus. These forms are without encrustation of the body wall and have a single mesogleal sphincter.

Isaurus elongatus Verrill 1928. Adult polyps—70 mm long, 9 mm in diameter—are usually separate but may cluster in groups of up to 50 individuals. Occasionally, colonies of up to 5 polyps are united by lamellate coenenchyme. New individuals arise as buds from the coenenchyme either near the bases of older polyps or at the ends of short stolons. After a period of development, the young polyp often loses its connection to the parent and stands alone. The column may stand vertically, horizontally, or at an angle; it may be straight or curved. Uniformity of the colony has never been observed with respect to column orientation (Fig. 1). Several rows of tubercles are seen on the upper third of the column of many large polyps. The thin-walled scapus has mesenterial insertions showing through in living specimens. The color in life is light tan (small polyps) to brown with white spots scattered randomly

Figure 1.—ZOANTHINIARIA. *Isaurus elongatus* Verrill 1928 (from Plate 1, Walsh and Bowers, 1971).

(large polyps). Often bright green areas are seen in the upper third of the column. Preserved specimens are brown. There are as many as 50 tentacles and mesenteries and up to 15 capitular ridges. The sphincter has numerous meshes; the mesoglea, numerous gastrodermal canals, cell islets, and lacunae. There are 3 to 5 basal canals

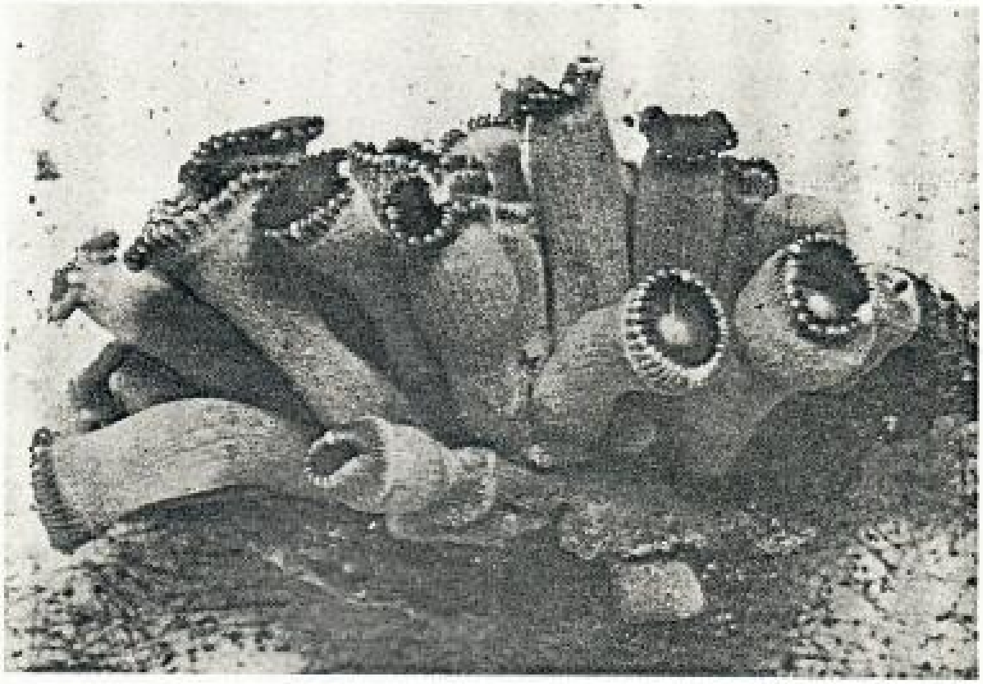


Figure 2.—ZOANTHINIARIA. *Palythoa vestitus* (Verrill 1928) (from Plate 2, Walsh and Bowers, 1971).

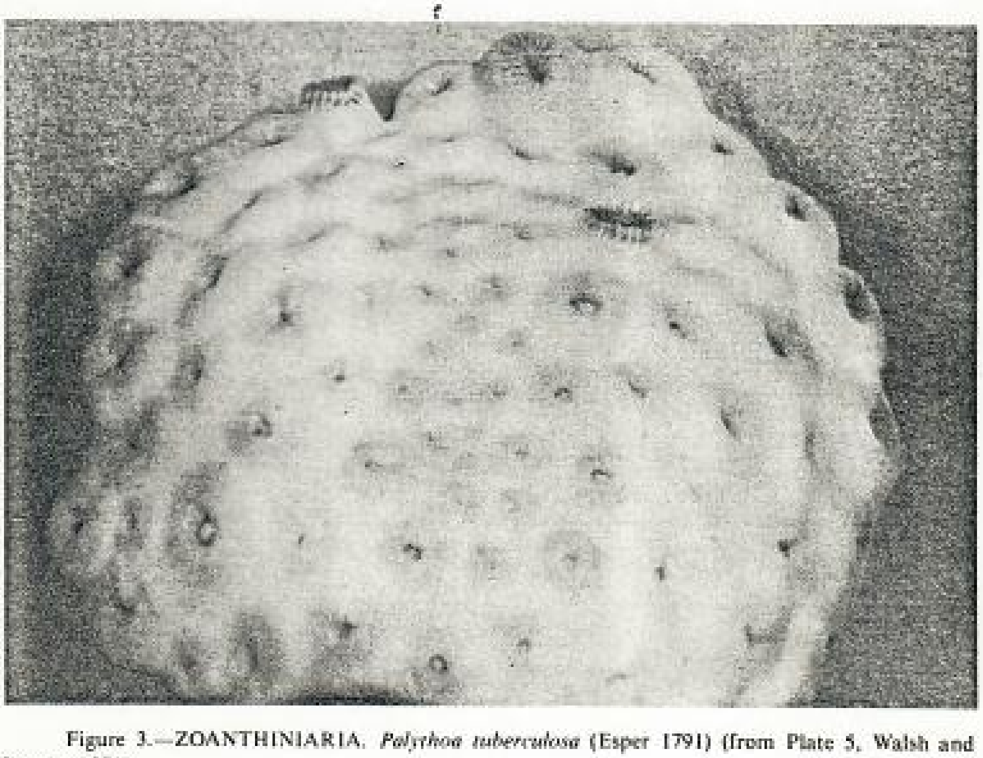


Figure 3.—ZOANTHINIARIA. *Palythoa tuberculosa* (Esper 1791) (from Plate 5, Walsh and Bowers, 1971).

along the entire length of the mesenteries. The mesoglea has numerous gastrodermal canals in the oral third of the column. This species is fairly common in the intertidal zone, where it is usually found on the undersides of rocks in subtidal shallow water, and in crevices on coral reefs. It is known from all the Hawaiian Islands.

Palythoa. In these forms, the body wall is heavily encrusted, and there is a single mesogleal sphincter.

Palythoa vestitus (Verrill 1928) [syn. *Zoanthus vestitus* Verrill]. The polyp is cylindrical when expanded, club-shaped when contracted (Fig. 2). The lamellate coenenchyme is thick, and the animal is heavily encrusted with sand. In the intertidal zone, expanded specimens may be 9 mm high with a diameter of 5 mm. In the subtidal zone, the height may be 14 mm; the diameter, 8 mm. In surge pools the height may approach 26 mm; the diameter, 11 mm. Capitular ridges number up to 30; mesenteries and tentacles, 60. The tentacles are short. The mesoglea has ectodermal, but no gastrodermal, canals. The outer half of the mesoglea of the column is embedded with sand. The inner half has numerous lacunae which contain zooxanthellae. The sphincter is moderately developed, with the largest cavities located distally. There are up to 9 canals at the basal half of the complete mesenteries. The oral disk is green or brown. The species is common on reefs, in surge pools, and in the intertidal and subtidal zones along rocky shores of Oahu, Kauai, Hawaii, and Maui. It has also been found on the reefs in Pago Pago Harbor on the island of Tutuila, American Samoa, and at Atimaono Pass, Tahiti.

Palythoa tuberculosa (Esper 1791). The polyps are immersed in coenenchyme, which may be as thick as 26 mm (Fig. 3). The mesoglea, which contains pigment

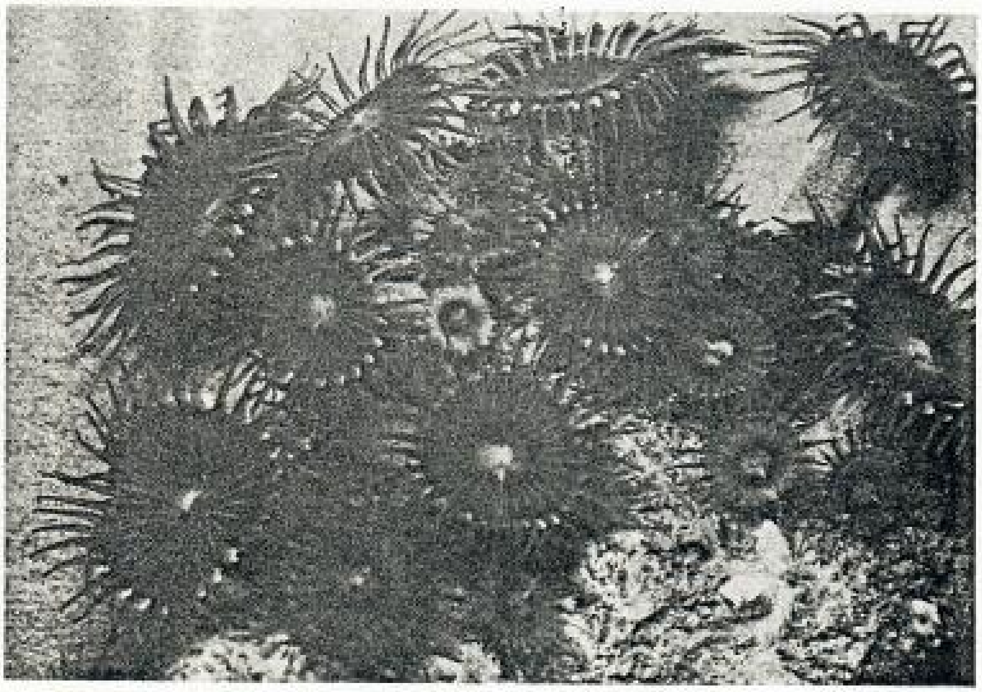


Figure 4.—ZOANTHINIARIA. *Palythoa psammophilia* Walsh and Bowers 1971 (from Plate 3, Walsh and Bowers, 1971).

granules, fills the entire space between the polyps. The diameter of living, contracted polyps removed from the colony is as much as 8 mm. There are up to 35 capitular ridges and up to 50 tentacles. The colony is heavily encrusted, the color of the animal being that of the encrusting material. There are numerous gastrodermal canals in the mesoglea. The sphincter is moderately developed. The complete mesenteries have 1 basal canal and up to 5 canals proximal to the filament. Colonies are found in surge pools, along rocky coasts, and on the reefs of Oahu, Kauai, Hawaii, and Maui. This species is known throughout the Indo-Pacific region.

Palythoa psammophilia Walsh and Bowers 1971. The polyps, buried in sand to the level of the oral disks, are erect and cylindrical. Stolonate coenenchyme attaches the colony to coral rubble below the surface of the sand. The epidermis is heavily encrusted with sand. Living polyps are as high as 22 mm and may have a diameter of 9 mm (Fig. 4). Capitular ridges number up to 30; mesenteries and tentacles, up to 60. The tentacles are long. The outer third of the mesoglea is heavily embedded with sand; it has numerous cell islets, ectodermal but no gastrodermal canals, and numerous lacunae with holotrichs and zooxanthellae. The sphincter is weak. There is a dense fibrillar tissue layer at the base of the epidermis of the oral disk. The color of the oral disk is green to light brown. The complete mesenteries have up to 6 basal canals and numerous pigment granules. The colonies are common on the sand flats of Kaneohe Bay, Oahu, the only recorded locality.

Palythoa toxica Walsh and Bowers 1971. The polyp is erect and cylindrical, with a slight swelling at the base, and is heavily encrusted (Fig. 5). The columns of expanded, preserved specimens are as tall as 14 mm with diameters up to 7 mm. The coenenchyme is lamellate. The capitular ridges number up to 30; mesenteries

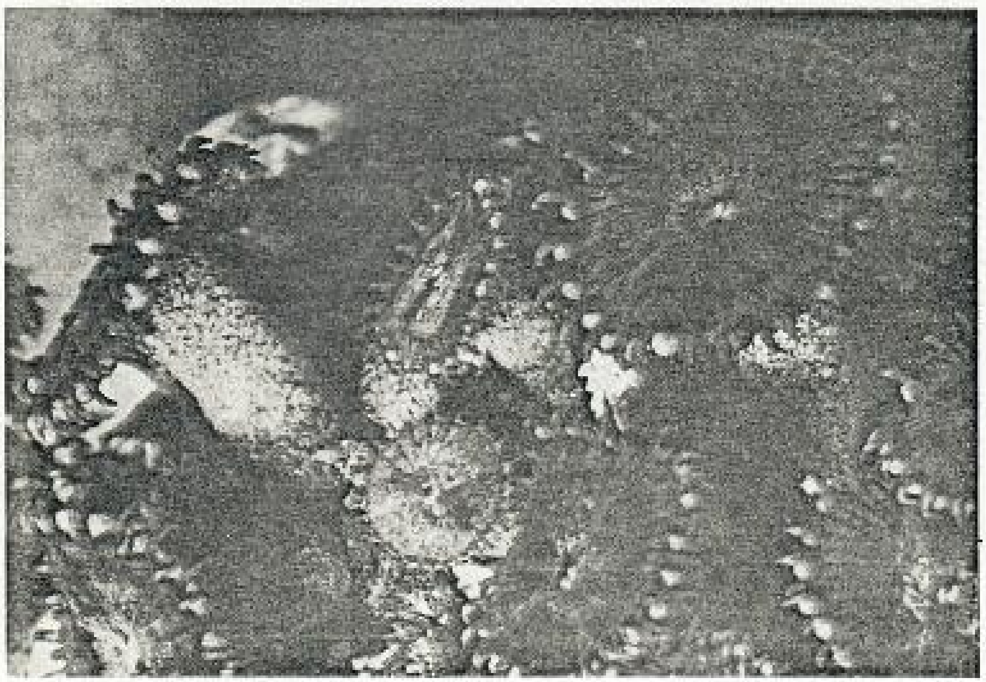


Figure 5.—ZOANTHINIARIA. *Palythoa toxica* Walsh and Bowers 1971. Disk diameter approximately 7 mm.

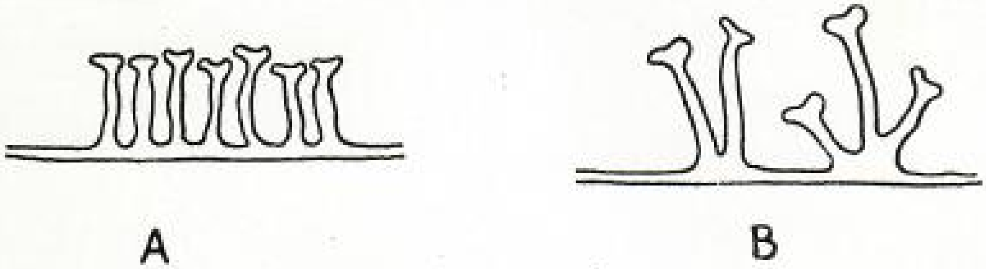


Figure 6.—ZOANTHINIARIA. *a*, Reef growth form of *Zoanthus pacificus* showing crowded polyps with separate bases; *b*, surge pool growth form of *Z. pacificus* showing less crowded polyps with bases united.

and tentacles, 60. Both ectodermal and gastrodermal canals are absent from the mesoglea, which contains pigment granules and is heavily encrusted throughout. The sphincter is weak, with cavities approximately the same size throughout. There are as many as 5 basal canals in the complete mesenteries, some of which extend into the mesoglea of the column. The oral disk is light or dark brown, often with a random pattern of small white spots around the mouth. These colonies have been reported only from surge pools at the Lanai Lookout and Blowhole, Oahu, and from the Hana District, Maui.

The name *toxica* was chosen for this species because a strong toxin is present in the mucus of the gastrovascular cavity. Great care must be taken when handling

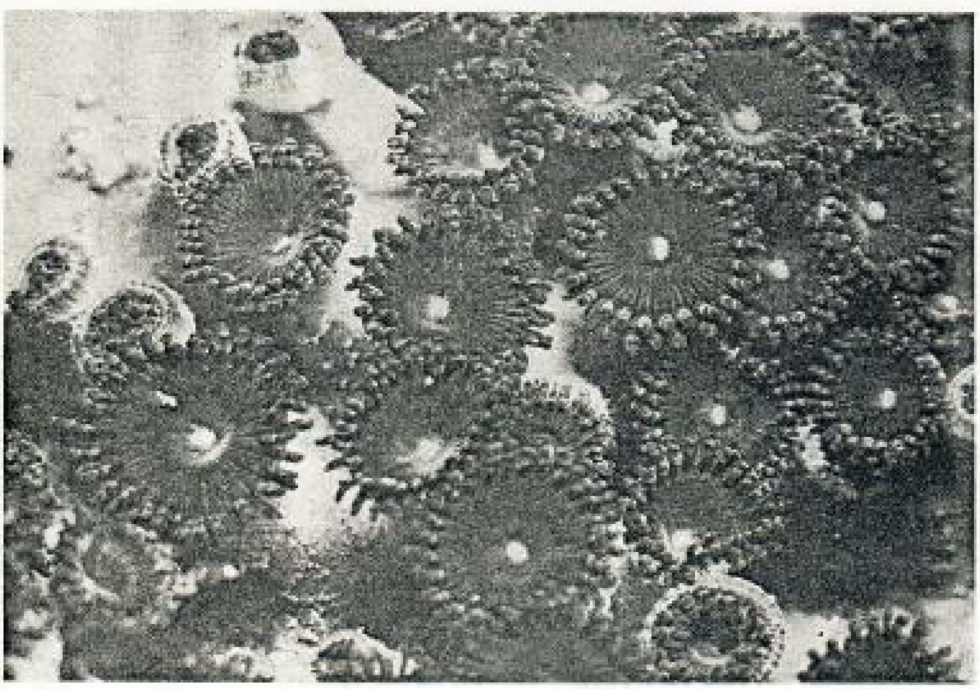


Figure 7.—ZOANTHINIARIA. *Zoanthus pacificus* Walsh and Bowers 1971. Oral disk diameter approximately 7 mm.

these polyps. A student collector, who inadvertently touched a colony to an open lesion, required hospitalization for two days (Walsh and Bowers, 1971). The toxic property of this zoanthid species was known to the early Hawaiians who called it *limu make o Hana* (deadly seaweed of Hana) and would smear it on spear points to make them fatal (Moore and Scheuer, 1971). A study on the nature of the toxin from several species of *Palythoa* has been reported (Moore and others, 1975).

Zoanthus. These zoanthids are without encrustation of the body wall and have a double mesogleal sphincter.

Zoanthus pacificus Walsh and Bowers 1971 [syns. *Zoanthus confertus* Verrill 1928, and *Zoanthus nitidus* (Verrill 1928)]. The external morphology of this species varies according to the habitat. On reefs, the polyps grow from lamellate coenenchyme and are in very close proximity to each other, but the bases are separate (Fig. 6*a*); in surge pools, lamellate coenenchyme gives rise to polyps not as crowded, the bases of which are often united (Fig. 6*b*); on rocky, wave-washed shores, the coenenchyme is either lamellate or stolonate, and the polyps are single or in groups of two to three, often between polyps of *Palythoa vestitus*. The living, expanded polyp may be 15 mm high; the diameter, 7 mm (Figs. 7, 8). Mesenteries and tentacles number up to 60. The proximal portion of the sphincter has cavities of irregular shape. Pigment granules are found in the epidermis and in the outer half of the mesoglea which has numerous ectodermal and gastrodermal canals. There is a single basal canal along the entire length of the complete mesenteries. The colonies are common on the shores of Oahu, Kauai, Hawaii, and Maui. This species is also known from Pago Pago Harbor on the island of Tutuila, American Samoa, and on the reef at Atimaono Pass, Tahiti.

Figure 8.—ZOANTHINIARIA. *Zoanthus pacificus* Walsh and Bowers 1971. Oral disk diameter approximately 7 mm.

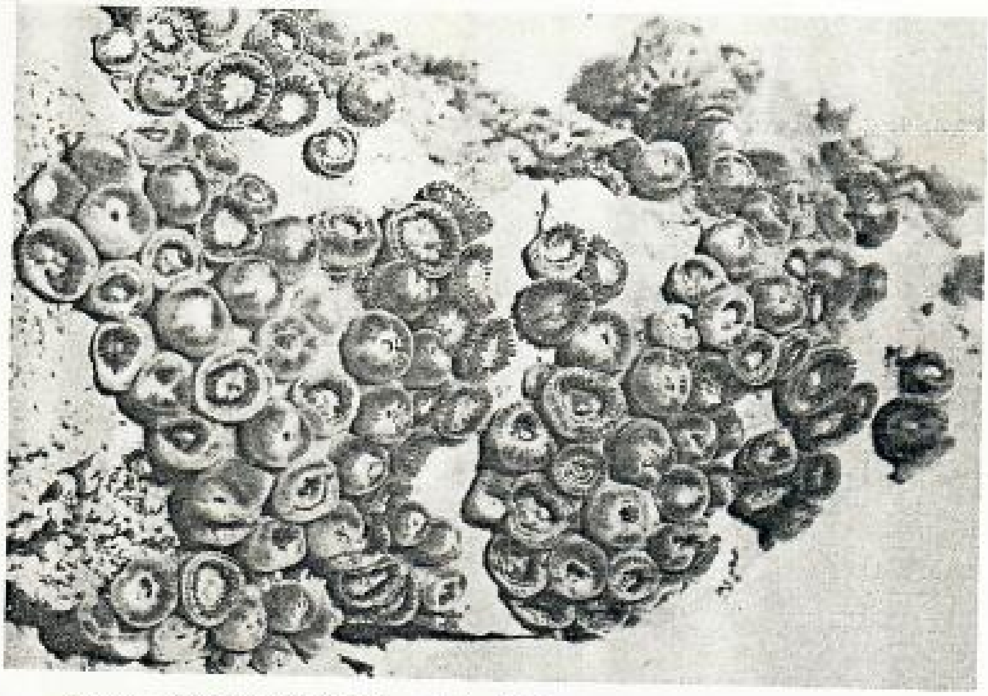


Figure 9.—ZOANTHINIARIA. *Zoanthus kealakekuaensis* Walsh and Bowers 1971. Disk diameter approximately 5 mm.

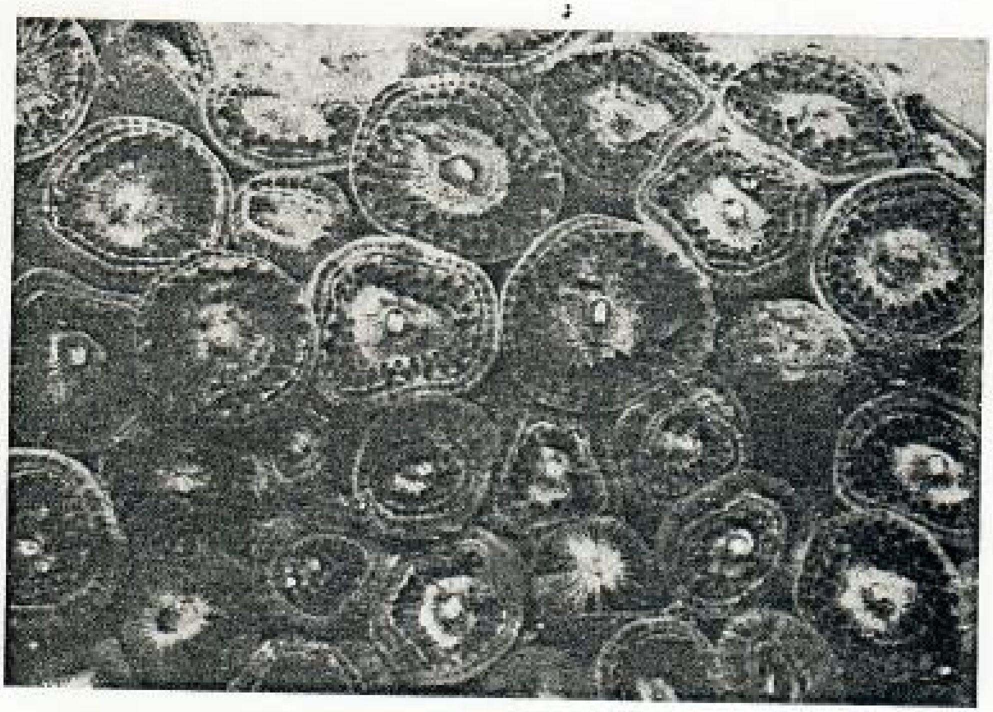


Figure 10.—ZOANTHINIARIA. *Zoanthus kealakekuaensis* Walsh and Bowers 1971. Disk diameter approximately 5 mm.

Zoanthus kealakekuaensis Walsh and Bowers 1971. The lamellate coenenchyme is highly developed, often extending to half the column height. Polyp bases are separate, and the height of living, expanded polyps may reach 10 mm; the diameter, 5 mm (Fig. 9). Mesenteries and tentacles number up to 54 (Fig. 10). All the cavities of the proximal portion of the sphincter are elongate. The mesoglea is without gastrodermal canals and has no pigment granules. The basal canals of the complete mesenteries are 5 in number at the base of the column. There is a single basal canal at the oral end. These colonies have been reported only from the intertidal zone of Kealakekua Bay, Hawaii, living on lava rock. As in *Palythoa toxica*, the gastrovascular mucus of *Z. kealakekuaensis* appears to contain a toxin and should be handled with great care (Walsh and Bowers, 1971).

GLOSSARY (ZOANTHINIARIA)

basal canals: small canals, located where the mesenteries are attached to the column and running parallel to the mesenteries.

capitulum: upper, short, thin-walled region of the column; sometimes having ridges.

capitular ridges: see **capitulum.**

cell islets: small groups of pigmented cells irregularly scattered in the mesoglea. The islets appear to be groups of ordinary mesogleal cells.

coenenchyme: an extension of the columns (body walls) of polyps; a common tissue which connects the polyps of a colony; it may appear as stolonate, lamellate, or as flattened expansions, which may fill the spaces between polyps.

column: the body wall of the polyp.

encrustations: except for *Zoanthus* and *Isaurus*, zoanthids incorporate sand grains, sponge spicules, foraminifera tests, and other hard particles into the body wall.

filament: see **mesenterial filament.**

gastrodermal canals: canals that connect the gastrovascular cavity of all polyps in the colony. These are found throughout the coenenchyme and can initiate the formation of new polyps.

gastrovascular cavity: the main area for digestion in the polyp, beginning at the mouth (located on the oral disk) and containing various regions of cell specialization, the mesenteries, and the gastrodermal canals.

holotrich: nematocyst with a tube of uniform diameter which is uniformly armored throughout its length; it is typically long, with a thin capsule and a nearly or completely coiled content.

lacunae: open spaces of various sizes in the mesoglea.

mesenterial (septal) filament: the free edge of each mesentery below the pharynx.

mesentery (septum): a longitudinal partition in the gastrovascular cavity of anthozoans which divides the cavity into chambers. The mesenteries are composed of gastrodermis and mesoglea. Complete mesenteries are those continuous from the column wall to the gastrovascular cavity.

mesoglea: a gelatinous transparent matrix that comprises the central portion of the body wall between ectoderm and entoderm.

mesogleal sphincter: present in the capitular region of the column of all shallow-water Hawaiian zoanthid genera; it is composed of a single band of muscle tissue in *Isaurus* and *Palythoa*, a double band in *Zoanthus*.

nematocyst (stinging cells, nettle cells): a cell organoid which consists essentially of a capsule containing a coiled capillary tube which, upon stimulation, discharges to the outside by turning inside out.

oral disk: the tissue that extends between the base of the tentacles and the mouth.

scapus: lower, thick-walled region of the column.

sphincter: see **mesogleal sphincter.**

ectodermal canals: large ectodermally lined canals which penetrate the mesoglea; the canals course in a radial direction and may pass into the mesenteries.

zooxanthellae: vegetative state of symbiotic dinoflagellate algae found in the tissue of some zoanthids.

Friday, February 8, 1980 Honolulu Star-Bulletin B-3

Dr. Clyde Roper of the Smithsonian Institution and Carla Skinder of the New England Aquarium examine the mammoth squid.

One Squid, Plenty Pupu!

BOSTON (AP)—A deep sea monster—450 pounds of squid—went on display this week at the New England Aquarium, as experts tried to figure how the beast reached the shores of Massachusetts.

The giant squid—not unlike the one battled by Captain Nemo, 20,000 leagues under the sea, in the Jules Verne classic—was found dead last weekend on Plum Island, Mass.

It was discovered by wildlife rangers at the Parker River Natural Wildlife Beach. Ten men were rounded up by the aquarium to carry it by stretcher from the beach.

The squid is about eight feet in body length, with tentacles 10 to 16 feet long. Nothing like it had been seen in Massachusetts since a similar squid was found in 1908.

Giant squids, according to aquarium experts, generally live 500 to 1,000 feet deep in the ocean.

Aquarium staff members said Wednesday the new specimen will be pumped full of a liquid formula to preserve it.

It will be on display for three weeks, then moved to the Museum of Comparative Zoology at Harvard.

The Honolulu Advertiser 5/13/96 A3

More than 300 treated for jellyfish stin[g]s at Waikiki

By Walter Wright
Advertiser Staff Writer

More than 300 swimmers and surfers were treated for box jellyfish stings on Waikiki Beach yesterday. Scattered incidents also were reported at Ala Moana, Sandy Beach and Punaluu.

Water Safety Capt. Edmund Pestana said lifeguards would check the shoreline at dawn today to see if warning signs need to be posted again.

By 2:30 p.m., a total of 306 persons had been treated at the several lifeguard stands on Waikiki Beach, and another 11 at Ala Moana Beach, Pestana said.

"A lot of the people getting stung are tourists, and they are just taking a chance" and entering the water despite the warning signs, Pestana said.

"Surfers were getting stung paddling out by Number Threes and Poplars, two of the outermost surf spots off Waikiki, so they (the jellyfish) are on the surface way out there," Pestana said.

Surfers who insist on going in the water should wear some sort of jersey to cover their arms and reduce the chance of stings while paddling, he said.

Pestana said it was the worst outbreak of stings in about two years.

"I had 50 calls from persons asking if it was safe to go in, and I tell them it's just not worth the risk," Pestana said.

Pestana said lifeguards will be back at their stations again this morning, stocked up with "Sting Aid," a spray-on antidote that helps neutralize the toxin carried in the jellyfish tentacles.

■ **Surf meet boxed in by jellyfish. See story, Page D5.**

Advertiser photo by David Yamada

Waters at Waikiki, abandoned yesterday. The reason — the aftermath of some kona winds and a change of current.

Sunday

Star-Bulletin & Advertiser

The jellyfish blues

"Mother, may I go out to swim?
Yes, my darling daughter:
Hang your clothes on a hickory limb
And don't go near the water."

So says the old nursery rhyme — and so said the Civil Defense and lifeguards in Waikiki yesterday.

But it wasn't mama's dread of drowning that kept folks high and dry on the beach — it was the jellyfish convention hitting town.

The jellyfish show up at swimming beaches once or twice a year, and their stings quickly clear the water.

At last count, nobody was seriously hurt, at least not enough to be hospitalized, but at least 10 people were treated at local medical centers.

Although that doesn't sound too bad, for those stung by the little water critters, it's something akin to having one's body charged with electricity. It starts with gooseflesh, that creepy-crawly body invasion feeling, and goes to abdominal pains and even a sense that one's breathing apparatus has been tampered with. That's what they say, anyway.

Swimmers all along Waikiki, Ala Moana and even at Hanauma Bay were warned that going into the water risked all of the above.

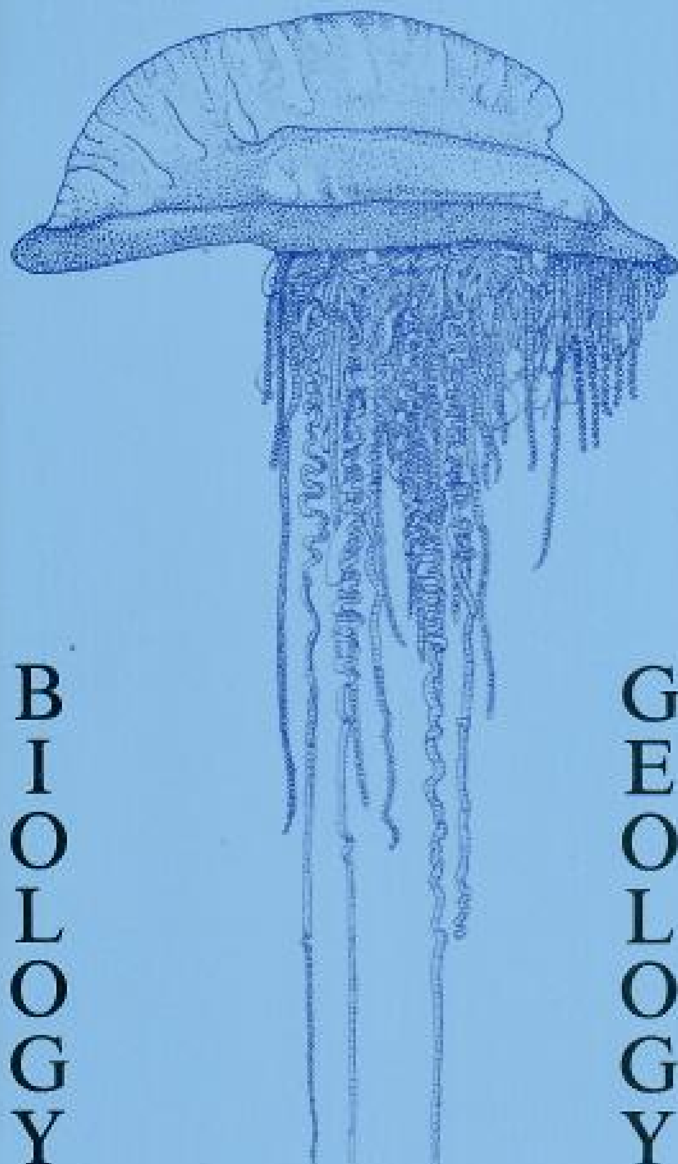
Lifeguards were treating the situation the usual way — meat tenderizer — and hospitals were adding alcohol to it to make a paste.

Swimmers who hit the beach today might be wise to check with lifeguards to see if the danger is past.

Hawaii Report

Honolulu, April 22, 1979 A-3

B I O L O G Y



G E O L O G Y

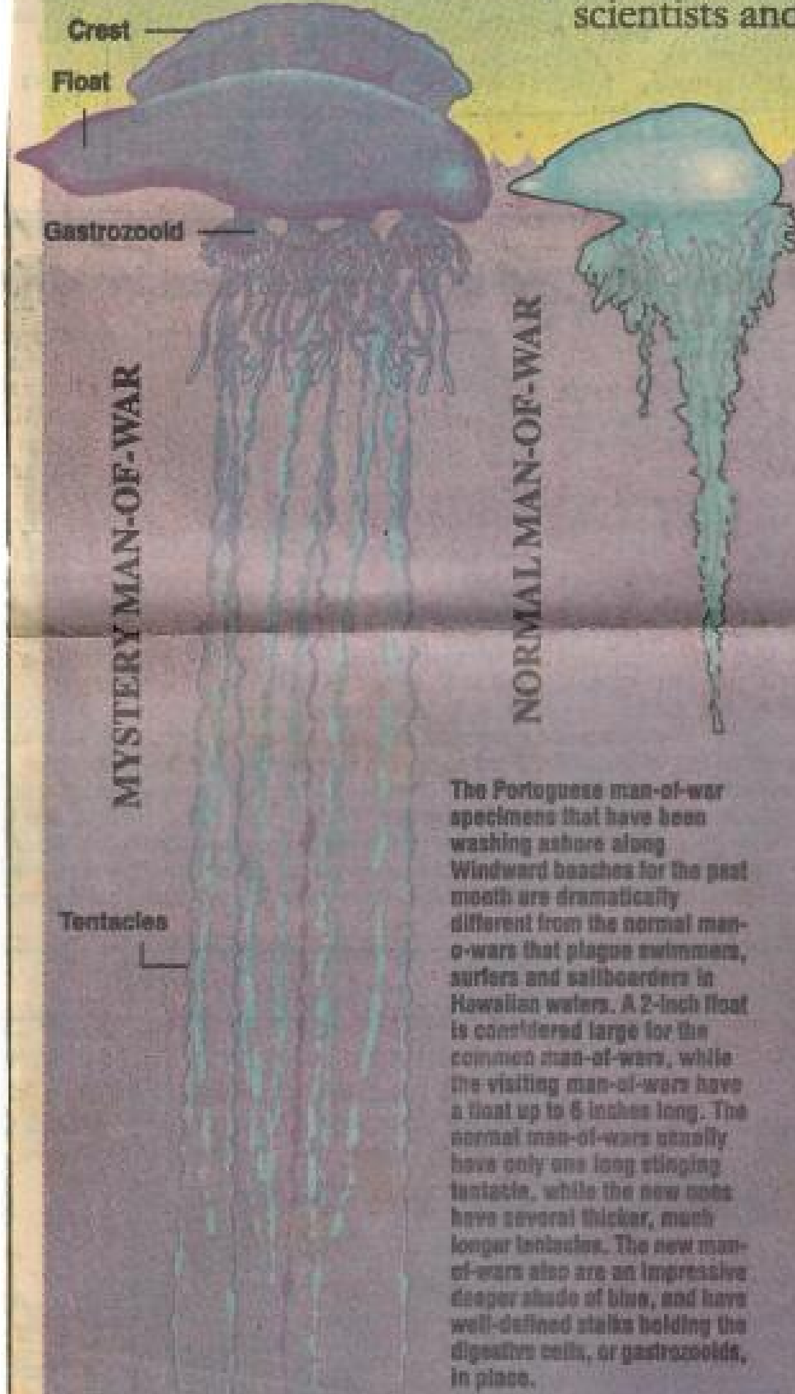
E. J. Brill — Leiden — 1984

A1 9/9/95 Honolulu Star-Bulletin

Man oh man oh man-of-war

A new species of man-of-war is perplexing scientists and terrorizing beach-goers

By Greg Ambrose
Star-Bulletin



The Portuguese man-of-war specimens that have been washing ashore along Windward beaches for the past month are dramatically different from the normal man-o-wars that plague swimmers, surfers and sailboarders in Hawaiian waters. A 2-inch float is considered large for the common man-of-wars, while the visiting man-of-wars have a float up to 6 inches long. The normal man-of-wars usually have only one long stinging tentacle, while the new ones have several thicker, much longer tentacles. The new man-of-wars also are an impressive deeper shade of blue, and have well-defined stalks holding the digestive cells, or gastrozooids, in place.

By Bryant Fukutomi, Star-Bulletin

A fleet of nasty, blue-tailed devils has been washing ashore from Kahuku to Makapuu for the past month, causing beach-goers to scurry to safety.

The culprits look like Portuguese man-o-wars on steroids, with beautiful cobalt blue 6-inch floats and frightening tentacles that appear thick enough to snare an ahi.

The invasion has stimulated a host of questions from beach-goers, such as what are these monsters? Where are they coming from? How painful is their sting? Why are they here? And when will they leave?

These new visitors are prompting more questions than answers from scientists.

When someone told Waikiki Aquarium education specialist Carol Hopper about the mystery visitors, her first thought was maybe there had been an increase in the prey of man-o-wars that allowed them to gorge and grow to a particularly large size.

Then she saw them beached while hiking along the Kahuku shoreline, and she wondered if perhaps the Atlantic man-o-wars had mated with the much smaller Pacific man-o-wars.

Still pondering how these dramatically different critters got here, Hopper briefly considered that jellyfish are transported by ships to new areas during their larval stage in the saltwater ballast. But because man-o-wars spend their life riding the winds on the open ocean, not enough is known about their life cycle to make a good guess.

Scientists still disagree on the most-basic question of whether there is only one species of man-o-war, *Physalia physalis*, with a huge range of diversity in size and color. Some argue that the smaller Pacific man-o-wars constitute a

PLEASE SEE **MAN-OF-WAR, A-4**

Kauai and Oahu beachgoers hit by a big sting

HONOLULU ADVERTISER 10/1/94
OCT. 1, '94 A1

By Jan TenBruggencate
Advertiser Kauai Bureau

Two of the most despised creatures of the Hawaiian shoreline have hit the south shores of Oahu and Kauai in the past two days, stinging dozens of beachgoers with powerful venom.

Kauai lifeguards yesterday closed Poipu Beach Park to swimming after a bather came out of the water about 9 a.m. with a long, painful red streak on his arm. He'd swum into a Portuguese man-of-war.

INSIDE:

■ How to treat stings / **Page A2**

Lifeguard Jay Gardner said he inspected the beach after treating the man, finding more of the small, bluish creatures than he could count, washed up in the high wash of the waves.

He put up no-swimming signs; a few folks went in anyway.

On Oahu, more than 40 people Thursday were treated for stings from box jellyfish, lifeguard Capt. Ivan Harada said.

In each case, lifeguards treated victims with a product from their medicine chests called Sting-Kill, containing Benzocaine and menthol. Local folks dealing with such attacks have developed a range of home remedies.

"Do you want to know what my dad does or what I do," asked one woman. "I use meat tenderizer. He uses pee."

Another woman said she carries apple cider vinegar to treat Portuguese-man-of-war stings.

Floating pain

Two main stinging creatures in Hawaii's shoreline waters are the box jellyfish and the Portuguese man-of-war.

The tentacles of both are used by the creatures for fishing. They contain powerful venoms that paralyze fish, which are then consumed.

■ The **box jellyfish** is a true jellyfish, 2 or 3 inches in diameter, with 4 stinging tendrils dangling several inches from its translucent body. It is capable of movement, and seems to come ashore on a regular basis, not entirely related to the weather.

■ The **Portuguese man-of-war** is a different kind of creature, not jelly-like at all but with a blue-purple, gas-filled bladder, under which dangles a very long blue tentacle covered with stinging cells called nematocysts. It is largely subject to wind and current for its movement, and washes up on Hawaii's shores with onshore winds.

Advertiser graphic

4/20/90 THA A4

The stings in the tide

Steeply rising and falling tides are believed to be the cause of an abundance of box jellyfish — and stings to numerous swimmers and surfers — off Waikiki Beach this week.

Yesterday, between the Kapahulu Wall to the Moana Hotel, the city's Water Safety Office put up signs warning swimmers of the jellyfish, which are hard to see in the water because they are transparent.

The signs were removed at sundown yesterday but will be put back up again at sunrise today if the jellyfish are still around then, said Capt. Ivan Harada of the Water Safety Office.

"When we're called to treat someone stung by a jellyfish, we mix vinegar and unseasoned meat tenderizer into a paste and apply it," Harada said.

"That breaks down the enzymes in the sting."

4/19/90 THA C3

Stinging box jellyfish invade Waikiki

Advertiser photo by Charles Okamura

Sign at Kuhio Beach warns bathers about jellyfish danger.

City water safety officials will check Waikiki Beach and Ala Moana Park this morning to see if warning signs will remain posted following an invasion of venomous jellyfish.

About two dozen people reported stings from the box jellyfish yesterday morning. None required hospitalization.

Earlier this year, Hanauma Bay was closed to swimmers for a day after box jellyfish invaded Oahu's south shores. There were no reports of jellyfish at Hanauma yesterday, the water safety division said.

If you get stung, the water safety division advises you wash the wound with alcohol, vinegar or ocean water. Avoid washing with fresh water. Then gently apply a paste of meat tenderizer containing papain or baking soda to neutralize the venom.

5/26/92 TTA

Jellyfish hitting beaches

30 swimmers seek treatment

City lifeguards yesterday posted warning signs at Waikiki and Ala Moana beaches after about 30 swimmers sought medical attention for box jellyfish stings, said lifeguard Capt. Ivan Harada of the Water Safety Division.

Symptoms include difficulty in breathing and abdominal cramps, Harada said. Ambulances responded to at least five calls by 2 p.m., which lifeguards said was the peak of the problem.

Swimmers were usually treated and released after receiving a shot that relieved the symptoms, Harada said.

No beaches were closed yesterday, and lifeguards planned to check again this morning to see if the translucent invaders returned.

Harada said southerly winds apparently were the cause for the jellyfish coming into the near-shore area yesterday.

An effective home remedy for jellyfish stings is to make a paste of vinegar plus unseasoned meat tenderizer that contains paba, Harada said. Enzymes in the paste break down proteins in the venom.

Advertiser photo by Richard Ambo

Despite warnings, beach-goers ventured into waters off Ala Moana Beach yesterday.

2/28/92 THA A1

Stealth stings shut Sandy Beach, Hanauma

By Walter Wright
Advertiser Staff Writer

An invasion of nearly invisible stinging box jellyfish forced closure of popular Hanauma Bay and nearby Sandy Beach yesterday when several persons in the water were stung, one so badly she was taken to a hospital for treatment.

Lifeguards, police and recreation workers took an hour to clear about 800 persons from Hanauma Bay beginning at about 9:45 a.m., and Sandy Beach was closed at 11 a.m., Water Safety Capt. Jim Howe said.

At Hanauma Bay, park manager Alan Hong said visitors didn't want to leave.

"If we could have been certain that they would stay out of the water, we wouldn't have had to close the park," Hong said, "but once people get down on the beach it would take an army of armed personnel standing every few feet to keep them out of the water."

Hong said some beachgoers argued that they could go in the water and avoid the jellyfish.

"But the box jellyfish is almost completely transparent, and it would be very difficult for anyone to see it, let alone avoid it," he said.

The jellyfish, known in Australia as a sea wasp, is roughly rectangular in shape, about two inches in diameter by three inches long, with translucent tentacles hanging down another four inches.

The box jellyfish has a much stronger sting than the more common Portuguese man-of-war, which is also easier to see in the water.

> The box jellyfish "present a serious, real threat to the public"
> — **Water Safety Capt. Jim Howe**

"They present a serious, real threat to the public," Howe said.

"When the lifeguards arrived on the beach, they saw about 100 jellyfish up on the shore at Hanauma Bay, and within the first hour of the beach being open they had six stings, including the person who was sent to the hospital," Howe said. The woman was treated and released, a hospital spokeswoman said.

Officials said the same jellyfish had been seen recently in the Waikiki area as well, but Windward and North Shore beaches reportedly were not affected.

Howe said officials "believe the jellyfish came in from the Kaiwi Channel with the recent onshore winds. With the winds changing back to normal trades, we expect they will be blown out again."

But Hong said he would wait to see if jellyfish are still present before deciding whether to reopen Hanauma Bay today.

Advertiser photo by Gregory Yamamoto

This box jellyfish was captured in a glass jar yesterday at Hanauma Bay.

Box jellyfish invasion shuts Hanauma Bay

By Sandra S. Oshiro
Assistant City Editor

Hanauma Bay was closed to swimmers and warning signs were posted along Waikiki Beach yesterday after jellyfish invaded Oahu's south shores for the second day in a row.

The box jellyfish, packing a nastier sting than their Portuguese Man-of-War cousins, stung more than 60 people at Hanauma Bay by mid-day yesterday and another 60 people at Waikiki, said Capt. Ivan Harada of the city Water Safety Division.

One 14-year-old girl was treated and released from Kapiolani Medical Center for Women and Children after she was stung at Hanauma Bay and developed an allergic reaction, said Harada.

Swimming at Hanauma was banned at 10:30 a.m. after the number of sting cases there began to mount.

Despite warnings from lifeguards, some people continued to wade and swim in the infested waters. People were allowed to sunbathe on the sand, however, Harada said.

City officials will decide today whether the swimming ban will remain in effect.

"We're just playing this from day to day," Harada said. If kona winds continue, the infestation could remain a problem through today, he said.

Box jellyfish are usually two to three inches long with tentacles several feet long.

They look squarish in the water, said Reid Withrow, Waikiki Aquarium's acting curator of live exhibits, but "if you see it on the beach it looks like a glob of translucent mush."

Dead or alive, their venom is still active, he said.

Those who get stung should wash off the wound with fresh water and rub it gently with a paste made of meat tenderizer or baking soda and water.

In rare cases, a sting can cause an allergic reaction.

THA 3/22/90

Advertiser photo by Bruce

Beachgoers beware

City lifeguard Seth McKinney puts up a sign warning Wa beachgoers of an invasion of box jellyfish yesterday. A of swimmers and waders there and at Ala Moana Beach stung by the venomous creatures, said Capt. Ivan Harad the city Water Safety Division. Officials will check the bea this morning.

TUESDAY, MARCH 20, 1990

UPDATE

Jellyfish blown inshore at Waikiki

Jellyfish were reported close to shore at several Waikiki beaches this morning, believed caused by southerly winds.

While there were no initial reports of stings, city lifeguards said a small number of jellyfish were seen in the area of the Pacific Beach Hotel and further down shore near the Hilton Hawaiian Village Hotel.

City water safety chief Ralph Goto said lifeguards will post warning signs if the problem worsens.

Numerous marine worms wash up on Lanikai Beach

7-3-89 HSB A2

OCEAN WATCH

By Susan Scott

A large number of worms washed up on the beach at Lanikai recently, causing a stir among swimmers and beachwalkers. It's certainly understandable — most people are about as thrilled to see worms on their beach as they are to see great white sharks.

But even though these small worms were from the fireworm family they didn't seem to be hurting anyone and they were beautiful: They had orange bellies, purple spots on the back and yellow bristles.

These and all fireworms belong to a large class of marine worms called polychetes.

Polychetes are segmented worms similar to earthworms except each segment has a tiny foot protruding from each side. Bundles of bristles stick out of the end of each foot like little whisk brooms, and that's where these worms get their name. Polychete means many bristles.

When free-swimming polychetes crawl over the ocean floor, the little feet take steps and the bristles help them grip the bottom. The bristles are sharp, protecting the animal as well as enabling it to hold onto the smooth walls of its burrow.

In the fireworm family, the bristles are like little harpoons that break off in the skin if you touch them with bare hands. The tips introduce a toxin which can cause itching and pain of various degrees.

The worms that washed onto the Lanikai beach are much smaller than the ones people here usually call fireworms but they are all members of the same family.

And even though the bristles easily fell off the Lanikai worms when I looked at them on the beach, no swimmers that I saw felt any stings.

So what were they doing there? They probably got stranded in the onshore currents after coming to the surface to spawn. Many polychetes have mating rituals that involve swarming at the water's surface at certain times of the year.

When Columbus approached the North American coast for the first time, he reported seeing something that looked like "candles moving in the sea." Researchers suspect that he may have been seeing the mating ritual of the polychetes called Bermuda fireworms, which glow in the dark during mating time.

In the summer, for a few days after the full moon, these bottom-dwelling worms swarm near the surface. The females swim in tight circles while throwing off a green light; the males are attracted to this light and swim toward it, making glowing green lines as they move forward.

Amid these circle-and-arrow fireworks, the males and females release their eggs and sperm into the water, and fertilization takes place. The light from these worms is bright enough that people can easily watch this ritual from a beach or boat.

Another polychete called the Pacific palolo worm swarms on one single night of the year, usually the seventh night after the first full moon of the autumn equinox.

The timing of this event was so predictable that this day marked the beginning of the new year in pre-Christian Samoa.

The palolo worms are so numerous on this one night that the water looks like boiling spaghetti. Samoans collect them by the netful, then pool them for a communal feast.

I have never heard of anyone eating polychetes in Hawaii, but we have enough to feed an army. More than 243 different species live in Hawaiian waters, but this count is not complete since researchers continually find more.

Polychetes are one of the most common animal groups in the ocean but we seldom see them because they often live under rocks or hide in sand and mud burrows. Most of us are familiar with a few species like the beautiful fanworms called featherdusters that live in harbors, but unless the free swimmers are swarming at the surface, we don't know they're there.

Some species of these worms are important to our coral reef stability by forming tubes of cemented sand grains or calcium carbonate. Others break up dead coral or deposits of coralline algae.

A few polychete species serve as indicators of polluted environments since they grow in great numbers where the water has some "organic enrichment," polite words for sewage.

Susan Scott is a marine ... writer and author of Ocean... guide to Hawaii's m... Her Oceanwatch... Monday in t...

A-2 Honolulu, April 2, 1989 The Sunday Star-Bulletin & Advertiser

Jellyfish ride with the tide; city says the coast is clear

That pesky flotilla of box jellyfish appears to have ridden quietly out of town on Friday night's high tide after showing swimmers from Kewalo Basin to Diamond Head who's really the boss.

The Water Safety Division of the city parks department sounded the all-clear for beach-goers at 9 a.m. yesterday, reopening popular beaches along a 3½-mile stretch of Oahu shoreline that had been closed since about midday Friday.

The invasion actually began shortly after midnight Thursday, when the first of about 50 victims tangled with the tentacles of the pint-sized pests.

Nine people, ranging in age from 10 to 41, were treated and released from local hospitals and clinics Friday after being stung by the jellyfish, which measured 1½ to 3 inches high and about 3 inches in diameter.

"We sent people out to check the shorelines and we went out in our inflatable boat and we found only a few along the shoreline," Capt. Ivan Harada of the Water Safety Division said yesterday.

A-2 Honolulu, April 30, 1989 The Sunday Star-Bulletin & Advertiser

Jellyfish at three beaches sting more than 40 Oahu swimmers

Venomous box jellyfish stung more than 40 swimmers in Waikiki, Ala Moana and Hanauma Bay waters yesterday, but no one was seriously injured, city Water Safety Division officials said.

Officials described yesterday's infestation as a minor one, unlike the invasion in late March that closed some beaches and sent nine people to hospitals and clinics with severe stings.

The beaches were kept open yesterday but signs were posted warning beachgoers of the jellyfish, which can sting with their long tentacles.

Officials said they hoped that the beaches will be clear of the pests today as overnight high tide washes them back out to sea.

The exact number of people stung wasn't known, but officials report at least 30 swimmers were stung at San Souci Beach, where they were training for an upcoming competition, and 10 swimmers suffered stings at Ala Moana Beach Park. A few more people were stung in Waikiki waters and Hanauma Bay, they said.

Minor stings can be treated with a vinegar rinse followed by a paste of meat tenderizer. In rare cases, people allergic to jellyfish poison can suffer anaphylactic shock, a potentially fatal reaction.

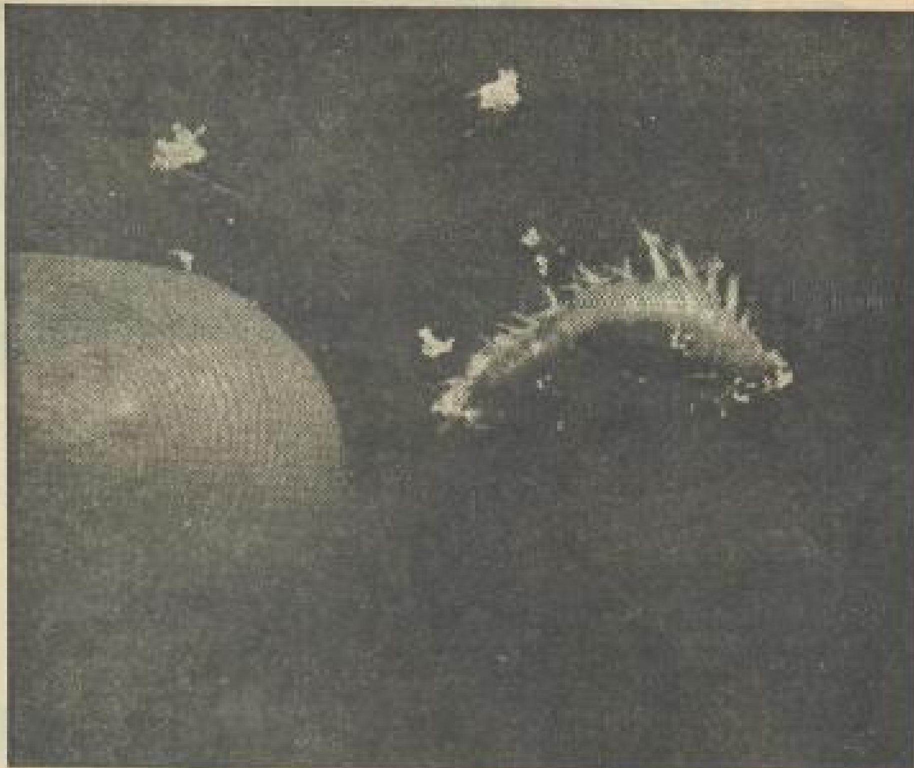
A new visitor pays a call at Lanikai Beach

□ The tiny creature could be a cousin of the 'fire worm'

A3

6-23-89
HSB

By Peter Wagner
Star-Bulletin



By Dean Sensui, Star-Bulletin

Who are these critters, anyway? These tiny, wormlike creatures came ashore at Lanikai Beach yesterday, causing some interest but apparently no problems.

They're small and spiny, and strewn on the beach they look like thousands of tiny orange petals.

That's how Peggy Hodge, a longtime Lanikai resident, described the strange creatures she spotted on Lanikai Beach yesterday after a morning stroll.

"I've been walking the beach every day for the past 30 years, and this is the first time I've seen this," Hodge said.

Scientists believe the critter, about a half-inch long and spiny on one side, is a sea worm called *Chloeia* flava. If so, it is closely related to "fire worms" that can leave minute spines in your skin.

Officials, therefore, advise leaving these worms, fiery or not, alone.

Chloeia flava lives on the sea bottom at depths between 600 and 2,000 feet, said Patrick Conant, an entomologist at the state Department of Agriculture. They come to the surface to spawn, which could have caused them to be blown ashore, he speculated.

Specimens examined yesterday were full of eggs, he said.

Conant doesn't believe the worms can do much harm to swimmers, "unless they get between you and your swimsuit."

Marine fisheries experts yesterday hadn't yet examined the visitors and couldn't comment on the phenomenon.

It wasn't immediately known if the worms washed ashore anywhere else.

"It's a weird thing," said Hodge, who picked one up without being stung. "When you put them on your hand you can see they look just like little caterpillars."

Jellyfish give beachgoers competition

☐ Uninvited guests wash up on a stretch of Waikiki's sand

By Crystal Kuo
Star-Bulletin

The 20 or so clear blobs sprinkled with sand were scrunched together in Doug and Lillian Eastoe's plastic bag.

"I've been coming here for 15 years and I've never seen them like that," Lillian Eastoe said, nodding to the stretch of Waikiki Beach where she had gingerly picked up the slimy creatures.

She was referring to the bubbly transparent jellyfish called *cubomedusa*, a relative of the lethal Australian sea wasp, which littered Waikiki Beach from the Moana Hotel to Queen's Surf yesterday.

The Eastoes, who vacation each winter in Hawaii to escape the cold of their Canadian home, had tried to clean the beach of as many jellyfish as they could.

Ralph S. Goto, the city's water safety administrator who oversees all city lifeguards, took the Eastoes' bag of see-through sea creatures to the Waikiki Aquarium, where they were identified by Carol Hopper, staff science adviser.

The cubomedusa sting is stronger than that of the Portuguese man-of-war but its effects are not deadly, she said.

The sting from the cubomedusa resemble "gecko feet marks" while a man-of-war sting "looks like the skin was whipped with little leaves," Hopper said. Doctors are able to tell the difference just by looking at the marks, she said.

The creature's body is square-shaped (thus the name "cubomedusa" refers to its cube shape) and it has reddish tentacles, Hopper said.

Waikiki police saw beached jellyfish from 1:45 a.m. on the shore fronting Fort DeRussy Park.

Some beachgoers had been stung but no serious cases were reported, Goto said.

Goto was out replenishing supplies of meat tenderizer and vinegar, which ease the pain of jellyfish stings, to all lifeguards after he learned the jellyfish were washing ashore.

Signs warning of Portuguese men-of-war in the water were posted near all lifeguard stands in Waikiki.

Yesterday's high tide and Kona winds were the right conditions for the critters to end up on shore, Goto said. By late yesterday morning, the tide and the normal tradewinds were pulling them back into the ocean.

But Goto feared that the jellyfish caught in the ponds fronting the Pacific Beach Hotel and the Holiday Inn may have a tougher time getting out to sea.

In March, jellyfish washed up on the leeward beach of the Hilton Hawaiian Village Lagoon and along a stretch from Sans Souci to Kuhio Beach.

The warnings did not stop some people from swimming or walking close to the shoreline.

Some beachgoers, including a woman hunting shells, weren't even aware of the problem.

"Oh, no. What do they look like?" said answered when she was asked if she'd seen any during her beachcombing.

12-4-88

By Craig T. Kojima, Star-Bulletin

The transparent jellyfish called cubomedusa, whose sting is strong but not deadly, has littered Waikiki.

HSB

7/11/79 A-1

Don't know what they are, but there's a lot of 'em

Thousands upon thousands of tiny, dead shellfish have been washing up on Kaua'i shores for the past two weeks, and the identity of the creatures has scientists puzzled.

Marine Adviser Jeremy Harris says the first of a dozen reports came last Monday, and since then reports have come in from all around the island.

A sample of the dime-sized crustaceans was sent to Honolulu, but scientists there were unable to identify the specimen. The only thing that could be concluded was that the creatures are some form of crustacean in its larval form.

Harris said identification is difficult because the creatures change form after each molting, which may happen up to a dozen times before the crustacean is full-grown.

Harris guesses that the creatures are probably crab, and if all of them are like those he has seen, they probably come up from "mid-water" level, about 1700 feet deep.

University of Hawai'i scientists believe the shellfish are shrimp.

LARVAL CRUSTACEANS . . . like these have been washing up on Kaua'i beaches in great numbers, and scientists have not been able to positively identify them.

To positively identify what the little things are, Harris said obtaining a live one and "growing it out" would be the best bet. Once it is grown up, he believes, the creature will be readily identifiable.

Harris said he does not suspect any biological cause of death, such as pollutants in the ocean. Rather, he believes the deaths are just part of a natural reproductive cycle many creatures go through.

For creatures of that size, the thousands of dead animals are not a lot of them, Harris said, considering that one female crab may bear two million eggs.

Reproductive "explosions" are common, he said, and the mass deaths may have been caused by a change in the current pushing the creatures to shore.

If anyone obtains a live specimen of these creatures and would like to find out what they are, contact Jeremy Harris at 245-4471.

Honolulu Star-Bulletin

6/29/87 HSB A-2

OceanWatch

Portuguese first to circle globe

Magellan made history books but jelly-boats won the race

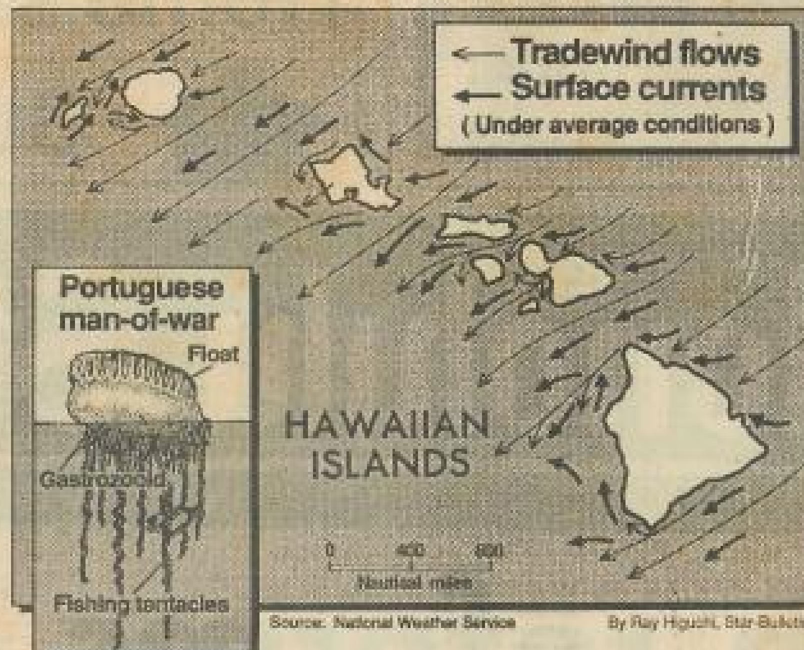
By Susan Scott
Special to the Star-Bulletin

Who was the first Portuguese sailor to circumnavigate the Earth?

Ferdinand Magellan, you say? Wrong.

The little Portuguese man-of-war, a jellyfish also called blue-bottle, was circling the Earth long before Ferdinand even existed, setting its tiny sail to cross the world's oceans.

These offshore animals travel in ocean currents. But sometimes, Kona or tradewinds become stronger than the currents and overpower the delicate "jelly-boats." It is after such windy periods that we see these unwelcome visitors around Hawaii's bays and beaches.



Source: National Weather Service

By Ray Higuchi, Star-Bulletin

ON TOP OF the familiar blue bubble that heralds the presence of the man-of-war lies an inflatable pink crest. This is the animal's "sail."

When there is little or no wind, the man-of-war flattens the crest and drifts with the current.

When the wind blows, however, blue-bottle sets sail. The pink crest is raised and individual polyps of the body work together like a well-trained crew to trim the sail, enabling the "boat" to broad-reach. In this way, the animal sets a course at an angle to the wind.

But where is the man-of-war going with all this efficiency? Well, fishing, mostly.

Hanging several meters below the water's surface are the animal's infamous tentacles. These sticky threads are trolling for fish as the animal moves through the water.

Stinging cells called nematocysts are located in abundance along the trailing tentacles. When contact is made, the spiny nematocysts stick into the skin of the prey, then discharge a powerful toxin which paralyzes the fish.

THE EFFECT OF nematocysts on human tissue is variable depending upon the number of cells that discharge into the skin and, of course, individual reaction to the toxin.

Since the toxin is a protein, meat tenderizer — which contains an enzyme that breaks down proteins — can help relieve the burning sensation.

Human urine, which is more abundant at the beach than meat tenderizer, is also effective in soothing the sting because its acidic properties also denature protein.

The burning sensation from a Portuguese man-of-war sting can last up to 24 hours, but the hives it can cause usually last longer.

If a person has a true allergic response to the toxin or has been stung extensively, a doctor should be seen. But for most cases, after denaturing the toxin, the best treatment for man-of-war stings is tincture of time.

Besides causing even dispersal throughout the world's oceans, the sailing mechanism of the man-of-war also prevents the jellyfish from colliding and tangling with lines of *Sargassum*, an offshore seaweed that also has air-filled floats and tends to form in lines parallel to the wind.

THESE SEAWEED lines get distorted by the effect of the Earth's rotation, going to the right in the northern hemisphere and to the left in the southern hemisphere.

Therefore, blue-bottles are generally "left-handed" in the northern hemisphere and "right-handed" in the southern half of the world. This adaptation maneuvers most of the jellyfish away from the seaweed.

Some species of sea turtles eat the Portuguese man-of-war and certain shore crabs feast on beached specimens.

Stinging cells in the tentacles of the man-of-war remain active after the jellyfish is dead, but the float is harmless. Examination of these fascinating sea creatures should always be done with caution.

Susan Scott is a marine biologist and free-lance writer. OceanWatch appears Mondays in the Star-Bulletin.

7/12/87 SSB&A

Opihi farming success on Big Isle

KEAHOLE, Hawaii — Ocean researchers have announced the successful spawning of opihi in a controlled environment, leading to fresh hopes of some day commercially producing the popular Hawaii limpet.

William Magruder and Redmond Humphrey of Makai Technology said they induced "mass synchronous spawning of yellow-foot opihi" in their experiments at the Natural Energy Laboratory, a state-county center for research and development near Kailua-Kona.

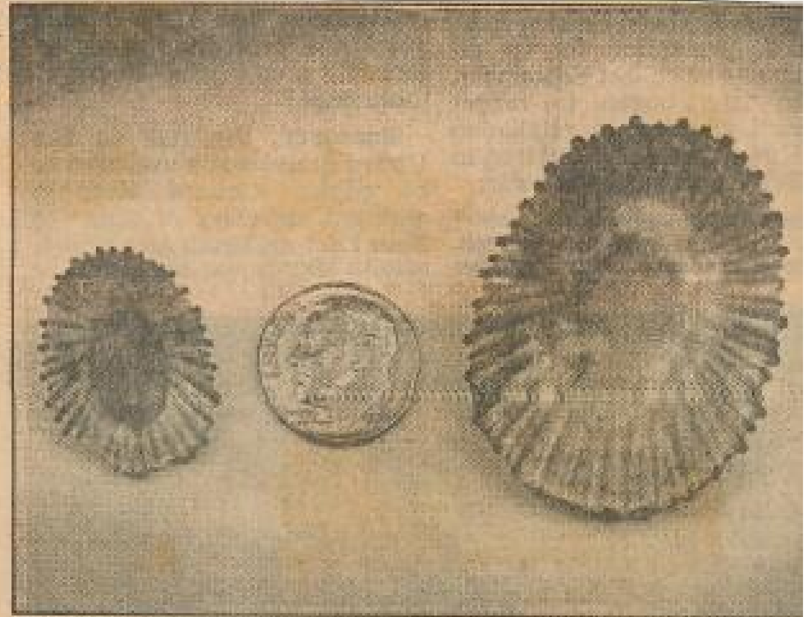
They said the method has worked on three successive occasions. They can produce a half-million juvenile larvae in a single 5-gallon tank, Magruder and Humphrey said.

The mass spawning was described as the "critical first step" in successfully raising opihi commercially.

The limpets have been in high demand in recent years but natural stocks have been depleted and expensive, despite efforts by the county and state to limit their harvest.

Researchers said the next step will be to develop methods of mass larval growth and settlement.

The opihi experiment is one of many under way at Keahole, where oysters, clams, seaweed, salmon, trout and abalone have been produced. Conditions at the center are ideal for opihi, which thrive in a mixture o[f] cold seawater, pumped fro[m] 2,000-foot depths, and war[m] surface seawater.



The successful spawning of opihi in a controlled environme[nt] increases hopes of reproducing it commercially.

* *

10-11 April 1980
TESTER Symposium

Carol T. Sorden, Department of Zoology, University of Hawaii

CRYPTOFAUNA OF FRENCH FRIGATE SHOALS, NORTHWEST HAWAIIAN ISLANDS

(Advisor: Dr. J. D. Parrish, Hawaii Cooperative Fishery Research Unit)

Coralline materials sampled at French Frigate Shoals, NWHI, were collected from different habitats and analysed for cryptofauna. Substrata include live coral, dead branching coral, branching coral colonies with approximately 50% living tissue, and dead, eroded, coral rock. The carbonate fraction of the coral was removed by nitric acid dissolution and the organisms were then identified and counted.

Polychaetes comprised the dominant taxon, with the families Syllidae, Eunicidae, Terebellidae, Sabellidae, Spionidae and Nereidae represented in all samples except the live coral. The endolithic fauna from the live coral was extremely sparse confirming reports from other studies. Both numerical and species abundance were highest in the eroded coral rock, which contained 18 polychaete species and approximately 16 species of crustaceans. Molluscs were represented primarily by vermetids. H' values for polychaetes are 1.759 for dead, eroded coral, 1.536 for the dead, branching coral; and 1.095 for the partially living branching coral. There were no polychaetes in the living coral sample.

The polychaete assemblages in these carbonate substrata are similar in familial composition to those found in other Indo-Pacific coral reefs e.g. Marshall Islands, Guam, and the Great Barrier Reef. The French Frigate Shoals community appears to differ only in species composition. The families represented exhibit diverse feeding methods including filter feeders, selective detritivores, herbivores and carnivores. Worms may erode burrows, utilize existing crevices in the dead, eroded rock; or live amongst encrusting and filamentous algae. This variety of habitats and feeding types allows a diverse assemblage of polychaetes to occupy dead coral rock. (This research was supported by the University of Hawaii Sea Grant Program, grant no. NI/R-4).

Advertiser photo by Charles Okamura

Sign of the sting

Venomous jellyfish and Portuguese man-of-war were carried by kona winds into the waters at Waikiki and Ala Moana beaches yesterday, causing many painful stings up and down the beaches. Some swimmers were determined to take their chances and went in despite warnings from the city parks department. The sign says "Portuguse," which was roughly translated from Portuguese.

12-29-83 HA

3/3/87 HSB

Man-of-War Teem off Waikiki

Star-Bulletin Staff

The waters off Ala Moana Beach Park and Waikiki Beach are teeming with Portuguese man-of-war, which can inflict painful stings.

Swimmers should stay out of the water until wind blows the intruders back to the open sea, according to the city Office of Information and Complaint.

Conches face extinction by 1990

GAINESVILLE, Fla. (AP) — Conches, the large marine snails that delight shell collectors and seafood lovers alike, may disappear within the next 10 years if present harvesting trends don't stop, a University of Florida researcher says.

"The conch is being exterminated throughout West Indian waters," said Dr. Fred Thompson, a mollusk specialist at the Florida State Museum here. "There is a very real possibility of them disappearing."

The conch population in warm Caribbean waters is only 10 percent to 20 percent what it was a decade ago and there seems to be no slowdown in the decline, Thompson said.

He compared the conch's possible plight to that of the snowy egret, which fell dangerously close to extinction at the turn of the century because of high demands for its fashionable plumes.

Commercial conch fisheries and shell collectors, as well as their customers, share responsibility for the decline of the conch and other colorful marine snails, Thompson said.

In the Indian and Pacific oceans, he said, commercial collectors have gone as far as blasting entire reefs with dynamite to get at the snails.

Thompson said it would take a 10-year ban on conch collection before the snails could return to former population levels. Only in the Cayman Islands are there laws protecting the conch, he noted.

3/23/86 Sunday Star-Bulletin & Advertiser

Crabs by thousands wash ashore here

Several thousand small crabs washed up dead on Kaneohe Bay shore between Kaneohe Beach Park and Waikalua Fishpond before dark last night. Biologists from the state Division of Aquatic Resources were investigating.

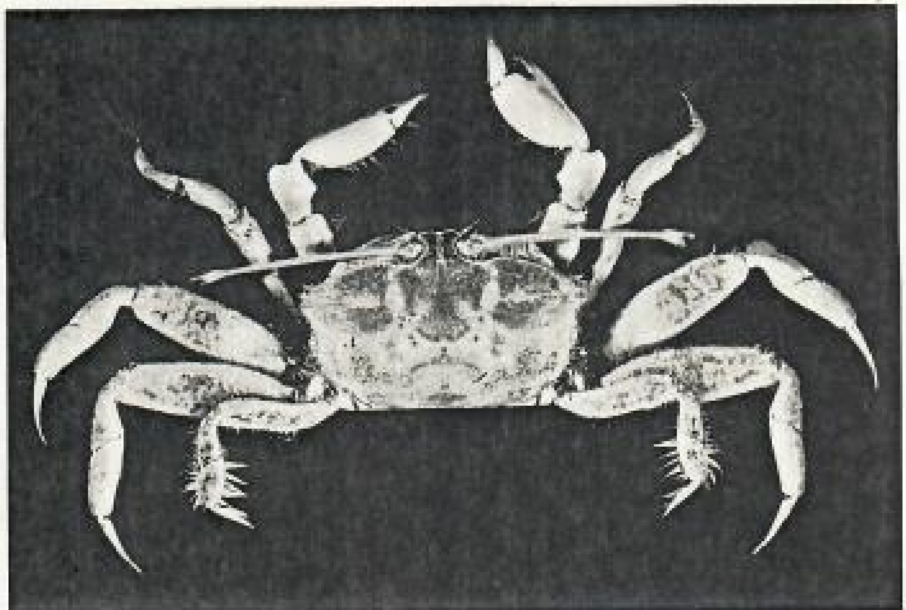
"It seems to be a type of small sand crab," said Paul Kawamoto, an aquatic biologist, after checking the coast about 50 yards on both sides of the small park. He said the kill seemed fresh but may smell by today.

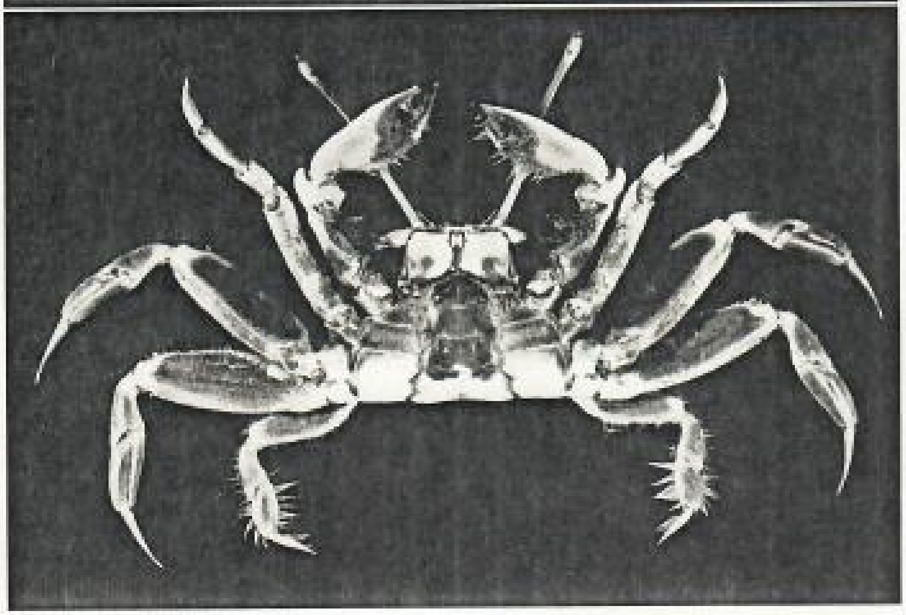
49 TELESCOPE-EYED GHOST CRAB
Macrophthalmus telescopicus (OWEN)

The most remarkable feature of this ghost crab is a pair of very long eyestalks which usually measure an inch or more in length and extend far beyond the edge of the carapace. The carapace is oval in shape and is about one and one-half inches in width in larger individuals. The chelipeds or pinchers are small, flat, thin, pointed, and channeled on their lower side. The walking legs are slender and somewhat pointed. The third and fourth pair of legs are fringed with hair at their anterior border, while the fifth leg is fringed with hair at both the anterior and posterior borders.

This species extends from Hawaii southward to Australia, westward across the tropical western Pacific Ocean to Japan, through the East Indies, and across the Indian Ocean to the Red Sea.

This crab inhabits shallow areas along the shoreline. It is a very alert and extremely agile species and is difficult to capture. It excavates burrows in which it dwells and into which it flees when danger threatens.





BECHE-DE-MER OF THE SOUTH PACIFIC ISLANDS

a handbook for fishermen

South Pacific Commission
Noumea, New Caledonia

Prepared for publication by the
South Pacific Commission Publications Bureau
and printed in Sydney by Bridge Printery Pty. Ltd.

ERRATA and ADDENDA

Since *Bêche-de-Mer of the South Pacific Islands* was first printed, a number of errors and omissions in the vernacular names of bêche-de-mer have come to light. The South Pacific Commission would like to thank Mr Surendra Sewak of the Ministry of Agriculture, Fisheries and Forests, Fiji, for supplying corrections to Fijian vernacular names, Mr D. H. Gibson, formerly Chief Fisheries Officer in the Gilbert Islands, for listing Gilbertese vernacular names, and Dr Frank Mahony for supplying corrections to Trukese vernacular names.

FIJIAN VERNACULAR NAMES

The following corrections should be made to Fijian vernacular names in this publication:

Teat Fish (White) (*Microthele nobilis*)	— **Sucuwalu, Dairo**
Teat Fish (Black) (*Microthele nobilis*)	— **Loaloa, Dairo**
Black Fish (*Actinopyga miliaris*)	— **Dri**
Deep-water Red Fish (*A. echnites*)	— **Dritabua**
Surf Red Fish (*A. mauritiana*)	— **Dairo-ni-cakau, Vulaika, Tina ni Dairo**
Stone Fish (*A. lecanora*)	— **Veata, Samu, Kotia**
Prickly Fish (*Thelenota ananas*)	— **Lesi**
Sand Fish (*Holothuria scabra*)	— **Dairo**
Leopard (Tiger) Fish (*Bohadschia argus*)	— **Vulakau**
Chalky Fish (*B. marmorata marmorata*)	— **Vulaniuniu**
B. marmorata vitiensis	— **Vula, Mundra**
Lolly Fish (*Halodeima atra*)	— **Loliloli**
Stichopus variegatus	— **Tarasea**
Pink Fish (*Halodeima edulis*)	— **Laqulaqu**

GILBERTESE VERNACULAR NAMES

Vernacular names of bêche-de-mer in Gilbertese:

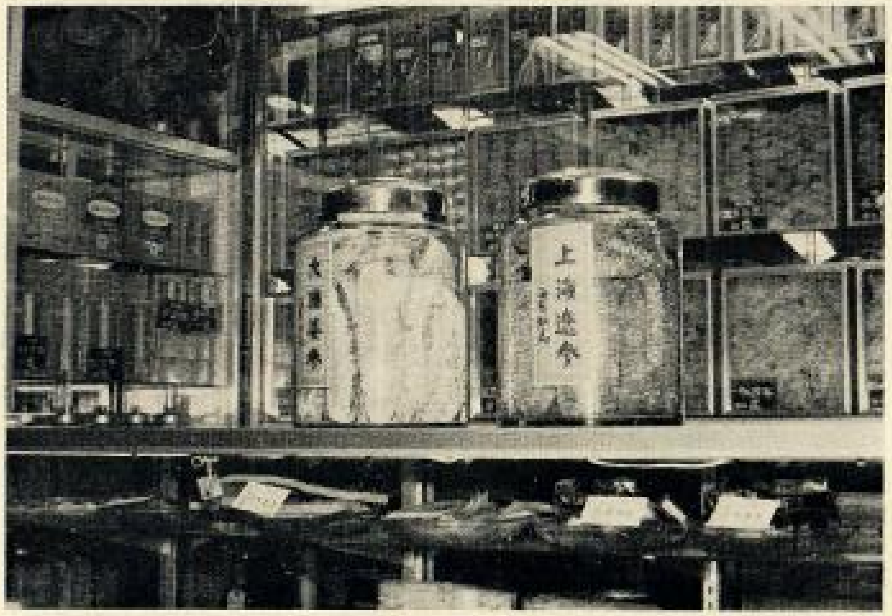
Teat Fish (White) (*Microthele nobilis*)	— **Temaimmama**
Teat Fish (Black) (*Microthele nobilis*)	— **Terammama**
Surf Red Fish (*Actinopyga mauritiana*)	— **Tewaeura**
Prickly Fish (*Thelenota ananas*)	— **Teuringauninga**
Leopard (Tiger) Fish (*Bohadschia argus*)	— **Tebunia**
Chalky Fish (*B. marmorata marmorata*)	— **Tewaemai**
B. marmorata vitiensis	— **Uniraganibakoa (known in English in the Gilbert Islands as Brown Sand Fish)**
Lolly Fish (*Halodeima atra*)	— **Ten Tabanebane**
Stichopus chloronatus	— **Teingiraro (known in English in the Gilbert Islands as Black Prickly Fish)**

TRUKESE VERNACULAR NAMES

These corrections should be made to the Trukese vernacular names given in this publication:

Teat Fish (*Microthele nobilis*)	— **Maɛhõnepech**
Black Fish (*Actinopyga miliaris*)	— **Chöen**
Leopard (Tiger) Fish (*Bohadschia argus*)	— **Asel'a**

CN/vmr.



White stone and plum flower in a retail shop in Hong Kong.

PREFACE

This handbook is based on work by Kanapathipillai Sachithananthan, *Bêche-de-mer* Consultant to the South Pacific Islands Fisheries Development Agency (SPIFDA), and was edited by R. H. Baird, South Pacific Commission Fisheries Adviser.

SPIFDA was a UNDP/FAO Regional Fisheries Project with the South Pacific Commission acting as the counterpart agency on behalf of the territories in the South Pacific.

The text and most of the photographs have been supplied by FAO; editing and printing have been arranged by the South Pacific Commission.

Acknowledgements and thanks are due to Miss A. M. Clark of the British Museum, London, and Dr G. Cherbonnier of the *Laboratoire de Biologie des Invertébrés Marins, Muséum National d'Histoire Naturelle*, Paris, for verifying and correcting identifications and bringing up to date the nomenclature of the species illustrated.

It must be emphasized that positive identification of genera and species of holothurians is not possible without microscopical examination of sections of the body wall. Miss Clark and Dr Cherbonnier have both emphasized this point. However, the most authoritative identifications that are possible from photographs have been made by these two world experts.

It may be that the local names given for the various species are not in universal use in the countries concerned. The editor would welcome comments and suggestions for a more complete list of local names which can be incorporated as an addendum in later editions of this handbook.

Mr Seamus McElroy, Fisheries Officer in the British Solomon Islands Protectorate, was consultant in the final preparation of the handbook and assisted greatly in some of the difficult identifications. His experience of the animals in the field has been of particular value. He also supplied two additional photographs.

The photographs of *Actinopyga mauretania* and *Stichopus variegatus* were kindly supplied by Mr Neville Coleman, A.M.P.I. of New South Wales through the good offices of Miss A. M. Clark, who also made the identifications.

INTRODUCTION

Bêche-de-mer has been a prosperous fishery in the Pacific region in the past. Early Chinese settlers introduced curing methods to the native populations of the Pacific islands and enjoyed the benefits of the trade by shipping the produce to China and other East Asian countries. The fishery was very prosperous during the German, Spanish, French and Japanese occupations of the very many islands in the Pacific. Truk Island in Micronesia is said to have exported nearly one million pounds annually during the early years of this century.

The first and second world wars interrupted the activities of this fishery. The Second World War fought in the Pacific region brought this industry to a near standstill in Micronesia and in the New Hebrides. In Papua New Guinea, British Solomon Islands Protectorate and Fiji the trade is not as prosperous as it was before the war.

A bêche-de-mer processing factory has been established in Honiara in the British Solomon Islands Protectorate. Once an active enterprise in Queensland, Australia, this fishery has now more or less died out as it is less attractive economically.

Bêche-de-mer is in big demand among the Chinese population in South-East Asia where it is thought to possess some aphrodisiac qualities. The varieties produced in the Pacific have a consumer preference and fetch high prices. The Pacific has an extensive resource of sea cucumbers that can be processed and sent to these Asian markets; the natural supply in the seas immediately surrounding the islands in the Pacific is good.

Harvesting involves collection by hand in tidal flats and pools and by diving for them in the deeper waters within the reefs. Diving equipment can be used in deeper water in areas where facilities for training in the use of and facilities for the maintenance of the equipment exist. The animals are processed into bêche-de-mer near the places of collection.

The processing method is simple: the collected animals are cleaned, boiled, smoked—then dried and packed for export. Although most of the Pacific islands are in the tropics, storage of this dried product is not a great problem. Usual methods of storage for fishery

products (chilling or refrigeration) to maintain freshness and avoid spoilage are not needed for this product. Markets are within reasonably easy reach of the islands; many islands are connected by regular shipping services to the two important markets, Hong Kong and Singapore.

Sea cucumbers form a very important part of the bottom fauna within the reefs of the Pacific islands. The shallow water lagoons enclosed by the very many reefs, islands and islets in the Pacific offer a variety of situations which provide shelter for these sluggish creatures, although some species occur in deeper water (down to 50 metres).

The larger types move about slowly in the sandy and grassy bottoms away from the coast towards the reef. Some types bury themselves in sandy mud, crowd into crevices of the coral colonies and the underside of rock fragments. They are mostly bottom (or sediment) feeders. Any sea cucumber that is to be of use as bêche-de-mer must be large but it is not true that all large sea cucumbers will make a satisfactory preparation. Generally, the more valuable species have a thicker body wall.

Sea cucumbers are easy to capture as they offer no resistance. Some animals throw out white sticky threads when disturbed (see page 16). These threads are called cuiverian tubules and are harmless to humans.

Bêche-de-mer is a Chinese delicacy. It has become part of the life and traditions of the Chinese people to eat bêche-de-mer preparations on festive occasions; purchased in dry form, it is soaked in water, cleaned and cooked in many delicious ways. It is rich in protein. The dried product has the following nutritional composition:

Protein	43%
Fat	2%
Moisture	27%
Minerals	21%
Insoluble ash	7%

GLOSSARY OF BIOLOGICAL TERMS USED IN THE TEXT

anal teeth: usually five in number; each a hard (calcified) triangular structure embedded in the anal wall.

anterior: the front part (with the mouth).

anus posterior (rear) opening of the gut.

contractile: able to shorten or become shorter.

cuiverian organs: consisting of sticky white thread- or ribbon-like structures which are thrown out from the anus of some species; a special defence mechanism.

dorsal: the upper part, top or back.

eviscerate: to throw out its guts (through the anus).

external: outside.

fauna: all animals in an area.

holothurian: a free-moving, bottom-living, soft-bodied, worm-like animal closely related to the starfishes and sea urchins.

papillae: similar to tube feet but smaller (commonly a few millimetres up to more than a centimetre in length), they are conical and pointed. Occurring chiefly on the back, they are also often seen on processes of the body wall, such as the teat-like processes of *Microthele nobilis* and *Thelenota ananas*. In *Stichopus chloronotus* they appear conspicuously on the tips of the finger-like processes, being a bright orange-brown colour.

pedicels: adapted from tube feet, they are small and tubular, as distinct from the conical papillae. Occurring on the back, they are commonly only a few millimetres long.

posterior: the rear part (with the anus).

projections: processes, parts of the body wall that stick out.

species: a group of similar animals (or plants) able to breed with each other, but not normally with others.

teat: a conical process of the body wall measured in centimetres.

tentacle: specialized tube feet crowned with many sticky processes. Normally occurring in a ring around the mouth, they are used in feeding. Usually measured in centimetres.

tube feet: long narrow retractable tubes with a broad sunken end, used as a sucker. Occurring mainly on the lower surface, they act together to propel the animal forward across a surface. Commonly of several millimetres up to over a centimetre in length.

tubercle: a small lump, elevation or roughness upon the surface of the body wall.

ventral: the lower bottom surface.

Units of Measurement

Abbreviations:

mm — millimetre
cm — centimetre
m — metre

10 mm = 1 cm
100 cm = 1 m

Conversion ratio:

1 cm = 0.4 ins. (approx. 3/8 ins.)
1 m = 39.37 ins.
1 inch = 2.54 cm

COMMERCIALLY EXPLOITABLE SPECIES OF BECHE-DE-MER IN THE PACIFIC ISLANDS

TEAT FISH *(Microthele nobilis)*

Chinese:	Seasom
Palauan:	Bakelungal
Trukese:	Majonpeth
Ponapean:	Matchip
Fijian:	Daro
Solomons:	Susu fish

Also known as **mammyfish**, it commands the highest prices in the bêche-de-mer market. The most distinguishing external feature is the presence of about six lateral teat-like projections (papillae), which are contractile. The body is a somewhat flattened oval in shape with a very thick body wall and five anal teeth. These animals are generally found in abundance in deeper water of more than 20 metres (65 ft.), on coral sand and grassy bottoms.

Colours found have been: dark brown or black on top and white beneath, all yellowish white; mottled black or brown on white.

Teat fish (white)
up to 500 mm (20 in.)

Teat fish (black)
up to 500 mm (20 in.)

BLACK FISH *(Actinopyga miliaris)*

Palauan: Erumrum
Trukese: Jan
Fijian: Dree

These are black or dark brown and cylindrical with numerous tube feet, tending to be arranged in three bands on the bottom side and have five anal teeth characteristic of both *Actinopyga* and *Microthele*. The juveniles of 20-35 mm (1-1½ in.) are generally found in murky shallow waters and are black in colour. Adults are found in depths of more than 2 m (6.ft.) in clearer water on coral sand bottoms. Prices in the market rank second or third to the teat fish.

Black fish
up to 350 mm (14 in.)

Other Species of Actinopyga

There are other species of the genus *Actinopyga* of commercial value, for example, *A. echinites* (Deep-water Red fish; Fijian: Dry Los-los or Dry-tala; Chinese: Hung-Hur) and *A. mauritiana* (Surf Red fish; Fijian: Dry-mata-mlia; Chinese: Hung-Hur) and *A. lecanora* (Stone fish; Fijian: Daro; Chinese: Seasom). All animals in this genus have five anal teeth and relatively thick body walls. All these species have a fairly high market value.

Physical differences are:

DEEP-WATER RED FISH *(A. echinites)*

Mid-brown, slightly darker on top. Papillae scattered on its slightly wrinkled dorsal surface. The body is stout in the middle, maximum breadth when contracted nearly half the length, tapering. It has three bands of tube feet on the bottom. Length up to 350 mm (14 in.).

Deep-water Red fish (A. echinites)
up to 350 mm (14 in.)

SURF RED FISH *(A. mauritiana)*

Chocolate-brown above contrasting with much lighter colour below. The tube feet are scattered all over the body surface forming small dark spots. A stout species, living in shallower waters than *A. echinites*. Length up to 400 mm (16 in.).

Surf Red fish (A. mauritiana)
up to 400 mm (16 in.)

STONE FISH *(A. lecanora)*

Has a dark upper surface ranging from brown to deep brownish black; the lower surface and a conspicuous area around the anus are much lighter, ashy or olive grey. Below, the tube feet are in three broad bands. Above, the papillae are scattered and very long. The body is almost cylindrical, but flattened below and slightly tapering anteriorly. Lives in shallow water, generally on the underside of large rocks. Length up to 400 mm (16 in.).

PRICKLY FISH *(Thelenota ananas)*

Chinese: Bufa som
Palauan: Temtamch
Trukese: Lachcha

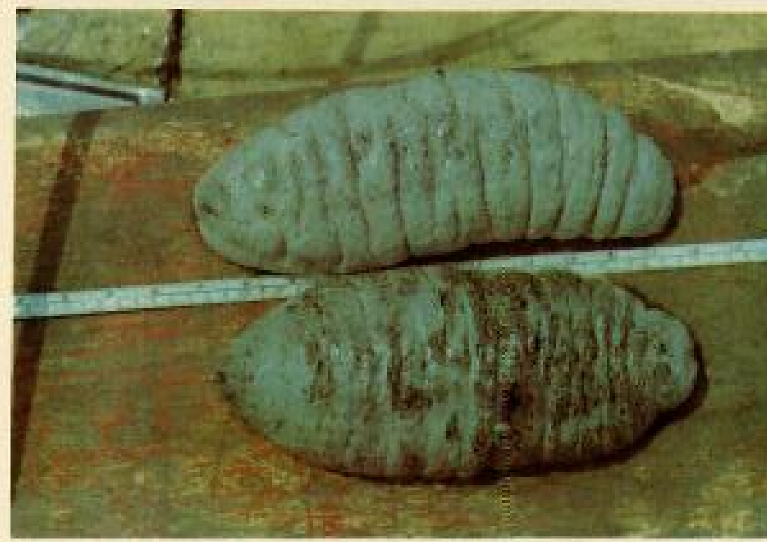
Has many very large teats in groups of two or three together and numerous tube feet on its bright red flat bottom side. This shaggy-looking animal is abundant in most of the reef-enclosed lagoons of the Pacific. It ranks close to the teat fish in commercial value. Found mainly at depths of 2-10 m (6-33 ft.) on the reef flat, and is commonly between 300-600 mm (12-24 in.).

Prickly fish
up to 800 mm (32 in.)

SAND FISH *(Holothuria scabra)*

Chinese: Tok som
Palauan: Rebothal

Colours found have been as follows: upper surfaces can be light grey, dull cream, olive brown or almost black; lower surface, though, is usually white. It is also covered with fine black spots speckled on its wrinkled dorsal surface. The body is short and stout and flattened at the ends. It is commonly found on coral sand in estuarine waters, near river mouths and drainage outlets. It can burrow in sand and is found mainly in depths of water of 2-10 m (6-33 ft.) on the reef flat. Previously widely used for bêche-de-mer. The processing method is slightly complicated (see page 25).



Sand fish
up to 400 mm (16 in.)

LEOPARD (TIGER) FISH *(Bohadschia argus)*

Palauan: Ehosobal
Trukese: Asaya
Ponapean: Penepen
Fijian: Vula

With eye-like spots all over its body, this is known as spotted or leopard fish. Previously known in some of the literature as tiger fish. The large brown spots are conspicuously encircled with a light colour (yellow, white or grey). It is found at depths of 2-6 m (6-20 ft.) and it throws out sticky white threads when taken. It is apparently of small commercial value.

Tiger fish
up to 400 mm (16 in.)

CHALKY FISH

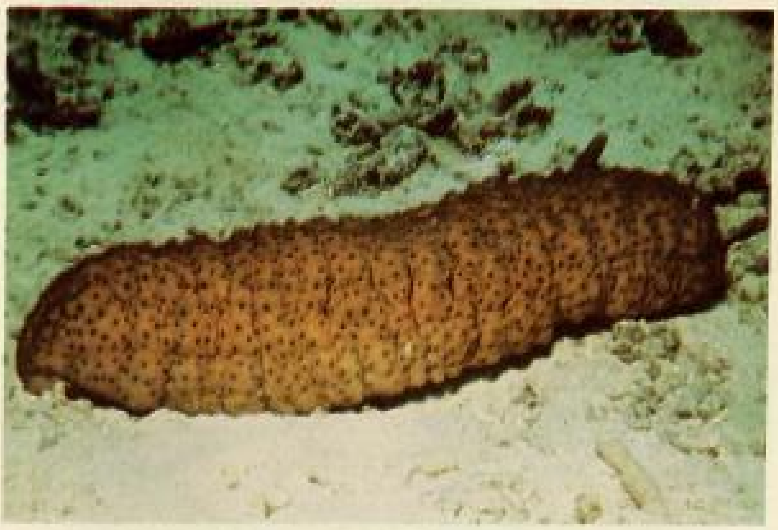
(Bohadschia marmorata marmorata)

A lengthy animal, almost cylindrical in shape, with numerous tube feet distributed all over the body. It is sometimes all white in colour or with brown patches on its white top side. The bottom side is pure white. It is found in the waters of the lagoons enclosed by the reef. Has some market value.

Chalky fish
up to 400 mm (16 in.)

*) *Stichopus variegatus*

Similar to the Prickly fish (*Thelenota ananas*) in size, this loaf-like animal lives exposed on sandy reef flats. Several irregular brown patches contrast with the yellow-grey background of the arched dorsal side. The flat lower side is white with numerous pink tube feet. It is considered to be of some commercial value.



**) no common name*
up to 900 mm (35 in.)

NON-COMMERCIAL HOLOTHURIANS

PINK FISH *(Halodeima edulis)*

Black or grey on top and pink below. This cylindrical animal is commonly found in shallow waters, in the open or attached to coral rocks.

Pink fish
up to 400 mm (16 in .)

PROCESSING

Processing is a simple method of boiling, cleaning and drying.

Cleaning

Animals sometimes have a tendency to eviscerate (that is to throw out their guts) during handling. If the animal does not eviscerate on its own, a small opening is made near the mouth to effect gutting. Water inside the body cavity is also squeezed out. All types except the teat fish are gutted before boiling. Teat fish is boiled before removing the guts. All animals are washed before boiling.

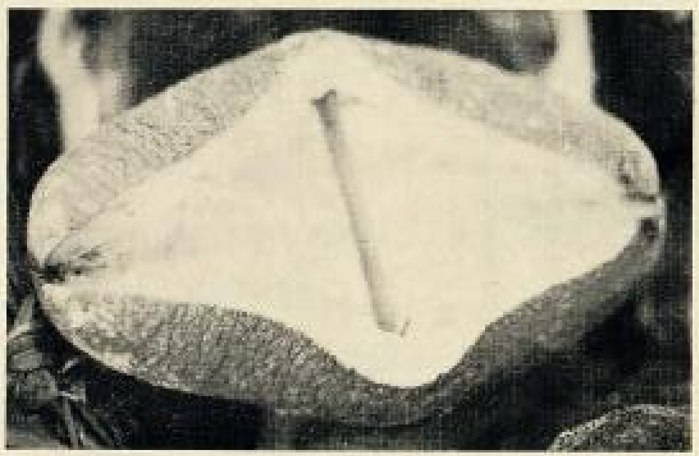
Cooking

Any suitable vessel will serve for boiling; for example, half a 44-gallon drum. OKAMA is the name of a shallow broad vessel which is sometimes used. Clean sea water is used. Animals are introduced when the water boils. Frequent stirring during cooking is necessary.

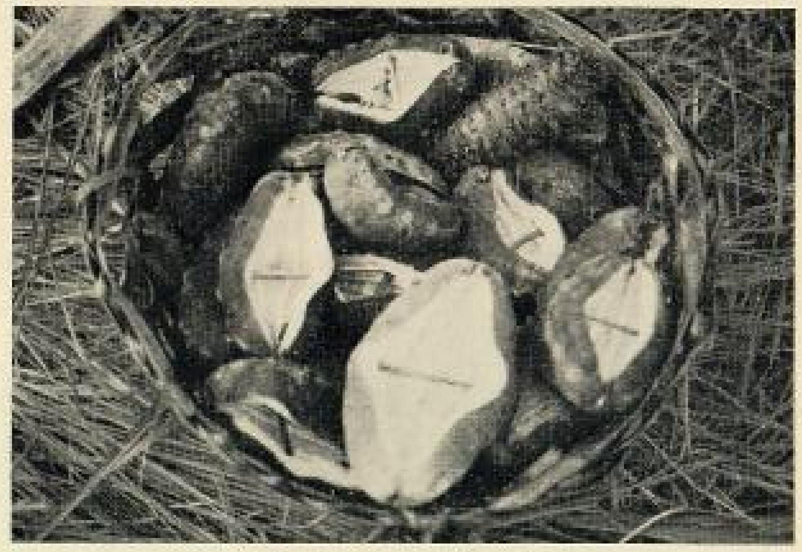
Animals of similar size should be boiled together as cooking time varies with the size of animal, for example, it takes 1-1½ hours to cook large teat fish. They attain a blubber-like form and bounce when dropped on a hard surface. On attaining this state the animals are cooled in a vessel containing cold sea water.

Second cleaning

Cooked animals are cleaned again. With teat fish, a longitudinal cut is made on the top side with a sharp knife and the guts are removed. The split walls are spread by means of a thin wooden splint.



Split dorsal body wall of bêche-de-mer spread with wooden splint



Bêche-de-mer ready for drying

Sand fish are cleaned by burying them overnight in clean, moist sand. Burial facilitates decomposition and easy cleaning of the outer skin layer. The outer skin layer is removed by hand scrubbing (coconut husks are used in some places). Special care is taken in cleaning the whitish lower layer of the skin. Sand fish is boiled again in sea water.

Drying

All varieties are dried after boiling and cleaning (and after re-boiling in the case of sand fish).

Sun drying is the cheapest method if climatic conditions are favourable. Cleaned animals are spread evenly over a mat or tray and left in the sun until they are hard and dry. This may take two or four days.

JAFFNA DRYER

For areas where relative humidity is high and rainfall is heavy, a drying unit is recommended. This dryer is essentially made up of drying trays kept in racks inside a drying house. Hot air and smoke come out from an open-ended, 44-gallon drum in which the fire is made. The drum is placed horizontally under the trays. Mangrove wood, where obtainable, is used to maintain the fire. The drying trays are of wire mesh with wooden frames. This drying unit can be a permanent construction or it can be portable. The technique of drying is very similar to that of copra drying.

A portable unit is built in three separate sections and assembled into one unit. The lower portion holds the hearth, the middle portion holds the trays and the top portion forms the roof. Asbestos or flat galvanised sheets are used, with wooden frames for support. The trays slide into the middle section and the drum containing the hearth is placed beneath them. Details of construction are shown below. Standard copra dryers are also frequently used.

Dryer constructed with corrugated sheets

Portable model of the Jaffna dryer

GRADING

Certain varieties of bêche-de-mer have consumer preference over others. Teat fish is called 'white stone' (and 'black stone') and is highly priced. Prickly red is called 'plum flower' and is priced next to 'white stone'.

Separation into species is the first step in grading. Size, appearance, odour, colour, moisture content and dirt content are other factors which determine the grade.

Size

Within a species, the larger the size the better the grade—and the higher is the price.

Appearance

A pleasing, smooth surface and a uniform shape are preferred to shrunken, uneven products. The body wall cut should be clean, not ragged.

Odour

A pleasing smell should be attained. Those smelling of decomposition should be discarded.

Colour

Dark coloration is generally preferred. The chalky white ventral surface of sand fish is to be avoided.

Moisture content

Bêche-de-mer stored in a humid atmosphere tends to absorb moisture and become soft. Twenty to thirty per cent moisture content by weight may be allowed. A hard, dry product is preferred to a soft, moisture-laden one.

Spoilage

Products should be free from bacterial and chemical spoilage.

PACKING AND STORING

Copra sacks are frequently used for storage. If possible, graded products are packed in polythene bags to be stored inside cartons before shipment.

Packed produce awaiting shipment should be stored in as dry an atmosphere as possible. Where the product has had to be stored for a long time in humid conditions, re-drying is generally necessary.

BECHE-DE-MER TRADERS

As it is difficult for a complete and up-to-date list of traders to be maintained, it is suggested that persons interested write to the Chambers of Commerce in the main trading centres, viz.:

Singapore

Hong Kong

Bangkok

Tokyo

Kuala Lumpur

Penang

BECHE-DE-MER OF THE SOUTH PACIFIC ISLANDS

a handbook for fishermen

South Pacific Commission
Noumea, New Caledonia