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OF THE

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AT

HARVARD COLLEGE.

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Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. XXX. NO. 1.

REPORTS ON AN EXPLORATION OFF THE WEST COASTS OF MEXICO, CENTRAL AND SOUTH AMERICA, AND OFF THE GALAPAGOS ISLANDS, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," DURING 1891, LIEUT. COMMANDER Z. L. TANNER, U. S. N., COMMANDING.

XXX.

THE SPONGES.

BY H. V. WILSON.

WITH TWENTY-SIX PLATES.

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CAMBRIDGE, U. S. A.:
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JULY, 1904.

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THE SPONGES.

INTRODUCTION.

The collection of sponges with which the following report deals has been found to include forty-seven species and subspecies. Of these, twenty-six, representing thirteen genera, fall in the Hexactinellida, seven, representing three genera, fall in the Tetractinellida, and fourteen, representing nine genera, fall in the Monaxonida. No calcareous or horny sponges and no Lithistids were taken. As was to have been expected, since the expedition was made in unexplored waters, a very large percentage of the forms (thirty-three species and subspecies) prove new to science.

ENUMERATION OF THE SPECIES ACCORDING TO THE STATIONS AT WHICH THEY WERE TAKEN.

Serial Number.	Latitude.	Longitude. West.	Depth in Fathoms.	Character of Bottom.	Species taken.
	° ′ ″	° ′ ″			
3354	N. 7 9 45	80 50 0	322	gn. M.	*Chonelasma calyx* F. E. Sch. (sp ?).
3358	N. 6 30 0	81 44 0	555	gn. S.	*Eurete erectum tubuliferum*, subsp. nov. *Eurete erectum mucronatum*, subsp. nov.
3359	N. 6 22 20	81 52 0	465	Rky.	*Eurete erectum tubuliferum*, subsp. nov. *Eurete erectum mucronatum*, subsp. nov. *Hexactinella ventilabrum* Carter (sp ?).
3362	N. 5 56 0	85 10 30	1175	gn. M. S. rky.	*Thenea fenestrata* O. Schm.
3363	N. 5 43 0	85 50 0	978	wh. glob. Oz.	*Hyalonema pateriferum*, sp. nov.
3368	N. 5 32 45	86 54 30	66	Rky.	*Phakellia lamelligera*, sp. nov.
3370	N. 5 36 40	86 56 50	134	Rks. and S.	*Staurocalyptus*, sp. *Eurete erectum* F. E. Sch. (sp ?) *Eurete*, sp. *Aphrocallistes vastus* F. E. Sch. (sp ?).
3376	N. 3 9 0	82 8 0	1132	gy. glob. Oz.	*Hyalonema pateriferum*, sp. nov.
3380	N. 4 3 0	81 31 0	899	Rks.	*Regadrella*, sp. *Hexactinella tubulosa* F. E. Sch. (sp ?) *Eurete erectum gracile*, subsp. nov. *Eurete*, sp. *Bathyxiphus*, sp.
3381	N. 4 56 0	80 52 30	1772	gn. M.	*Hyalonema*, sp.
3382	N. 6 21 0	80 41 0	1793	gn. M.	*Hyalonema ovuliferum* F. E. Sch. *Caulophacus schulzei*, sp. nov. *Bathydorus levis spinosus*, subsp. nov.
3384	N. 7 31 30	79 14 0	458	gn. S.	*Iophon chelifer ostia-magna*, subsp. nov.
3399	N. 1 7 0	81 4 0	1740	gn. Oz.	*Hyalonema*, sp. *Caulophacus schulzei*, sp. nov. *Bathydorus levis spinosus*, subsp. nov.

Serial Number.	Latitude.				Longitude. West.			Depth in Fathoms.	Character of Bottom.	Species taken.
		°	′	″	°	′	″			
3400	S.	0	36	0	86	46	0	1322	lt. gy. glob. Oz.	*Thenea fenestrata* O. Schm.
3404	S.	1	3	0	89	28	0	385	R.	*Euplectella*, sp. *Regadrella delicata*, sp. nov. *Hexactinella ventilabrum* Carter (sp?). *Poecillastra tricornis*, sp. nov. *Penares foliaformis*, sp. nov. *Oceanapia bacillifera*, sp. nov.
3405	S.	0	57	0	89	38	0	53	P. Co. Sh.	*Hexactinella labyrinthica*, sp. nov. *Poecillastra cribraria*, sp. nov. *Polymastia maeandria*, sp. nov. *Petrosia variabilis crassa*, subsp. nov. *Petrosia similis densissima*, subsp. nov. *Tylodesma vestibularis*, sp. nov. *Iophon lamella*, sp. nov. *Iophon lamella indivisus*, subsp. nov. *Iophon indentatus*, sp. nov. *Auletta dendrophora*, sp. nov. *Tylodesma alba*, sp. nov.
3406	S.	0	16	0	90	21	30	551	R.	*Hexactinella tubulosa* F. E. Sch. (sp?) *Hexactinella ventilabrum* Carter (sp?) *Sclerothamnopsis compressa*, gen. et sp. nov.
3413	N.	2	34	0	92	6	0	1360	glob. Oz. dk. Sp.	*Thenea fenestrata* O. Schm.
3414	N.	10	14	0	96	28	0	2232	gn. M.	*Hyalonema pedunculatum*, sp. nov. *Hyalonema*, sp. *Caulophacus*, sp. *Thenea lamelliformis*, sp. nov. *Thenea pyriformis*, n. sp.
3415	N.	14	46	0	98	40	0	1879	br. M. glob. Oz.	*Hyalonema bianchoratum*, sp. nov. *Thenea echinata*, sp. nov.
3425	N.	21	19	0	106	24	0	680	gn. M. and S.	*Farrea occa claviformis*, subsp. nov. *Farrea*, sp.
3430	N.	23	16	0	107	31	0	852	bk. S.	*Farrea mexicana*, sp. nov.
Station recorded as "Acapulco."										*Pachychalina acapulcensis*, sp. nov.
Station recorded as "Panama."										*Gellius perforatus*, sp. nov.
17 (Cruise of "Albatross" in 1900.)	N.	0	50	0	137	54	0	2463	lt. y. gy. glob. ooze	*Hyalonema pateriferum*, sp. nov.

In addition to the discovery of new forms, some results of general biological interest have accrued from the study of the collection, and are discussed or stated under the respective species concerned. For convenience of reference the more important of these facts may be here classified.

Remarkable forms. *Hyalonema pedunculatum*, p. 15, is noteworthy for the peculiar pedunculate form of body; *Sclerothamnopsis compressa*, p. 80, for the shrub-like habitus in which it resembles the hitherto unique *Sclerothamnus clausii* Marsh.; *Regadrella delicata*, p. 32, for the character of the sieve-plate region, which may be construed as representing a simpler (although not necessarily a more primitive) phylogenetic condition than the otherwise closely similar *Regadrella phoenix* O. Schm.

Distribution and *Habitat.* *Thenea fenestrata* O. Schm., p. 87, hitherto known only from the Atlantic and Caribbean Sea, is now recorded for the

Pacific. Some of the Hexactinellids from great depths have been found to live clustering upon one another: *Caulophacus*, pp. 39, 46, attached to root spicules of *Hyalonema; Bathydorus*, p. 47, attached to root spicules of *Hyalonema* and to stalks of *Caulophacus* or similar sponge.

Morphology in general. Further evidence of a convincing character has been gained that the complex *Eurete* and *Farrea* colonies are derived ontogenetically from simple cup-like forms, pp. 60, 61, 66. —— The close similarity between the main afferent and efferent canals and their apertures in *Poecillastra tricornis* is worthy of remark, p. 97. —— The observations of Sollas and of Dendy on the occurrence of a peculiar fenestrated membrane (Sollas's membrane) in the flagellated chambers of certain sponges have been confirmed for two Tetractinellid genera, *Poecillastra* and *Penares*, pp. 99, 103, 109.

Pathological phenomena in general. In *Euplectella* skeletal septa of a reticular character have been found crossing the cavity of the sponge, p. 29. —— In *Chonelasma* similar septa have been observed, p. 70. —— In *Hexactinella labyrinthica* skeletal masses of a reticular character, such as have been especially described by Weltner, occur, p. 75. In some cases such masses form layers separating one part of the sponge from another. —— Possibly all these phenomena are pathological and similar, in so far as they may indicate an effort of the sponge to shut off one part (diseased?) of the body from the rest.

Morphology of spicules — variations and *"pathological" conditions.* In *Hyalonema pateriferum*, pathological amphidiscs such as have been observed by Marshall and Meyer and F. E. Schulze occur. In these spicules, p. 28, several additional rays of the hexact are developed. —— Certain details in the structure of the discohexasters of *Caulophacus schulzei* suggest that a hexaster may arise from a hexact through the development of *lateral* branches on the hexact rays, pp. 44, 45. —— Another case is afforded by *Hexactinella labyrinthica* of what seems to be the degeneration of an uncinate into an oxydiact, p. 77. —— In scopulae present in *Sclerothamnopsis compressa*, the arrangement of the axial canals indicates that the spicule is equivalent to a branched diact, as Schulze has supposed, p. 82. —— Abundant transitional forms indicate that the protriaenes of *Thenea* are modified dichotriaenes, p. 85. —— In *Thenea pyriformis* a type of metaster is common which may be interpreted as transitional between spirasters and euasters, p. 96. —— In *Penares foliaformis* peculiar dichotriaenes are found which approach the shape of the Lithistid phyllotriaene, p. 109.——The occurrence of pathological branching oxeas is recorded for *Petrosia*, p. 115.

Variation. The variability of sponges in regard to points of adult structure is universally recognized. O. Schmidt and Vosmaer, in particular, have laid stress on the phenomenon as bearing upon the problems of systematic classification. The observations recorded in this report will fall under the following heads: —

1. Variation in *body-shape* and *general anatomy.*

Attention may be called to the difference in shape exhibited by specimens of *Hyalonema pateriferum*, p. 24, *Caulophacus schulzei*, p. 39, *Thenea fenestrata*, p. 84, *Petrosia variabilis crassa*, p. 114.——In *Eurete* the spiral form of body beset with cup-like outgrowths varies toward a bilateral symmetry, p. 72.—— In *Tylodesma alba* massive and lamellate bodies occur, as parts of one continuous specimen, p. 132.——In *Gellius perforatus* a uniform habit of growth may result in very different body shapes, p. 128.——In *Thenea* individuals the number and size of the pore areas vary, pp. 84–85 (comp. especially Vosmaer, 1882, 1885); also the spicular fringe round the osculum, p. 84.——In *Iophon lamella* the character of the surface varies in different parts of the same individual, owing to the divergence in character of the main efferent canals and their apertures, and to the varying amount of collenchyma round such canals, pp. 142–144.

2. Variation in *same individual* in the *skeletal framework* or the *skeleton in general.*

In *Chonelasma calyx* the tuberculation of the beams of the dictyonal framework varies, p. 71.——In *Hexactinella ventilabrum* there is considerable variation in the way in which the hexacts combine to form the dictyonal framework, p. 79.——In *Thenea fenestrata* there is variation in the development of the spicular fringes round the pore areas, p. 85.——In *Petrosia variabilis crassa*, p. 116, and in *Petrosia similis densissima*, p. 118, a skeletal reticulum remains undeveloped in spots.——In *Pachychalina acapulcensis* the skeletal framework in places is fairly regular, although in general irregular, p. 122.——In *Phakellia lamelligera* the skeletal lamellae vary in respect to branching, p. 153.——In *Petrosia similis densissima* over some parts of the surface there are no projecting spicules, while over other parts such spicules are present in considerable number, p. 118.——In *Gellius perforatus* there is considerable variation in the character of the spicular tufts which project from the surface, p. 128.——In *Iophon lamella* there is variation in the number of spicules which combine to form the side of a skeletal mesh, p. 145.

3. Uncorrelated variation in the *megascleres* of an *individual, i. e.* variation apparently not correlated with the structural peculiarities of the body-locality.

As regards size of the spicules, there seems to be noticeable variation in all sponge species.—— The shape of one of the macramphidiscs varies considerably in *Hyalonema bianchoratum,* p. 20.—— In *Caulophacus schulzei* the principal hexacts are occasionally tuberculated, p. 40, and in the same species the tuberculation of the pentacts varies, p. 43.—— The character of the diact ends varies commonly, *e. g.* in *Bathydorus levis spinosus,* p. 49.—— In *Farrea mexicana* the pentacts vary in respect to tuberculation, p. 56. —— In *Eurete erectum* the character of the distal ray of the gastral pinules varies extensively, p. 62 (comp. F. E. Schulze, 1899).—— In *Petrosia variabilis crassa* the oxea sometimes assumes the shape of a strongyle, or style, p. 115.—— In *Penares foliaformis* the triaenes vary considerably, p. 109.—— In *Pachychalina acapulcensis* the size of the oxea varies within wide limits, p. 121.—— In *Phakellia lamelligera* the oxeas and the two kinds of styles all vary considerably in shape, p. 152.

4. Uncorrelated variation in the *microscleres* of an *individual.*

The microscleres as well as the megascleres very commonly vary in size and detailed shape, although in them, as in the megascleres, there is a size and pattern which are characteristic of the individual (species), *i. e.* to which the majority of the spicules of an individual conform.

Some striking cases of variation are afforded by the micro-oxyhexacts of *Hyalonema bianchoratum,* p. 19, plesiasters and spirasters of *Thenea fenestrata,* p. 86, sigmata of *Tylodesma alba,* p. 133.

5. Correlated variation in the *spicules.*

In some cases the variation of spicules is obviously not ungoverned by the rest of the body, but is correlated with body-locality.

Thus while the pentacts in *Hexactinella labyrinthica* vary at large in respect to length of the several rays, the pentacts overlying the larger inhalent canals commonly have noticeably short proximal rays. Such a phenomenon would customarily be referred to as "adaptive."—— The variation of dichotriaenes toward the protriaene type, round the pore areas of *Thenea,* pp. 85, 89, 92, 95, is another instance of the same phenomenon.—— A complex instance of correlated variation is afforded by the dermal and gastral pinules of *Caulophacus schulzei*, which coat the opposite surfaces (pore and oscular) of the body. The two kinds of pinules vary in the same direction in different individuals, and thus the proportionate difference between them is preserved, p. 42.

6. *Qualitative variation?*

Two sets of individuals living together in the same locality, and which are otherwise indistinguishable, differ conspicuously in respect to a single point. An instance is afforded by *Eurete erectum mucronatum*, which differs from *Eurete erectum tubuliferum* in having oxyhexasters instead of onychasters, p. 64. Another instance is afforded by *Iophon lamella indivisus*, which differs from *Iophon lamella* only in the character of the bipocillus, which is not chelate, p. 145.——In order not to confuse the facts with hypothesis, the two sets of individuals have in each case been separated as subspecies. It is idle to dogmatize or to speculate *in extenso* on the value, from the standpoint of heredity, of the point of difference. Whether this point is inheritable and thus marks off two races, or whether it merely marks off two sets of individuals which started out alike and the offspring of which are alike, and which owe their difference to the action on the individual of the environment, no one can say. The recording of the difference is the duty of the systematist, who, when he has done so, has pointed out an additional case suitable for the experimental study of heredity and environmental action.

7. *Variation towards other species or subspecies.*

A class of spicules in one subspecies may vary in considerable number towards a condition characteristic of a subspecies inhabiting a different locality. An instance is afforded by *Eurete erectum gracile*, in which the tuberculation of the gastral pentacts and hexacts is sometimes very similar to that found in the other subspecies of *Eurete erectum*, p. 66.

Or a form of spicule characteristic of one species may occur infrequently in a related species. For instance, in *Caulophacus schulzei* the pinuli occasionally have the shape characteristic of *C. latus* and *C. elegans*, p. 42. A striking case is afforded by *Farrea occa claviformis*, in which a few gastral clavulae were found closely similar to the peculiar clavulae of *Farrea convolvulus*, p. 55.

8. *Constancy* of *character in spicules.*

It often happens that while in a single individual the *size* of a particular spicule may vary within wide limits, the *character* remains fairly constant, *e.g.* pinuli of *Hyalonema bianchoratum*, p. 20.—— The character of a spicule even in minute details may apparently become fixed for the species. Thus in a specimen of *Hyalonema ovuliferum* the rays of the micro-oxyhexacts have the same sudden terminal curving exhibited by the corresponding spicules of Schulze's type specimen, although the two sponges were taken 49° of latitude apart, pp. 13, 15.—— A form of spicule which in some sponges varies greatly in size, in other species varies but little. Thus in *Gellius perforatus* the sigmata vary only slightly, p. 129, whereas in *Tylodesma alba* they vary greatly, p. 133.

I do not undertake a comparative consideration of the geographical distribution of the forms making up the collection. Such a consideration would demand a knowledge of the actual systematic value to be attached to many *species* recorded in the literature of sponges. And such knowledge is not to be had at present. In modern sponge literature, *e.g.* in the two great monographs of Schulze and Sollas (Schulze, 1887; Sollas, 1888), the species conceived are, as it seems to me, what H. M. Bernard contends for in his interesting recent discussions (Proc. Cambridge Phil. Soc. Vol. XI. Pt. IV.; Verhdlg. V. Intern. Zool.-Congress) of the species-question as affecting the method of recording certain data, *viz.* homogeneous morphological groups. The sponge species are often very homogeneous, because represented by single specimens. That such groups answer always to natural species, as we understand the word when we speak of the human race, *Passer domesticus*, *Littorina litorea*, or other organisms which we know in great number, is not only open to doubt, but is excessively improbable. It is, I suppose, from this latter point of view (the envisaging clearly the *a priori* probability that sponges in general exhibit those individual and local differences which all species known intimately exhibit) that O. Schmidt was led to record in literature the existence of such species as *Farrea facunda*. Perhaps *Farrea facunda* is a "natural species," but the data at hand make such a statement only a subjective assumption. Or when the distinguished systematist Topsent expresses the opinion (1902, p. 12) that five species of *Poecillastra* recorded by Sollas probably represent the variations of two or three species, one is justified in saying "perhaps, but the known specimens differ in certain definite respects." Such subjective interpretations of differences perhaps always affect the manner in which we record the occurrence of certain morphological peculiarities in association with geographical and bathymetrical site. But whereas once they were rampant, to-day they are reduced to a minimum, with the result, as I have said, that the *species* of modern sponge literature are strikingly homogeneous groups, which need not be thought of as always corresponding to natural races.

That this method of precise analysis is the only method capable of yielding trustworthy data, seems to me incontestable. That it may result in temporarily recording more species than exist in nature, will only trouble those who incline to the view that the one excuse for systematic zoölogy is to provide them with a handy collection of names for the animal kingdom.

The data which are thus accumulating as to the occurrence of this or that peculiarity of structure in a certain locality are growing rapidly through the labors of systematists. Scarcely begun is the accumulation of the almost equally important data (comp. Poléjaeff, Report on the "Challenger Keratosa," p. 85), as to what peculiarities of structure are due to a difference in the physiological state of individuals belonging to the same race. Such knowledge, to be acquired through continuous observation of living individual sponges under normal and under modified conditions (experimental method) may be expected to bring about the union of many recorded *species*.—— Another most important class of data can only be revealed through the physiological study of the *race, viz.* through the breeding of sponges. And with the increase in the number of marine laboratories at which observations may be carried on continuously throughout the year, the inauguration of such studies may be anticipated.—— The modern statistical method of considering the differences between individuals of such groups as are procurable in large numbers is a refinement of what is commonly understood as systematic work, and a promising field for those acquainted with the structure of sponges. Such studies, by revealing the kinds and the extent of structural modifications which occur among individuals not separable into morphologically definable groups, may be expected to provide invaluable special cases for experimental study.—— It is through the combination of these several classes of data that we must hope to learn the limits of the natural groups of sponges as they exist to-day. When such trustworthy definitions of natural groups are at hand, the facts of the geographical distribution of the species will doubtless become intelligible.

In the classification of the Hexactinellida the changes introduced by Schulze and Ijima in the system of the former, as laid down in the "Challenger" Report on the Hexactinellida, have been in general adopted, where they concerned the types treated of in this Report. For the Tetractinellida I make use of Sollas's system. Topsent in a recent discussion (1902) proposes certain changes in Sollas's treatment of the streptastrose forms, but the changes proposed especially concern the *definition* of the genera and the two subdivisions, and do not materially alter the classification of the group. Lendenfeld's very extensive changes in the classification of the *Astrophora* (1894, 1903) do not seem to me an improvement on the system of Sollas. In dealing with the Monaxonida I employ Topsent's group *Hadromerina* (1898) and also follow this author (1894 *a*) in the division of the *Halichondrina* into families.

In regard to spicule terminology the usage except in minor particulars and with respect to a few terms has been practically uniform since the "Challenger" Reports. The useful list of Schulze and Lendenfeld (1889) includes terms employed in the "Challenger" Reports and others as well. Some of the latter offer no advantage over the "Challenger" terms, and have not been generally adopted, *e.g. amphiox* for *oxea, amphistrongyl* for *strongyle, amphityl* for *tylote, chelotrop* for *calthrops.* Vosmaer (1902) in a recent paper full of interest discusses some of the forms with regard to which there is not a uniform usage. Prominent among these is the *streptaster.* Sollas (1888) included under this head a long series of forms, which he divided into *plesiasters, metasters, spirasters, amphiasters,* and *sanidasters.* Of these the first four, and especially the first three, intergrade freely. Vosmaer thinks it impossible to carry out in practice the distinction between *plesiasters, metasters,* and *spirasters,* and would designate them all *spinispirae,* including under this term some at any rate of Sollas's *amphiasters.* Schulze and Lendenfeld (1889) use *spiraster, amphiaster,* and *sanidaster* in the sense of Sollas, and do not use *plesiaster* and *metaster,* but employ the term *streptaster* for spicules which in Sollas's terminology would fall under these two heads. Lendenfeld (1903, p. 12) continues to use the terms *amphiaster* and *spiraster,* but does not employ *streptaster, metaster, plesiaster,* nor *sanidaster.* The *sanidasters* (Sollas) are included under *microrhabds* (Lendenfeld), *e.g.* in *Tribrachion schmidtii* Weltn. The *spirasters* and *metasters* of Sollas are together included in *spirasters* (Lendenf.), *e.g.* in *Pachastrella* (*Poecillastra*) *schulzei* (Soll.) The *plesiasters* (Sollas) are passed over to the *oxyasters* of Lendenfeld, *e.g.* in *Ancorina* (*Thenea*) *fenestrata* (O. Schm.). Thus Vosmaer and Lendenfeld do not agree, and they both differ from Sollas.

In this matter Topsent (1902) adheres to the terminology of Sollas, and I likewise employ it. That the types singled out from the streptaster series by Sollas exist is of course indisputable. That they also intergrade, cannot be questioned. And this latter fact makes it necessary, whatever technical terms be employed, to *describe* the spicules of each species. Nevertheless Sollas's subdivision of the *streptasters* and his technical terms greatly facilitate reference to the spicules, and also make for accuracy of description. By combining the terms the transitions between the types may in a measure be indicated, *e.g.* in *Poecillastra cribraria* the microscleres of the dermal membrane (Plate **14**, Fig. 12 *a*) are typical *spirasters*, while those of the parenchyma are *plesiasters* (Plate **14**, Fig. 12 *b*) or *plesiaster-metasters* (Plate **14**, Fig. 12 *c*, 12 *d*) and more rarely typical *metasters*.

The lists of generic synonymy that are given include references to memoirs in which the genus as a whole is defined or in some way discussed, but are by no means complete guides to the species of the several genera.

In stating the size of tapering spicule rays, the thickness given is the greatest thickness, unless mention is made to the contrary.

In the case of some macerated skeletons of Hexactinellids only a direct comparison with types or with determinable specimens could give any warranty for an identification. And even then a doubt, expressed by a query, remains as to the species, although the direct comparison enables one to say that forms agreeing in dictyonal framework with certain described species occur in such a region.

After having made provisional identifications of the forms included in the collection, I found that before the work could be completed, it would be necessary to examine certain types deposited in European museums. The trustees of the University very kindly granted me leave of absence for the year 1902–03, for which I offer to them and to President Venable my sincere thanks. To the trustees and to President Gilman of the Carnegie Institution I wish also to express my hearty thanks for a generous grant which enabled me to carry out my plans. My year was spent chiefly in Berlin, in the laboratory of Geheimrath F. E. Schulze, although visits were made to the museums in London, Paris, and Leyden. To Geheimrath Schulze I am under lasting obligation, not only for the permission to occupy a working place in his Institut, but for the generosity with which he allowed me to make use of his library, photographic atelier, and collections, in particular his magnificent collection of microscopical preparations of the Hexactinellida, and finally for the helpful suggestions and friendly aid with which he responded to all of my calls for assistance. To another friend in Berlin, Professor Wilhelm Weltner, Custos in the Museum für Naturkunde, I am likewise under deep obligations for assistance in the use of the admirable collections of the Museum, and for aid of many kinds. To Geheimrath K. Möbius, Direktor of the Museum für Naturkunde, I offer my respectful thanks for the use of the photographic atelier, and for the kindly permission to make free use of the library and collections in the Museum. My respectful thanks are also due to Geheimrath E. von Martens of the Museum für Naturkunde for facilities allowed me during the course of my work in the Museum.

To the following gentlemen also I beg leave to express my thanks: to Professor E. Ray Lankester, Director of the British Museum (Natural History), for permission to examine types, and to Professor T. Jeffrey Bell and especially to the curator of sponges, Mr. R. Kirkpatrick, of the same Museum, for courtesies shown me during my visit; to Professor Edmond Perrier, Director of the Muséum d'Histoire Naturelle, for permission to examine the collections, and to Professor E. L. Bouvier of the Muséum for courtesies shown me during my visit; to Professor E. A. Jentink, Director of the Rijks Museum in Leyden, for permission to examine types, and to Dr. R. Horst of the same Museum for courtesies shown me during my visit.

Finally I desire to thank Mr. Agassiz not only for the opportunity of studying the valuable collection upon which I now report, but for the patience with which he has waited for the report.

University of North Carolina,
Chapel Hill, N. C.
Jan. 22, 1904.

SYSTEMATIC ACCOUNT OF THE GENERA AND SPECIES.

HEXACTINELLIDA O. Schmidt.

AMPHIDISCOPHORA F. E. Schulze.

HYALONEMATIDAE Gray.

Hyalonema Gray.

1832. *Hyalonema* Gray, 1832, p. 79.
1887. *Hyalonema* Gray, Schulze, 1887, p. 189.
1893. " " " 1893 a, p. 28.
1894. " " " 1894, p. 18.

Hyalonema ovuliferum F. E. Schulze.

1899. *Hyalonema ovuliferum* F. E. Schulze, 1899, p. 13, Taf. ii. Figs. 9–12.

Station 3382. One fragmentary specimen, comprising the lower end of what must have been a larger sponge than Schulze's type.

The fragment is a solid, elongated, and bilaterally compressed mass, through the middle of which the root spicules pass as a compact bundle. The root spicules are broken off 10 mm. below the rounded lower end of the sponge, and do not quite project from the upper end. Over the upper end of the fragment the dermalia and hypodermalia and the peripheral layer of parenchymal hexacts are absent, and this end doubtless represents the place at which the upper part of the body was broken away. The sponge is compact, although soft and easily torn. The surface, which is much injured, shows the apertures of numerous small canals not exceeding 1 mm. in diameter. The piece is 50 mm. long, with transverse diameters of 25 and 15 mm. respectively.

At the extreme lower end the sponge tissue round the emerging root tuft is not differentiated to form a hard and dense mass (basal collar-pad), although the principalia here exhibit the usual modification. The free portion of the root tuft is 3 mm. in diameter, and includes about 12 spicules, which are in the neighborhood of 400 μ thick, none exceeding 450 μ in thickness.

In the smooth principal oxyhexacts the rays are 250 to 850 μ long, with a basal thickness of 12 to 40 μ. In the peripheral region of the parenchyma these spicules are abundant, and for the most part regularly disposed, so as to produce roughly cubical meshes. In the deeper part of the parenchyma the hexacts are rare, and are arranged without regularity.

The smooth oxydiacts measure 750 to 1700 μ in length, with a thickness of 8 to 20 μ near the median enlargement. They are comparatively scarce in the dermal membrane and peripheral parenchyma, but very abundant in the deeper parenchyma, where they run in all directions, often arranged more or less distinctly in bundles.

In the smooth, hypodermal oxypentacts there is no trace of the distal ray. The tangential rays vary from a length of 200 μ, with a basal thickness of 16 μ, to a length of 1000 μ, with a basal thickness of 80 μ. The proximal ray is commonly half again, or twice as long as the tangential rays. The spicules are very abundant, and almost alone are concerned in forming the hypodermal meshwork, hypodermal diacts being rare.

The smooth micro-oxyhexacts are very abundant throughout the parenchyma. The rays are 24 to 30 μ long, slender and straight nearly to the end, where they are rather suddenly and distinctly curved.

The dermal pinules are very long and slender. The tangential rays are nearly cylindrical and then rather suddenly pointed, beset with scattered sharp microtubercles. On the distal ray the teeth are sharp and short, not exceeding 10 μ in length (measured along upper border of tooth), becoming gradually reduced in size toward the upper and lower ends of the ray. The upper end of the distal ray in the spicules scattered over the general surface is broken off, but the ray becomes very slender above, and the shape indicates that it terminates in a long point. In the common sizes of this spicule the tangential ray measures 60 to 90 μ long by 12 μ thick; the distal ray, 750 to 900 μ long, thickness of the lower smooth part of ray, 16 μ. At the extreme lower end of the specimen the pinules have distal rays only about $\frac{1}{3}$ as long as elsewhere. In Schulze's type specimen the dermal pinules had a distal ray 300 to 400 μ long. As regards this point, therefore, my specimen differs from the type, but the difference cannot be regarded as of importance, since the *character* of the pinule is the same in both sponges.

The larger variety of macramphidisc has a total length of 200 to 320 μ. The length of the bell-shaped umbel is slightly less than $\frac{1}{3}$ the total length of the spicule, and $1\frac{5}{10}$ times the width of the umbel. The shaft bears at its middle a circle of small protuberances, and usually other protuberances are scattered irregularly along it. In some cases there are three circles of protuberances, one in the middle, and one toward each end of the shaft. The shaft is very slender, excluding tuberosities about 5 μ thick. The spicule is abundant in the dermal membrane, and is present also in the parenchyma, particularly in the peripheral region.

The ellipsoidal form of macramphidisc has a total length of 60 to 80 μ. The greatest width of the umbel is about equal to its length, and the umbels nearly meet at the equator of the spicule. The arrangement of the protuberances on the shaft varies. More commonly they are aggregated into one group at the middle. Frequently, however, there may be two such groups, on opposite sides of the middle point of the shaft. In some spicules the protuberances extend nearly over the entire length of the shaft. The spicule is abundant in the dermal membrane, and also present in the parenchyma.

Small amphidiscs, which collectively may be referred to as **micramphidiscs**, are abundant in the parenchyma. How abundant they are in the dermal membrane is impossible to determine, since the surface is injured. The smallest of these spicules are micramphidiscs of the common type, with umbels about $\frac{1}{3}$ the total length of the spicule, or somewhat less. The total length of the spicule is 16 to 24 μ. The umbels are as wide as deep, and with numerous (about 16) teeth. The shaft is generally smooth and enlarged in the middle; in some of the larger spicules spinose in the middle.——Other small amphidiscs in which the umbels closely approach or reach the equator of the spicule, and in which the shaft is spinose, form a series leading up from a length of 30 μ to the ellipsoidal form of macramphidisc 60–80 μ long. As an example may be given a spicule measuring 30 μ long by 18 μ wide, in which the teeth of the opposite umbels meet at the equator.——Still another type of small amphidisc 30 to 50 μ long, resembling in general the elongated form of macramphidisc, is abundant in the parenchyma. The shaft bears sharp tuberosities, and the umbels are bell-shaped, somewhat deeper than wide, and something more than $\frac{1}{3}$ the total length. Very rarely a spicule is found intermediate in size and character between these and the smallest indubitable specimens of the elongated macramphidisc, which measure about 110 μ in length, and themselves are not common.——In the small amphidiscs, up to lengths of 50 μ, it is only possible to count the umbel rays with accuracy, in apical or approximately apical view. In such view it may often be seen that the number of rays is more than 8, being in the neighborhood of 14.

At the extreme lower end of the specimen acanthophorae are found in considerable abundance. They include diactines, tauactines, and stauractines, in which the ends are spinose, and commonly rounded and enlarged, although sometimes pointed. In the tauactines and stauractines the rays are subequal or very unequal, 12 to 16 μ thick, and commonly less — often much less — than 200 μ in length.

I have examined preparations of Schulze's type, and find that the only tangible point of difference between the two sponges is the difference in the length of the distal rays of the dermal pinules. On the other hand, the dermal pinules, the two forms of macramphidisc, and the micro-oxyhexacts, have in the two sponges the same *character*, even as to many minute details of structure, such as the sudden curving exhibited by the rays of the micro-oxyhexact.

The type specimen was taken to the west of Prince of Wales Island (55° 20′ N., 136° 20′ W.), at a depth of 2869 metres on a muddy bottom.

Hyalonema pedunculatum, sp. nov.

Plate 3, Figs. 1-6.

Diagnosis. Body pipe-shaped, produced below into a peduncle bent upon the body. Gastral surface deeply concave. Canals very small, and consistency dense. Dermal and gastral pinules with bushy distal ray, 320–440 μ long, ending above in a cone. Micro-oxyhexacts with straight or slightly curved, minutely denticulate rays, 50–60 μ long. Macramphidiscs of one kind, 120–180 μ long, with wide umbels, which nearly reach the equator of the spicule.

Station 3414, one specimen.

The lower part of the sponge (Plate **3**, Fig. 5) forms a peduncle-like process, strongly bent upon the morphological vertical axis of the body. The peduncle was broken across at a short distance from the body, the actual lower end of the sponge not being present. The upper or gastral surface exhibits a deep, narrow concavity, shown in sectional view in the figure, which represents the sponge after a part of the lateral surface has been sliced off. A ridge such as usually marks the passage of the upper or gastral into the lateral or dermal surface is distinguishable only on one side of the body, and does not contain peculiar marginal diacts. The gastral surface to one side of the deep cavity exhibits a sharp protuberance, which superficially suggests the central conus found in some species of Hyalonema. At another point (in the left of the figure) the periphery of the body, where gastral and dermal surfaces meet, is produced into an ear-like lobe overarching a lateral concavity. The expanded part of the body has a greatest horizontal diameter of 24 mm., and a similar depth. The peduncle, which is flattened, is 10 mm. thick in one transverse axis and 5 mm. thick in the other.

At one side of the stalk-like process, just beneath the surface, traces of the bundle of root spicules remain. Three of the spicules are still in place. These are broken across at their lower end, but may be followed upward in the sponge as far as the union of the peduncle with the expanded part of the body. In addition, seven cavities remain, from which root spicules have been pulled out. These cavities are mostly 350 to 400 μ in diameter, while the actually remaining spicules range in diameter from 75 to 200 μ.

The entire body is very dense and firm, the canals being 0.5 mm. and less in diameter. These small canals open in some abundance on both dermal and gastral surfaces. The dermal and gastral membranes are not reticulate, but exhibit where uninjured a thick furze of projecting pinuli, which is discernible to the eye.

The parenchymal macroscleres are smooth oxyhexacts and smooth oxydiacts. In the oxyhexacts the rays are subequal and tapering. In the commoner sizes the ray measures 420 x 24 μ to 1 mm. x 70 μ. The spicule is only fairly abundant.——The oxydiacts are exceedingly abundant, scattered in all directions in the upper body, arranged predominantly lengthwise in the stalk. There is commonly an enlargement, often very slight, at or near the middle, and the rays taper evenly. The spicule measures 1–2 mm. in length, 12–20 μ in thickness.

The hypodermalia and hypogastralia are abundant and alike. They are smooth oxypentacts with no remnant of the distal ray, the other rays tapering evenly. The size varies considerably. In a common size the tangential ray measures 370 μ x 36 μ, the proximal ray 670 μ x 40 μ, but much smaller spicules are abundant.

The **micro-oxyhexacts** are extremely abundant throughout the parenchyma. The rays are straight (Plate **3**, Fig. 3) or slightly curved (Plate **3**, Fig. 1), taper gradually to a fine point, and are beset with very minute sharp prickles. The ray is 50–60 μ long, and 4 μ thick at the base. Both the straight and curved varieties are common, although the form with straight rays predominates.

The **dermal and gastral pinuli** are alike. They are large, strong pentact pinuli (Plate **3**, Fig. 4), with no trace of the proximal ray. The distal ray is 320–440 μ long, with a greatest diameter of 30–60 μ, and a basal diameter of 10–16 μ. The stouter forms, in which the distal ray has a distinctly fusiform outline, as in the figure, are the typical spicules, although slenderer forms in which the distal ray is nearly cylindrical occur. The ray ends above in a terminal cone, and the upwardly projecting scales are narrow and sharp. These degenerate in the lower third of the ray to prickles, below which the ray is smooth. The scales in the thickest part of the ray have a length, measured along their upper border, of about 16 μ. The tangential rays are 40–50 μ long and 8–12 μ thick; about cylindrical and then suddenly curving to the point; with a few scattered, sharp, microtubercles. On the surface of the peduncular part of the body, only a few pinuli remain, and over much of the dermal surface they have been lost. On the gastral surface and on the uninjured parts of the dermal surface, they are thickly crowded.

In the walls of the larger canals a few **canalar pinuli** are to be found. They are of the same general type as the dermal and gastral pinuli, but with a shorter and relatively more slender distal ray.

Macramphidiscs of the type shown in Fig. 2, Plate **3**, are very abundant in the dermal and gastral membranes. The shaft is smooth, and the umbels closely approach the equator of the spicule. The umbels are wide, evenly rounded, not truncated apically, and include 8 tongue-shaped rays, which are rounded at the free end. A typical spicule has the following measurements: total length of spicule, 160 μ; width of umbel, 100 μ; depth of umbel, 70 μ; greatest width of umbel ray, 24 μ. The total length of the spicule commonly varies from 120 to 180 μ, but larger spicules are exceptionally found which reach a length of 200 to 250 μ. The umbel rays are sometimes not strictly rounded at the free end, but round-pointed, and occasionally even sharp-pointed.

Mesamphidiscs having the character shown in Fig. 6, Plate **3**, are abundant in the walls of some of the canals, and are scattered in the parenchyma. The shaft bears small, scattered, irregular tubercles, often a circle of tubercles, in the middle. The umbel has a deep bell shape, and is more than $\frac{1}{3}$ the total length of the spicule. The umbel rays are 8 in number, long, narrow, and pointed. A typical spicule has the following measurements: total length, 60 μ; length of umbel, 24 μ; width of umbel, 20 μ. The total length of the spicule varies from 40 to 65 μ.

Micramphidiscs of the common Hyalonema type, 25 to 30 μ long, are fairly common in the parenchyma. Transitional forms between these and the mesamphidiscs are easily found.

The skeletal resemblances between this species and *Hyalonema bianchoratum*, sp. nov., are striking, involving as they do the characteristic spicules, macramphidiscs, dermal pinules, and oxyhexacts (comp. Plate **2**, Figs. 2, 5, 10, and 11). Nevertheless the form of body is very different in the two species, and in *H. bianchoratum* there are two types of macramphidisc. Moreover, the macramphidisc of *H. pedunculatum* never assumes the shape with truncated poles and flattened sides which is common in *H. bianchoratum* (Plate **2**, Fig. 1). The resemblance is thus only partial, although close in the parts concerned.

Hyalonema bianchoratum, sp. nov.

Plate 2, Figs. 1-11.

Diagnosis. Body cup-shaped with deep gastral cavity. Numerous efferent canals open independently on the gastral surface; their apertures covered in by the gastral membrane. Micro-oxyhexacts with minutely denticulate rays about 50 μ x 4 μ; rays commonly slightly curved or straight. Dermal and gastral pinuli are alike, and pentacts; distal ray 250–530 μ long, comparatively stout, with long appressed upper spines and outwardly projecting lower spines, with a terminal cone. Macramphidiscs of two types. In one type the umbel is $\frac{1}{4}$ to $\frac{1}{3}$ total length, with acutely pointed rays; umbel width greater than its depth; total length about 450 μ. In the other type umbels closely approach equator of spicule; rays rounded at the end; umbel wider than deep; total length, 150 μ–250 μ.

Station 3415, one specimen.

Sponge body (Plate **2**, Fig. 6) is cup-shaped and, possibly owing to packing, is laterally compressed. The entire cup is 50 mm. deep, and has a greatest width of 75 mm. The cavity of the cup is 30 mm. deep, and the wall about 12 mm. thick. The wall thins away toward the free edge, but a marginal fringe separating the inner or gastral surface from the outer or dermal surface, is not present, possibly owing to the bad preservation of the specimen. The root spicules have been pulled out. The wall of the cup is excavated by numerous canals 4 mm. and less in diameter, and the consistency of the sponge is soft and flabby. The dermal membrane is badly injured, the gastral membrane less so. The latter is not separated from the sponge tissue, but simply passes over the apertures of numerous efferent canals.

The **parenchymalia principalia** are chiefly **oxydiacts**, which vary greatly in size and considerably in details of shape. There are many slender, often slightly curved, nearly cylindrical forms, with slight enlargement at or near the middle showing an axial cross. Common sizes are 1.5 to 2 mm. long by 20 μ thick. The ends are sometimes rounded and slightly enlarged. The spicule really tapers slightly from the middle toward the ends, and when the length is short (0.5 to 1 mm.) the outline becomes noticeably fusiform.—— There are some similar but much larger forms, connected by intermediate stages with the above. These may reach a size of 6 mm. x 34 μ. There is no median enlargement.—— There are other stouter diacts of a distinctly fusiform shape, ranging in size from 600 μ x 20 μ to 1350 μ x 60 μ. These exhibit an enlargement with axial cross. The enlargement may be faint or conspicuous, and may or may not extend quite round the spicule. This diact is not common in the interior, but is the predominating form at the dermal and gastral surfaces.

Other principalia are smooth **oxyhexacts**, which are scattered through the parenchyma in some number. The rays, which are not always of the same length, commonly range from 200 to 850 μ in length. A considerable number of large forms are present, having a ray length up to 3.5 mm.

The **hypodermal** and **hypogastral pentacts** are alike, and are strong, smooth oxypentacts, with no remnant of the distal ray. The tangential rays commonly vary in length from 350 to 850 μ. The proximal ray may be somewhat shorter than, or two or three times as long as, the tangentials.

Micro-oxyhexacts are abundant throughout the parenchyma. The spicules are strong spicules with rays 40–60 μ long and 3–4 μ thick at the base; commonest size of ray about 50 μ x 4 μ. Very minute, sharp denticulations are scattered along the ray, which tapers to a fine point. Spicules the rays of which are slightly curved, as in Plate **2**, Fig. 10, predominate, but abundant straight-rayed spicules (Plate **2**, Fig. 11) occur, and not infrequently spicules are met with in which the rays are conspicuously curved as in Plate **2**, Fig. 9. When the rays are curved, the curvature is of the usual character, *viz.* opposite rays of a diameter are bent in opposite directions.

The dermal and gastral pinuli are alike, and are pentacts. The distal ray (Plate **2**, Figs. 2, 3) is comparatively stout, ending above in a terminal cone. In the upper half of the ray the spines are long, narrow, and appressed. Below they are shorter and project outward in hook-like shape, degenerating farther down into a few prickles. The lowest part of the ray is smooth. The tangential rays bear a few scattered, sharp microtubercles. The range of size is considerable. Large spicules are abundant (Fig. 2, Plate **2**) in which the distal ray is 530 μ long, with a greatest thickness of 64 μ and a basal thickness of 24 μ; tangential rays, 44 μ x 16 μ; spines on distal ray reaching a length of 40 μ, measured along their upper border. Smaller spicules (Fig. 3, Plate **2**) are abundant down to a size in which the distal ray is 250 μ long, with greatest thickness of 32 μ, and a basal thickness of 10 μ; tangential rays, 30 μ x 10 μ. Still smaller sizes (Fig. 4, Plate **2**) occur, although not commonly, in which the distal ray may be only 175 μ long. Some of the shortest spicules have tangential rays as long as are met with in any of the pinuli, the length reaching 60 μ. Although the size of the pinuli varies within such wide limits, the *character* remains fairly constant. The character is expressed especially in the terminal cone, the long and narrow appressed upper spines, and the lower hook-like spines.

The macramphidiscs are of two types. The first type of macramphidisc, Fig. 8, Plate **2**, is only moderately abundant. It occurs, in the present condition of the specimen, both at the surface and in the interior. The shaft is slightly expanded, not always symmetrically, at the middle, and is smooth or bears one or two scattered small, sharp protuberances. The umbel is rather evenly rounded, although somewhat truncated at the apex, where there is a depression. It is considerably wider than deep, and its depth is from $\frac{1}{4}$ to $\frac{1}{3}$ the total length of the spicule. There are 8 rays which are acutely pointed. The variation in size is not great, and a typical spicule has the following measurements: total length, 455 μ; depth of umbel, 122 μ; greatest width of umbel, 188 μ; greatest width of umbel ray, 36 μ; thickness of shaft, at the middle of spicule, 30 μ.

The second type of macramphidisc is more abundant. It occurs especially at the surface, or in the peripheral parenchyma. In this spicule

(Figs. 1 and 5, Plate **2**) the shaft is smooth and only slightly thickened at the middle. The rays, 8 in number, are wide, tongue-shaped, rounded at the free end, and closely approach the equator of the spicule, rays of opposite umbels alternating. There is a depression at each pole of the spicule. The precise shape of the umbel varies. In many spicules (Fig. 5, Plate **2**) it has an evenly rounded outline, while in others (Fig. 1, Plate **2**) it is truncated at the pole and flattened on the sides. The two varieties shade into each other. A typical spicule with evenly rounded umbel has the following measurements: total length, 188 μ; depth of umbel, 80 μ; greatest width of umbel, 128 μ; shaft, 18 μ thick at the middle. A typical spicule with truncated and flattened umbel has the following measurements: total length, 210 μ; depth of umbel, 95 μ; greatest width of umbel, 152 μ; shaft, 20 μ thick at the middle.

Mesamphidiscs (Fig. 7, Plate **2**), 60–80 μ long, are present, but in small number, in the parenchyma. The shaft bears scattered, minute, sharp denticulations, and often but not always a circle of somewhat larger similar protuberances at the middle. The umbels are deep bell-shaped, slightly deeper than wide, and a little more than $\frac{1}{3}$ the total length. The umbel rays are 8 in number, rather narrow, and with pointed free end. A typical spicule measures: total length, 80 μ; umbel depth, 36 μ; umbel width, 30 μ.

Smaller amphidiscs, micramphidiscs, agreeing in shape with the mesamphidiscs, are scantily present. They range down to a total length of 28 μ.

Hyalonema, species diversae.

Plate 2, Figs. 12–16.

Under this heading I briefly describe several specimens so fragmentary that the shape of body cannot be inferred with any approach to certainty. The skeletal elements of them all, especially of the forms designated *Hyalonema 1* and *Hyalonema 2*, offer close resemblances to those of *H. bianchoratum.*

Hyalonema 1.

Station 3381, a fragment, apparently from the lower end of the sponge, including a part of the bundle of root spicules and surrounding tissue. The bundle of root spicules in its thickest part has a diameter of 5 mm., and the larger spicules a diameter of 700 μ.

The micro-oxyhexacts agree with those of *H. bianchoratum.*——The dermal pinules also resemble those of the latter species, differing only in that the upper spines on the distal ray are somewhat longer, the ray thus appearing more bushy.——There are two types of macramphidisc essentially like those of *H. bianchoratum.* In the case of the larger type, the total length reaches 510 μ; the shaft bears 3 or 4 scattered sharp microtubercles; the depth of the umbel is $\frac{1}{3}$ the total length; spicule fairly abundant. In the case of the shorter type, the umbel rays commonly reach equator of spicule, often slightly interdigitating; total length reaching 255 μ; larger sizes of the spicule truncated at the poles and with flattened sides, as in Fig. 1, Plate **2**.——The smaller amphidiscs, 24–70 μ long, do not differ from those of *H. bianchoratum.*——Acanthophorae are present and include stauractines and diactines. Spicules are spinose only at the ends of the rays; ends often rounded and enlarged, also pointed. The spiculation indicates that the fragment belongs to *H. bianchoratum,* perhaps representing a local variety of this species.

Hyalonema 2.

Station 3414, a fragment from the peripheral part of the sponge including both dermal and gastral surfaces, and about 50 mm. wide with a greatest thickness of 20 mm. On the gastral surface are the apertures of several canals about 7 mm. wide.

The micro-oxyhexacts agree with those of *H. bianchoratum,* but forms with straight rays predominate.——The pinules of the dermal and gastral surfaces agree closely with those of *H. bianchoratum.*——There are two types of macramphidisc, shown in Figs. 13 and 16, Plate **2**, which differ only in minute details from the macramphidiscs of *H. bianchoratum.* In the larger type, Fig. 13, the total length is 250–320 μ; shaft smooth or with a few scattered sharp tubercles and often with 4 or 6 protuberances at the middle. A typical spicule measures: total length, 280 μ; depth of umbel, 90 μ; width of umbel, 130 μ. In the smaller type, Fig. 16, the total length is 100–150 μ; rays of opposite umbels often slightly interdigitating at the equator of spicule. The umbels are never conspicuously truncated and flattened as in many of the spicules of *H. bianchoratum* (Fig. 1, Plate **2**). A typical spicule measures: total length, 144 μ; depth of umbel, 70 μ; width of umbel, 100 μ.

In addition, amphidiscs of the type shown in Figs. 14 and 15, Plate **2**, are fairly abundant. The total length is 150–180 μ; umbel depth varying from $\frac{1}{4}$ nearly to $\frac{1}{3}$ total length; shaft with a few scattered tuberosities, and frequently but not always with a ring of tuberosities at the middle. The umbel is often evenly rounded, as in Fig. 15, but as frequently somewhat truncated at the poles and flattened along the sides, as in Fig. 14. These spicules, which owing to their size may be regarded as a third type of macramphidisc, pass through intermediate stages into very similar mesamphidiscs, 60–80 μ long, in which the umbel depth somewhat exceeds $\frac{1}{3}$ the total length.——The mesamphidiscs are connected by transitional forms with micramphidiscs, 18–20 μ long, of the character usual in *Hyalonema.*

The skeletal resemblances to *H. bianchoratum* are extensive and close. The only important point of difference is afforded by the third type of macramphidisc, which might properly be designated as an enlarged mesamphidisc, since it is connected by an unbroken series with the latter.

Hyalonema 3.

Station 3414. Three fragments, all including the lower end of the sponge with the root tuft.

The largest piece is a laterally compressed triangular mass 45 mm. wide by 50 mm. high. The root tuft where it adjoins the sponge is 5 mm. thick, and includes about 25 spicules varying in thickness from 200 μ to 730 μ. The spicules are all broken off below, the fragment of root tuft measuring 100 mm. in length. The tuft bears no anemone. At the base of the body there is a conspicuous firm and dense collar-pad surrounding the root spicules.——The other two fragments are likewise laterally compressed triangular masses, but from smaller sponges. The upper diameter of the root tufts is something less than 2 mm., and the spicules do not exceed 250 μ in thickness. Again the lower ends are all broken off, although the tuft in one case is 200 mm. long. Both tufts at the upper end are surrounded by small *Palythoa* colonies, each including two individuals. In these specimens the basal collar-pad has not developed.——It is noteworthy that in all three specimens the lower end of the sponge body has a triangular outline, and is laterally compressed to a marked degree.

The surface is so injured that it is not possible to reach a conclusion as to the character of the dermal pinuli.——The micro-oxyhexacts, which are abundantly scattered throughout the parenchyma, are small slender forms (Fig. 12, Plate **2**) with rays 30–36 μ long by 2 μ at the base, tapering gradually to the point. Rays are faintly roughened, almost smooth; slightly curved or straight, both types common.——Two types of macramphidisc quite similar to the spicules of *Hyalonema 2*, which are shown in Figs. 13 and 16, Plate **2**, are sparsely present.——A third type of macramphidisc, quite like the spicule of *Hyalonema 2*, which is represented in Figs. 14 and 15, Plate **2**, is present in great abundance. The spicule measures 150–180 μ in length, and is connected by abundant transitional forms with similar mesamphidiscs 40–60 μ long. **Micramphidiscs**, of the usual character, 16–20 μ long, are abundant.

The similarity to *Hyalonema 2* afforded by the amphidiscs is striking.

Mention may here be made of imperfect tufts of root spicules taken at Stations 3381 and 3399. The spicules resemble those of the specimen of *Hyalonema pateriferum* from Station 3376.

Hyalonema pateriferum, sp. nov.

Plate 1, Figs. 1-13.

Diagnosis. Body obconical to saucer-shaped, the upper surface approximately flat, the under surface very or moderately convex. No main gastric cavity, but instead a comparatively large number of efferent canals covered in by the gastral membrane. Root spicules thick, about 1 mm. in diameter. Characteristic micro-oxyhexacts with slender, curved, and minutely denticulate rays 30–45 μ long. Dermal pinules, slender forms; distal ray, 150–200 μ long, ending in a slender point. Characteristic macramphidiscs 100–200 μ long, with smooth shaft and umbels which have the shape of wide, shallow bowls; depth of umbel about $\frac{1}{5}$ the total length, or shallower.

Station 3376, 1 specimen; *Station 3363*, 1 specimen and 3 fragments; *Station 17* of the "Albatross" 1900 cruise, 2 specimens.

In the specimen from Station 3376 (Figs. 12 and 13, Plate **1**), the body is irregularly obconical, and is somewhat compressed in one of the morphological horizontal diameters. The root tuft emerges from one side of the base, and exhibits an open spiral curvature. The general asymmetry is doubtless an individual feature, associated with the position assumed by the animal in its habitat. If in the natural position the root tuft was vertical, then the body of the sponge probably lay under a stone or some such object, the gastral face looking out from under this protection. The sponge body is 65 mm. high and has a greatest width of 90 mm. The root tuft is 330 mm. long, 6 mm. thick, near the body, and includes about 50 spicules, most of which are thick, having a greatest diameter of about 1 mm., although much slenderer ones are intermingled. At its base the tuft is embraced by a single *Actinia*-like anemone of a yellow-brown color and firm leathery consistency.

A marginal ridge is sharply defined round the greater part of the gastral surface. The membrane covering the gastral surface is in general a typical reticulum, but in places near the periphery of the surface the reticulum is not developed, the membrane here appearing to the eye dense and perforated only by scattered oscula about 1.5 mm. in diameter. The membrane covers in a relatively large number of efferent canals, the transverse diameter of which at the surface is 5–10 mm. These canals extend more or less vertically into the body, and largely excavate it. Some of them are easily traceable from the gastral surface to the base of the body. The dermal membrane, covering the lateral surface of the body, is a reticulum with a somewhat finer mesh than the gastral membrane. Over a considerable part of the surface the dermal membrane has been abraded, disclosing the canals beneath. These, presumably afferent, canals are in general smaller than the canals opening on the gastral surface. At the base of the body there is a rather inconspicuous collar-pad, surrounding the root tuft and containing the characteristic acanthophorae.

The entire specimen from Station 3363 is a saucer-shaped mass, with a flat upper and convex lower surface. The root tuft has been torn out, leaving an evenly bounded aperture, 6 mm. wide, about in the centre of the lower surface. The sponge body has a depth of 40 mm., the horizontal diameters being respectively 85 mm. and 65 mm. In other respects, the description given of the specimen from Station 3376 applies to this specimen.

The better specimen from Station 17 (*1900 cruise*) resembles in essential shape the one from Station 3363, but is even flatter. The depth is 15 mm., the horizontal diameters respectively 80 and 60 mm. The root tuft has again been torn out, leaving a somewhat irregular aperture 7 mm. in diameter. The gastral membrane, covering the upper surface, appears continuous and not reticular, the probable explanation being that the apertures are closed. The dermal membrane, covering the under surface, is reticular as in the other specimens. Toward the periphery the body thins away to a sharp margin, which is somewhat injured. The other specimen from this station is fragmentary, but appears to have belonged to a much-flattened sponge similar to the one just described. It is of course possible that in the packing these specimens have been artificially flattened. There is, however, every indication that the present shape is approximately the natural one.

The parenchymal macroscleres are oxydiacts and oxyhexacts. The oxydiacts are very abundant, scattered in all directions through the parenchyma, chiefly in tracts, but also singly. They are smooth, with or without a median swelling, the rays tapering evenly to points. The size varies from 500 μ long by 8 μ thick, near the middle, to 3 mm. long by 28 μ thick.—— The oxyhexacts are few in number. The rays are smooth, straight, and tapering, measuring in a typical case 700 μ long by 48 μ thick at the base. The hypodermalia and hypogastralia are alike, and are smooth oxypentacts and oxydiacts. The oxypentacts are abundant, with no trace of the distal ray, the other rays tapering to points. They vary in size from small ones with tangential rays 150 μ x 12 μ to large ones with tangential rays 600 μ x 48 μ. The proximal ray is in general longer than the tangential rays, but on the gastral surface it is sometimes shorter.—— The diacts are abundant, sharing with the tangential rays of the pentacts in forming the supporting reticulum of the surface. They are similar to the diacts of the interior.

The common and characteristic form of parenchymal microsclere is a micro-oxyhexact with slender, curved, and minutely denticulate rays, 30–45 μ long and 2 μ thick at the base (Fig. 9, Plate 1). The denticulations are sharp and just perceptible, with a power of 600 diameters. The curvature is well marked. Mingled with these are a good many similar oxyhexacts, in which the ray is either straight (Fig. 8, Plate 1) or shows only a very slight curvature. These average a larger size, the ray length being 40–60 μ. Oxyhexacts and oxypentacts with straight, minutely denticulate rays, 60–80 μ long, are found sparsely in the parenchyma, and in or near the walls of some of the canals. They are probably in all cases canalaria.

The dermal pinules (Fig. 3, Plate 1) are slender spicules, in which the distal ray ends in a pretty long slender point ("endspitze"), and bears sharp spines, which are not thickly crowded. The lower part of the distal ray, ¼ to ⅓ the total length, is smooth. The tangential rays are smooth, or nearly so, and pointed. There is no trace of the proximal ray. The distal ray is commonly 150–200 μ long, with a basal thickness of 5 μ; tangential rays 30–40 μ long. Spicules in which the distal ray is only 100 μ long, or as long as 220 μ, occur. The pinules are abundant, and their tangential rays rest upon the reticulum formed by the hypodermal diacts and the tangential rays of the hypodermal pentacts.

The **gastral pinules** are in general like the dermal pinules; but long, very slender forms of the type shown in Fig. 2, Plate **1**, occur. In these spicules the spines on the distal ray are so reduced in size as to be mere prickles. The distal ray is 300–400 μ long; tangential rays about 40 μ long. Transitional forms between these and the ordinary type of pinulus occur. The gastral pinules are arranged in the same way as the dermal.

Canalar pinules are rather sparsely scattered over the walls of the larger efferent canals. They are similar to the common type of dermal and gastral pinulus, but are somewhat shorter. The distal ray is 110–150 μ long; tangential rays 40 μ long. Only a comparatively small percentage of the spicules rest upon the underlying diacts.

The marginal ridge is well preserved in only one specimen, that from Station 3376. Oxydiacts (marginalia) in considerable number project radially from the ridge. Many are like the common hypodermal diact; *i. e.*, smooth and enlarged at the middle. Others are specialized marginalia, in which the outer projecting half is covered with small, sharp spines, while the inner half is smooth (Fig. 1, Plate **1**). An occasional prickle is found in some spicules on the inner half. A typical spicule is 700 μ long and 12 μ thick near the middle. This form of marginal diact is shorter and slenderer than the common sizes of the smooth form.

The characteristic macramphidisc of the species is shown in Figs. 5, 6, and 7, Plate **1**. The shaft is ordinarily smooth, very rarely with one or two rounded protuberances at the middle. The umbels have the shape of wide shallow bowls; depth of the umbel about $\frac{1}{5}$ total length of the spicule, or less; umbel rays 8 in number, broad and leaf-like, pointed. In the specimens from Stations 3376 and 3363 the macramphidiscs are alike. In these specimens the total length of the spicule is 100–200 μ; thickness of the shaft at the middle 8–16 μ; depth of the umbel varying somewhat, but close to $\frac{1}{5}$ the total length. One of the smaller sizes is shown in Fig. 5, one of the larger in Fig. 6.——In the specimens from Station 17 (1900 cruise), macramphidiscs occur that are similar to those of the other specimens, but in most of the spicules the umbels are very shallow, and with noticeably flat tops. The umbel depth is commonly about $\frac{1}{7}$ the total length. The total length is the same as in the other specimens. A typical macramphidisc of this specimen is shown in Fig. 7, Plate 1.—— The macramphidiscs are very abundant in the dermal and gastral membranes of all specimens. A few are found in the internal parenchyma, but this position may not be natural.

Mingled with the characteristic 8-rayed macramphidiscs are a considerable number of amphidiscs of the type shown in Figs. 10 and 11, Plate 1. The umbel is usually 4-rayed, but umbels with 5 and 6 rays occur. The shaft is smooth, and the umbel rays very similar to those of the 8-rayed form. The spicule varies somewhat as regards the precise shape of the umbel, which in some spicules (Fig. 10) is deeper than in others (Fig. 11). The total length is 60–100 μ. It is possible that these spicules represent young stages of the 8-rayed form.

Mesamphidiscs (Fig. 4, Plate 1), 50–80 μ long, are abundant. The shaft bears scattered small tubercles in varying number. The umbel is deep bell-shaped, with 8 pointed and rather narrow rays. The umbel depth is slightly more than $\frac{1}{3}$ the total length.

Micramphidiscs of the common *Hyalonema* type, 20–25 μ long, are abundant. Intermediate forms between these and the mesamphidiscs are common, and especially abundant in the walls of the main efferent canals.

Pathological amphidiscs of small size are occasionally observed, similar to those described by Marshall and Meyer, 1879, p. 261, Taf. XXV Figs. 19, *a*, *b*, *c*. In one such, which measured 72 μ in total length, 3 rays of the hexact had developed umbels which were not quite alike, one ray was club-shaped at the end, and a fifth ray had the form of a short spine.

The lower end of the body is well preserved in only one specimen, that from Station 3376. The collar-pad here bears on its outer surface the ordinary dermal skeleton, but round the root spicules there is a thick dense layer of acanthophorae. In these, only the ends of the rays are spinose. The ends are frequently but not always slightly enlarged. The spicules include diacts, tauacts, stauracts, pentacts, and hexacts. Stauracts with subequal or very unequal rays are the commoner forms. In a representative diact, the total length is 900 μ. In a typical stauract the length of the longest ray is 250 μ.

The basalia vary in greatest diameter from 130 μ to 1 mm. The spicules in their lower portions taper rather rapidly and over a considerable distance, 60 mm. or so, exhibit the well-known annular ridges. The lower ends are broken off.

Of the known species of *Hyalonema,* the form here described stands nearest *H. conus* F. E. Sch. (Schulze, 1887, p. 209; 1893, p. 35). A precise point of difference concerns the micro-oxyhexacts which in *H. conus* have straight and distinctly roughened rays 50–60 μ long. The pinules and macramphidiscs are very similar in the two species, although in *H. pateriferum* the macramphidisc umbels are wider and shallower, especially in the specimens from Station 17 (1900 cruise).

HEXASTEROPHORA F. E. Schulze.

EUPLECTELLIDAE Gray.

Euplectella Owen.

1841. *Euplectella* Owen, 1841, pp. 3–5.
1887. *Euplectella* Owen, Schulze, 1887, p. 53.
1901. " " Ijima, 1901, pp. 37–58.

Euplectella, sp.

Plate 4, Fig. 4.

Station 3404, 6 imperfect specimens. The specimens include only the dictyonal framework, with no free spicules, and thus a closer identification is impossible.

The specimens represent in all cases the lower part of the body, which is somewhat curved and tapers to the inferior apex. The paragastric cavity is limited below by a "bottom plate." The extreme lower end of the body is worn in most of the specimens, but in one the longitudinal bundles of the wall are continued below the body, curving toward one another so as to form a conspicuous cone, which extends 6 mm. below the bottom plate.

The wall is made up of the longitudinal, transverse, and oblique silicious strands characteristic of *Euplectella,* all firmly united together by exceedingly numerous synapticula. The longitudinal tracts on the outer surface are strongly, whereas the transverse tracts on the inner surface are feebly, developed. Along the former, and also along the oblique tracts, are here and there developed isolated protuberances, which in places are united to form parietal ridges. The parietal apertures are rounded and for the most part arranged in fairly regular transverse or oblique rows.

The specimens are of interest in that the cavity of the sponge is crossed by one or more horizontal or oblique septa. The septa (Fig. 4, Plate 4) are obviously similar structures to the well-known "bottom plate," which has been observed in several species of *Euplectella* (Schmidt, 1880, p. 60; Schulze, 1895, p. 17; Schulze, 1902, p. 53; Ijima, 1901, pp. 40, 92, 103, 207). The septa are spongy, easily broken, and composed of a reticular tissue formed by the continued deposition of silica chiefly round small diacts, with the development of synapticula. The diacts discernible in the beams of the reticulum have rounded and slightly enlarged ends. The proper skeletal strands of the sponge wall take no share in forming the septa.

In the specimen figured the septa are arranged one above the other. In the other specimens there is but one septum. The septa are thicker at the periphery, thinning out toward the centre. Except in one case they are perforated by several rounded apertures, about the size of the parietal apertures. In the case referred to, the septum is imperforate, but is exceedingly thin in spots. On its upper surface the reticular beams have a predominantly radial disposition, and moreover are vaguely divided into groups, each of which radiates from a particular part of the body wall. This arrangement suggests that the septum arises as a number of centripetal outgrowths from the wall, the outgrowths meeting and coalescing. And in fact, in the specimen figured, three independent outgrowths of this character, all lying in the same transverse plane, exist above the uppermost septum.

The reticular tissue of the septa, at the periphery of the latter, is prolonged as a thin unevenly developed layer over the adjacent parts of the sponge wall. In some of the specimens, in which there are no septa, this reticular layer is developed over extensive areas of the gastral surface, and in a less degree over the outer surface. In such places the tissue is thick enough to hide completely from view the proper composition of the wall, passing over and so closing the parietal apertures.

The union of the smaller parenchymalia into a finely reticulate tissue, which in the one case spreads over the surface of the sponge, and in the other crosses the paragastric cavity, would seem to be everywhere essentially the same phenomenon, perhaps having a definite physiological function. The structure of the "bottom plate" in the specimens studied is similar to that of the septa.

Regadrella O. Schmidt.

1880. *Regadrella phoenix* O. Schmidt, 1880, p. 61.
1887. *Regadrella* O. Schm., Schulze, 1887, p. 84.
1901. " " Ijima, 1901, p. 220.

Regadrella, sp.

Plate 9, Fig. 9.

Station 3380, two fragmentary specimens including only the macerated skeletal framework.

In both specimens the base is preserved with the lower part of the tube wall. The better specimen is figured (slightly above the natural size, owing to an accident in the taking of the photograph). In the other specimen the base is smaller, and less of the wall is included. The base in each is a nearly flat plate with few irregularities. The skeletal strands forming the wall are cemented together at the points of crossing, and the wall as a whole is somewhat flexible and elastic.

I have had for comparison specimens of *R. okinoseana* Ijima and *R. phoenix* O. Schm. As compared with the former species, and in a less degree as compared with the latter, the "Albatross" specimens are remarkable for the thin character of the parietal strands and the consequent large size of the meshes. As compared with the only other species of *Regadrella* the whole body of which is known, *R. kameyamai* Ijima, it would seem from Ijima's description (1901, p. 257) that the parietal strands in my specimens undergo a more extensive fusion. These specimens again differ from the described species of *Regadrella* in the greater regularity of arrangement displayed by the skeletal strands. On the gastral surface the obliquely transverse beams, which are very strongly developed, are arranged parallel to one another. Crossing them at about right angles are ascending bundles. The meshes would thus be squarish, but oblique fibres extending both to the right and left cross the meshes usually at the corners, thus giving rounded apertures. The oblique fibres may cross the middle of the mesh in such a way as to obliterate the aperture. The arrangement of the skeletal strands thus approaches the regularity found in *Euplectella.*

The coarser skeletal strands are made up, each, of one or a few large diacts surrounded by very slender diact comitalia, all united by and covered with cement. The principal diacts are 120 μ or somewhat less in transverse diameter, tapering gradually toward the ends, which are apt to break off or remain concealed in the cement. The comitalia are very slender, often only 6 or 8 μ thick. The length of the principalia may exceed 20 mm., and they are frequently though not always bent at the middle, as in the similar spicules of *R. phoenix* (Schulze, 1899, p. 21).

The reticulum of silicious beams constituting the basal plate presents no peculiarly characteristic features, agreeing in general with the description given by Ijima (1901) for *R. okinoseana* and *R. kameyamai.*

Regadrella delicata, sp. nov.

Plate 3, Figs. 7, 8. Plate 4, Figs. 2, 11.

Diagnosis. The marginal spicules round the sieve-plate are stauracts, the longitudinal axes of which are not included in the skeletal bundles of the body wall. The superior rays of the stauracts are accompanied by slender parenchymalia, not by the parenchymalia principalia. Species close to *Regadrella phoenix* O. Schm., agreeing with it in general spiculation.

Station 3404, one specimen.

The specimen is fragmentary, including a part of the lateral wall of the sponge, which had been ripped open longitudinally. In packing, the piece was compressed so that it reached me in the shape of a folded plate, the line along which the folding had taken place corresponding with the long axis of the sponge. This plate-like fragment had a length of 150 mm. and a greatest width of 50 mm. Its upper edge is formed by the margin of the sieve-plate area, and seems to be uninjured. The dermal and gastral surfaces of the lower part of the piece are shown in Fig. 11, Plate **4**.

When the two halves of the specimen, which had been folded together, were separated, some idea of the natural shape of the sponge was obtainable, and it could be seen that the sac tapered markedly toward its upper end. The upper edge is 25 mm. long. How much of the natural periphery of the sieve-plate area this represents could not be ascertained, although the curvature of the wall indicates that it represents a very large part.

The wall of the sac is thin, about 1.5 mm. thick. The rounded parietal apertures are mostly 2 to 1.5 mm. in diameter, except in the extreme upper part of the sponge, where the diameter is very commonly about 1 mm., although much smaller apertures are here present. The apertures exhibit an imperfect arrangement in oblique or nearly transverse rows, and are mostly 3–5 mm. apart; more closely crowded in the upper part of the sponge, where the interval is 2 mm. to 0.75 mm. On both dermal and gastral surfaces, the small apertures of the numerous canals, 0.5 mm. and less in diameter, give the sponge a porous appearance.

The gastral surface is smooth, and the dermal surface, which is without prostalia, exhibits no elevations, except that as in other species of the genus the coarse skeletal bundles project. These latter bundles pursue a nearly longitudinal or somewhat oblique course, converging toward the lower end of the fragment, where there are some cases of anchylosis. Elsewhere there is no, or only the feeblest anchylosis. The obliquely transverse bundles on the gastral surface are not large enough to cause elevations of the gastral membrane. In the uppermost part of the body the transverse arrangement of these bundles is more marked than elsewhere.

The spiculation agrees with that of *R. phoenix* as described by Schulze (1887, p. 84; 1895, p. 34; 1899, p. 20) and Ijima (1901, p. 265), except in a few details. And the close resemblance to *R. phoenix* possibly indicates that the specimen represents a late stage in the development of that species.

The principal diacts, smooth and tapering to a point at each end, bent at the middle or more evenly curved in bow-like shape, reach a diameter of 300 μ and a length of 30 mm. There are abundant smaller sizes down to 12 mm. x 170 μ, below which still smaller spicules with the characteristic shape down to 6.5 mm. x 90 μ are found.

The slender cylindrical comital diacts of various lengths are mostly 6–8 μ thick. They are swollen in the middle, and usually with subterminally roughened ends, which are often but not always enlarged. Similar diacts, 6–30 μ thick, constitute the smaller bundles or lie loose in the parenchyma. Other small parenchymalia, intermediate between the diact and hexact condition, with cylindrical rays rounded at the ends, are also found. The tauact and stauract forms are the commonest.

The comital diacts are not cemented together over the principalia, and the latter are only loosely combined to form bundles. Many of the principal diacts lie scattered through the parenchyma, unassociated in bundles. Some of these are without comitalia, although in general so provided. To form a long bundle the ends of succeeding diacts overlap, and become covered with a continuous sheath of comitalia. Very commonly 4 or 5 diacts, each with its own sheath of comitalia, lie side by side, but separated by considerable intervals, thus forming a tract, but not a single bundle. Frequently such diacts in one part of their course will be closely bound together, while separate elsewhere. This is the commonest arrangement, although there are bundles consisting of 2 to 4 parallel diacts, which are closely bound together by comitalia throughout their length.

The principal diacts in the extreme upper part of the body average a smaller size than elsewhere, the larger ones here measuring only 10–13 mm. in length by 200–220 μ in thickness. Some of them exhibit the characteristic bend, which is frequently not at the middle, while others are gently curved or nearly straight. They are in general surrounded by relatively few comitalia and lie separately or in approximately longitudinal bundles composed of a few (2–4) spicules. In one part of the marginal region, about 5 mm. wide, the parietal apertures are scarcely developed, being here few and small and not rounded but irregularly elongated gaps. In this small region the principal diacts show what is probably the general arrangement before the apertures develop. They are here arranged close together in an approximately longitudinal direction, radiating toward the upper margin, reaching or nearly reaching or projecting slightly beyond this margin, and are without proper comitalia, although the slender diacts are present in abundance between them.

The dermalia are slender hexacts, which agree with the description given by Ijima (1901, p. 273) for *R. phoenix.* The short distal ray is cylindrical or only very slightly expanded, 6–8 μ thick, rounded at the end and with "obsolete microtubercles." Measurements of a characteristic spicule are: distal ray, 80 μ long; tangential rays, 160 μ long; proximal ray, 200 μ long; tangentials and proximal, about 8 μ thick at the base. Meshes of the dermal network formed by the tangential rays are in general square, 160–250 μ on the side, including 3 or 4 pores which are 50–110 μ in diameter.

In the upper part of the body, within a distance of 15 mm. from the margin, the dermal hexacts are much less uniform in structure than elsewhere. While spicules occur, like those which are common lower down, most of the hexacts are larger, stouter forms, in which the short distal ray is either rounded or pointed at the end, and the tangential rays taper conspicuously to points. Many sizes are found, ranging up from spicules, in which the rays are about as long but twice as stout as in the common dermalia, to large forms with tangential rays 600 μ long and 65 μ thick. In the larger ones the tangential rays are commonly of unequal lengths. Some of these stout spicules are found here and there over the general surface of the body.

The **gastralia** are scattered. Pentacts answering to the description given by Ijima (1901, p. 275) for *R. phoenix* are common. The tangential rays are equal or unequal, and mostly 150 to 250 μ long by 10 to 12 μ thick. The proximal ray is longer, frequently 500–750 μ by 10–12 μ. Similar tauactines and stauractines are common. Hexact forms also are frequent, like the pentacts except that the small rounded boss is represented by a ray, which is usually much shorter than the tangentials, and is smooth, terminally rounded, cylindrical, or slightly enlarged, the greatest thickness sometimes reaching 16 μ. Gastralia similar to those here described are present in a specimen of *R. phoenix* from the Museum of Comparative Zoölogy.

Onychasters are abundant. The principal rays measure 4–6 μ, the terminals about 30 μ in length. The terminals are slender and tapering, usually 3 to a principal. The spicules differ from those of *R. phoenix* (Schulze, 1899, p. 21, Plate III.; Ijima, 1901, p. 216, Plate X.) in the size of the claws. In *R. phoenix,* according to Schulze's and Ijima's figures, the claws are fully 2 μ long. In my specimen the claws are 1 μ long and exceedingly fine. The difference, although one of degree, is easily noticed. In a preparation of *R. phoenix* (specimen in Museum of Comparative Zoölogy) I can observe the claws with a power of 300, and can study them very well with a power of 600. In my specimen, with the former power, all the spicules look like oxyhexasters, and even with 600 most of them present this appearance. To make sure of their general presence, it is necessary to use an immersion objective. In the spicule, only two claws can be made out on each terminal, and these project forwards.

A **floricome** is found in the immediate neighborhood of the distal ray of each dermal pentact. The spicules are like those of *R. phoenix* (Schulze, 1887, p. 85, Plate XIII.; Ijima, 1901, p. 276, Plate X.), but the size is something smaller than that given by Ijima, the diameter being about 80 μ.

Graphiocomes must be rare. I do not find any in my preparations, and only a very few rhaphides. Nor do I find any spicules peculiar to the border of the parietal apertures.

Over a part of the surface, as in the specimen of *R. phoenix* studied by Ijima (1901, p. 269), the hydranths of a commensal hydroid cause minute elevations. The elevations are not abundant nor conspicuous, although the opaque body of the hydroid catches the eye. As in Ijima's specimen very large and modified dermal hexacts, mingled with the common dermal hexacts, are found round the hydrozoan body. The spicules differ in some details from those found by Ijima (1901, p. 274, Plate X. Figs. 25–27). The distal ray is not club-shaped but cylindrical, beginning to taper near the upper end and running out to a point. The tubercles spread over its distal half. The tangential rays are sometimes short, as in Ijima's spicules, again almost as long as the distal ray, and they vary in length in the same spicule. The proximal ray is generally shorter than, but sometimes as long as, the distal ray. A fairly characteristic such spicule has the following measurements: Distal ray, 1 mm. x 85 μ; proximal ray, 500 μ x 50 μ; tangential rays, 500 μ x 50 μ to 200 μ x 50 μ. The spicules in a single clump vary in absolute size and in proportions of parts. For instance, in some cases a tangential ray is much the longest of all. Many intermediate sizes between the dimensions above given and the ordinary dermal hexact are to be seen. The preservation of the hydroid itself is very imperfect. But it can be seen that the form is a tubularian hydroid, that the hydranths have several tentacles, and are borne upon a slender branching stolon.

The sieve-plate region presents a simpler structure than in *R. phoenix*. The sponge ends above in a thickened margin which contains 6 large stauractines arranged in a ring (Fig. 7, Plate **3**; Fig. 2, Plate **4**). The superior rays of the stauractines project obliquely upward and centripetally, as if to form the radial beams of a sieve-plate. With the exception of one stauractine the superior ray of which is bare (Fig. 7, Plate **3**), these rays are densely covered with the smaller parenchymalia, chiefly slender, cylindrical diacts 8–20 μ thick, mingled with which are small tauacts, stauracts, pentacts, and hexacts. These latter spicules, like the slender diacts, have smooth cylindrical rays, usually of unequal lengths in the same spicule, rounded or round-pointed at the ends, where they are frequently enlarged and subterminally roughened; rays, 34–225 μ long, 8–20 μ thick. The tip of the large stauract ray emerges from its covering.

Unlike the adult *R. phoenix,* no principal diacts accompany the superior rays of the large marginal stauracts. The inferior rays which extend longitudinally down into the sponge wall are unaccompanied by comitalia, and with the exception of one case are not in intimate association with particular principalia. In the case alluded to, Fig. 2, Plate **4**, the tip of the inferior ray is well overlapped by the two principal diacts of a longitudinal skeletal bundle. There is but one case of anastomosis between the bundles which are supported by the superior rays of the stauracts (Fig. 2, Plate **4**), and in only one of these bundles is there any evidence of an existing or beginning transverse connection. This bundle bears a laterally projecting small hexact (Fig. 2, Plate **4**). Whether the central ends of the bundles, which are supported by the superior rays of the stauracts, were connected in the living sponge, must remain an open question. It may be added, however, that the upper margin of the sponge and the surfaces of the bundles are smooth, and there is no indication in the specimen itself that anything has been torn away.

The marginal stauracts are 1.5 mm. to 3 mm. apart. The two rays corresponding to the proximal and distal of the dermal hexact are reduced to conical bosses. (This condition, instead of the pentact, is occasional in *R. phoenix* according to Ijima, 1901, p. 271.) The superior ray is always long, nearly cylindrical, tapering eventually to a point, smooth or with a surface made undulating by scattered low and rounded tubercles. The three other rays are smooth and taper gradually to a point. They vary greatly in absolute and relative lengths. The inferior ray may be the longest or much the shortest of the four developed rays. The lateral rays, lying parallel to the sieve-plate margin, may be equal or unequal in length, and very much shorter than or nearly as long as the superior ray. In the largest spicules the superior ray is 4.5 mm. to 4.8 mm. long and 250 μ to 300 μ thick at the base; the other rays having about the same basal thickness. Two of the marginal stauracts, one of which is shown in Fig. 7, Plate **3**, are much smaller than the others, the superior ray measuring about 2.4 mm. x 120 μ. The marginal stauractines, it will be seen, are small as compared with the larger of the corresponding spicules in *R. phoenix* (Ijima, 1901, p. 272, gives the combined length of the superior and inferior rays as reaching 30 mm.), and the rays vary more in relative length than in the spicules examined by Ijima.

The thickened margin representing the cuff of some other species is a band about 1 mm. wide. It consists chiefly of closely packed diacts, mostly slender forms 10 to 30 μ thick, with some larger ones up to 60 μ thick, arranged in large measure parallel to the free margin of the sponge. Mingled with these are some of the other common, small parenchymalia, intermediate between the diact and hexact conditions. The band projects on the gastral surface, and while larger, is essentially similar to the slender skeletal bands which elsewhere project on this surface. The marginal stauractines lie on the dermal side of the band.

In *R. phoenix* Schulze describes the margin of the sieve-plate area (1887, p. 84, Plate XIII.) as surrounded by large dermal hexacts, the long spinous distal rays of which project radially from the surface to a distance of about 5 mm. Ijima also finds enlarged dermal hexacts, which "lie crowded on the cuff edge" (1901, p. 275), but the spicules are much smaller, the distal ray measuring 1 to 1.25 mm. in length. Large dermalia of this character are not found in the marginal region of *R. delicata*, unless the single spicule shown lying on the marginal band in Fig. 7, Plate **3**, belongs in this category.

In the extreme marginal region of *R. delicata* many of the dermalia have probably been lost, but groups remain here and there. Among these are hexacts which do not differ from the common forms of dermalia found in the upper part of the sponge. Several such are shown in Fig. 8, Plate **3**. In the upper left corner a fairly typical dermal hexact is figured. Lower down lie other hexacts differing considerably in size and detailed character.

In some of the larger dermalia, near the margin, the distal rays are reduced to conical bosses, and the proximal rays are but little longer. A group of three such spicules is shown in Fig. 8, Plate **3** (to the right). The tangential rays here, as in the other enlarged dermalia, are subequal or strongly unequal. The condition of these spicules is not far from that of the marginal stauractines, and it seems probable that it is from them that the stauractines are recruited as the sponge increases in size. That is, the condition of the marginal region of this specimen suggests that an enlarged dermal hexact, in which one of the tangential rays is especially elongated, is from time to time pushed to the edge, the tangential ray in question becoming the projecting superior ray of the stauract.

ASCONEMATIDAE F. E. Schulze.

Caulophacus F. E. Schulze.

1887. *Caulophacus* F. E. Schulze, 1887, p. 124.
1897. *Caulophacus* " 1897, p. 6.
1903. *Caulophacus* F. E. Sch., Ijima, 1903, pp. 85, 112.

Caulophacus schulzei, sp. nov.

Plate 4, Figs. 1, 3, 5-10; Plate 5, Figs. 1-6, 8-10.

Diagnosis. Body of the usual character, and gray-brown in color. Dermal and gastral pinules are hexacts, which differ only in that the dermalia are slightly shorter and stouter than the gastralia. The usual spinose discohexacts and discohexasters are present. In the smooth discohexaster the terminals are commonly 5–10 in number, arranged in a whorl, and considerably longer than the principals.

Station 3382, 10 specimens; Station *3399,* 4 specimens.

The body (Fig. 3, Plate **4**) varies from a disc shape to a distinctly calyculate shape, and has a diameter varying from 22 mm. to 50 mm., with a thickness, taken midway between the attachment of the stalk and the edge, of 3 to 6 mm. The thickness diminishes toward the edge, which is sharp. The dermal surface of the body — that to which the stalk is attached — is in several specimens distinctly convex, in other specimens flat or slightly concave. The opposite, or gastral surface, is in general slightly concave, but in some of the specimens it is slightly convex. In all cases the stalks are broken off near the body. There can be no doubt, however, that five of the six stalks that were in the same jars with the sponge bodies, belong to them. This is demonstrated by the agreement in spiculation, and in diameter and appearance, between the upper end of the detached stalk and the lower end of the fragment that is united with the body.

The stalk is more or less curved, slender, the diameter in the middle region ranging from 2 to 3 mm.; about cylindrical, but enlarging above and below. Below, the stalk makes an angle with its narrow, elongated base, the precise shape of which varies, although the surface of attachment is in all cases flattened. In the natural condition the base is evidently attached to the root spicules of *Hyalonema,* round which it grows. Fragments of some of the *Hyalonema* spicules remain, perforating the base in the direction of its long axis, also the parallel impressions left by others of these spicules on the attaching surface of the base.

The stalk enlarges at its upper end, where it passes into the body. Its connection with the body is always excentric, and except in two specimens oblique, as shown in the figure. In the two cases referred to, the remnant of the stalk projects vertically from the body. The body itself is heavy, and because of the numerous canals perforating it, is easily torn. The stalk is firm and hard, except in its uppermost region. Here, where there are no synapticula between the principal supporting spicules, it is comparatively soft and easily broken, although in the living specimen doubtless flexible. The attachment of the stalk to the *Hyalonema* root spicules shows that the body itself cannot, in the natural position, be far from the surface layer of mud. And this fact, taken together with the character of the uppermost part of the stalk, suggests that the disc rests upon the surface mud, something after the fashion of a *Renilla,* instead of projecting freely in the water.

Both surfaces of the body exhibit the apertures of very numerous canals, which pass vertically into the interior. They are about equal in abundance and size on the two surfaces, being smallest in the peripheral region. The diameter of the apertures ranges from less than 1 mm. to 2 mm., or in some individuals to 4 mm., and on both surfaces they are covered in by the dermal and gastral membranes respectively. The axial canal in the stalk is $\frac{1}{3}$ to $\frac{1}{4}$ the diameter of the stalk, widening greatly above where the stalk passes into the body, and opening into several smaller canals. In two specimens examined these canals pursued so intricate a course that I could not trace them to their openings. In another specimen the canals were larger and opened on the gastral surface, as described by Schulze for *Caulophacus latus* (1887, p. 124) and *C. agassizii* (1899, p. 37).

As in the other species of the genus, the principal parenchymalia are hexacts and diacts. The hexacts are distributed through the body of the sponge, where they are abundant but not crowded (Fig. 10, Plate 5). In the stalk they are few in number, and those seen lay outside the main diact skeleton. The hexacts are rather slender, with straight or gently curved rays which are often accompanied by a few diacts. The rays are smooth, taper evenly to rounded points, and in general are equal or subequal, measuring 700–1200 μ x 28–48 μ. Rarely hexacts are found in which all the rays are covered with sharp microtubercles. Such spicules seem to be modifications of the hypodermal pentacts.

The diacts of the body are slender, straight, or slightly curved; in general cylindrical, or somewhat thicker in the middle region and tapering toward the ends, which are enlarged, rounded, and subterminally roughened with microtubercles. The ends may not be swollen and may be smooth. Often, though not always, a trace of the lost rays is retained in the form of a slight annular thickening containing an axial cross. The spicules vary in length from 1 to 4 mm., in thickness from 8 to 12 μ. Lengths of 1.5 to 2.5 mm. are the commoner sizes. Exceptionally the diact is thicker and perceptibly fusiform, tapering evenly from the middle to the rounded smooth points. A typical spicule of this character measures 1700 μ x 24 μ. Bundles of diacts and, less commonly, separate diacts run in all directions through the sponge body (Fig. 10, Plate **5**).

The wall of the stalk is largely occupied by diacts, which run for the most part longitudinally. In the upper part of the stalk these spicules are free. Elsewhere they are connected by abundant synapticula, a continuous framework thus being produced. Scattered diacts protrude radially from the surface of the stalk to a distance of from 1 to 5 mm. The diacts as a class are similar to those of the body, but longer and thicker, many reaching a size 7–8 mm. x 24–32 μ. The extremities may be entirely covered with sharp microtubercles, or the tuberculation may be subterminal. In the lowest part of the stalk some diacts are met with which have smooth, pointed extremities.

The dermal and gastral pinules (Figs. 7 and 10, Plate **4**) are much alike. They are both hexacts in which the proximal and tangential rays are about equal in length and thickness. These rays are pointed and tapering, with very small, sharp microtubercles near the end, elsewhere smooth or with only a few scattered tubercles; about 100 μ x 8–10 μ. In both pinules the distal ray is covered with overlapping upwardly projecting narrow scales, which have a greatest length of 16–20 μ. Near the base the scales degenerate into small prickles, projecting at about right angles to the axis of the ray, and at the extreme base the ray is smooth. The ray ends above in a terminal cone, not in a long point. This in the slenderer spicules is commonly longer than wide, but in the stouter ones is as wide as long and is nearly concealed by the uppermost scales, its tip not infrequently being rounded instead of pointed.

Except in two specimens the dermal and gastral pinules differ slightly as regards the length and thickness, and consequently the outline, of the distal ray. In the two specimens referred to, measurements failed to show a constant difference between the pinuli of the two surfaces. In the other specimens the dermal pinuli have distal rays which are slightly shorter and thicker than those of the gastral pinuli. *Measurements show that this relative difference between dermal and gastral pinuli exists, although in some specimens both kinds of pinuli are perceptibly stouter than in others.* Thus in a number of specimens the gastral pinuli were like the one shown in Fig. 10, Plate **4**, where the distal ray is so slightly swollen in the middle as to be almost cylindrical in outline. In the same specimens the dermal pinuli were like the one shown in Fig. 7, Plate **4**, where the distal ray is sufficiently swollen in the middle for the outline to be distinctly fusiform. In other specimens the *gastral* pinuli were quite as stout and fusiform as Fig. 7, Plate **4**, and the *dermal* pinuli still somewhat stouter and more fusiform. Thus while the individual sponges differ among themselves, within narrow limits, to be sure, in respect to the precise shape of the distal ray, the relative difference between the two surfaces is usually maintained. This generalization is illustrated by the following tabular statement, showing the common range of variation among the spicules of two individuals, the one with pinuli as slender as in any of the specimens, and the other with pinuli as thick as in any of the specimens.

	Distal Ray of Dermal Pinule.		Distal Ray of Gastral Pinule.	
	Length.	Greatest Thickness.	Length.	Greatest Thickness.
1. Sponge with slender pinules,	240–320 μ	36–40 μ	260–360 μ	32–36 μ
2. Sponge with stout pinules,	210–240 μ	44–56 μ	280–320 μ	36–40 μ

On both surfaces the following uncommon types of pinuli make their appearance. In one type, Fig. 8, Plate **4**, the distal ray is conspicuously shortened but not very swollen. Much less frequent is the type shown in Fig. 1, Plate **4**, in which the distal ray is very short and greatly swollen. The latter spicule is similar to the dermal pinuli of *C. latus* F. E. Sch. and *C. elegans* F. E. Sch.

The general dermal covering of the stalk is in all cases lost, but in one of the specimens some of the pinules on the upper part are preserved. These are smaller than the pinules of the body, the proximal and tangential rays measuring about 80 μ x 6–8 μ, the distal ray about 200 μ x 24 μ. The covering spines on the distal ray are not so closely set as in the pinules of the body.

The hypodermal and hypogastral pentacts (Fig. 9, Plate **4**) are alike. All the rays taper to rounded points, and there is no trace of the distal ray. The proximal ray is ordinarily longer than the tangentials, but occasionally is very short, especially in the case of pentacts lying over the main canals. The proximal ray is roughened with sharp microtubercles in its upper part. The tangential rays commonly show a few sharp microtubercles near the point of intersection, but may be smooth, or on the other hand extensively covered with microtubercles in this region. The tangential rays are straight or very slightly incurved; exceptionally somewhat outcurved. The spicules vary in size in the same individual, the tangential rays measuring 400–750 μ x 36–48 μ, the proximal ray measuring commonly 780–1000 μ x 50–60 μ.

The tangential rays of the pentacts overlap and give rise to a meshwork, the meshes of which are very commonly square or squarish. The size of the mesh varies considerably in different regions of the same individual as well as in different individuals; diameter commonly 340–680 μ. Where the pentacts are crowded, some lie at a slightly lower level than others, and so interfere with the regularity of the meshwork.

On the upper part of the stalk a few of the hypodermal pentacts remain. Some are like those of the body; others differ in that they are quite smooth.

The spinose microsclere (Figs. 1, 4, 5, 9, Plate 5) found in all the species of the genus is here present in the greatest abundance, everywhere filling the parenchyma. While the true discohexact, in which none of the rays are branched, occurs in all of the specimens, and in a few is the predominant form, it is in most of the specimens uncommon. The rays of the discohexact are 80–110 μ x 8 μ, tapering strongly toward the apex, which is capped by a watchglass-shaped end-plate, 10–12 μ in diameter, divided marginally into about 6 strong teeth. The rays except near the centre of the spicule bear strong recurving spines, which diminish in size toward the apex of the ray.

In most of the specimens the great majority of these spicules are imperfect hexasters (Figs. 1 and 4, Plate 5). Spicules in which 3 or 4 of the original hexact rays are branched, while the others remain single, are the commonest types, although perfect hexasters, in which all 6 original rays are branched, occur. In the hexasters, imperfect or perfect, the principal rays are smooth and short, and the combined length of principal and terminal equals the length of the undivided hexact ray. The terminals are spinose and capped, as in the true hexact forms. The principals may bear 2 or 3 terminals, but 2 is the commoner number. Exceptionally, as in one of the rays of Fig. 9, Plate **5**, there is no proper principal, the branching occurring so close to the centrum of the spicule that the terminals are confluent with it.

A detail of some interest as bearing on the mode of development of the hexaster form is indicated in Figs. 1 and 4, Plate **5**. In spicules where the principal ray bears but two terminals, the latter commonly pass into the principal in an asymmetrical fashion. One of the terminals makes a bend at its lower end, thus becoming strongly convex on this part of its outer surface, while the corresponding surface of the other terminal and the adjoining part of the principal form a weakly concave surface. This fact, together with the angles which the several rays make with one another, often suggests that certain rays represent the primitive hexact rays and that *other terminals are produced as lateral branches* on these. Much less commonly the two terminals are symmetrically disposed on the principal, suggesting an early dichotomy, but in such cases the symmetry may have been superinduced on an earlier asymmetry. Where the principal bears 3 terminals, the arrangement is usually symmetrical and gives no hint as to whether the branching had been lateral or not. But exceptional spicules, like that shown in Fig. 5, Plate **5**, occur which speak for the lateral origin of the branches, in that two terminals occupy a lateral position on the same side of what seems to be a primitive hexact ray.—— Very frequently, perhaps always, the opposite rays of a diameter branch in planes at right angles to one another, as shown in Fig. 4, Plate **5**,— a phenomenon observed by Schulze in the hexasters of several species (1887, p. 31).

A form of discohexaster, Fig. 5, Plate **4**, very similar to the corresponding spicule of *C. latus* F. E. Sch. (Schulze, 1887, Plate XXIV.) and *C. agassizii* F. E. Sch. (Schulze, 1899, Plate VI.) occurs with about the same distribution as in the latter species (Schulze, 1899, p. 38). It is most abundant near the gastral membrane and in the walls of the large efferent canals, less abundant near the dermal membrane and in the walls of the main afferent canals. In this spicule, the principals are smooth, and taper very slightly toward the apex, where they enlarge to form a base for the terminals. These commonly vary in number from 5 to 10, and are arranged in a whorl. Not infrequently, however, spicules are found with more numerous terminals, up to 16, which do not form a whorl but a brush, some being surrounded by others, Fig. 6, Plate **5**. The terminals are roughened and very slender, and taper toward the apex, where they bear small end-plates of a watchglass shape. In the larger spicules the end-plate is obviously divided into marginal teeth, and the ray in its distal half is not merely roughened but bears small recurving spines. The size of the spicule varies considerably in the same specimen. The terminals as a rule considerably exceed the principals in length, being from 1.5 to 2.5 the length of the latter. The principal measures 36–50 μ x 6 μ, the terminal 60–100 μ x 2 μ.

Occasionally this discohexaster exhibits an abnormality of some interest. One or several of the principal rays, in addition to bearing terminal umbels, bear one or in some cases two lateral branches, one above the other, Fig. 2, Plate **5**. Such lateral branches resemble the terminal rays. Moreover, examination of the larger discohexasters shows that the base of the umbel is frequently asymmetrical. An extreme case of this kind is shown in Fig. 8, Plate **5**. These appearances receive an explanation on the hypothesis that the umbel of terminals represents an aggregation of lateral branches, and that during the growth of the spicule some of the lateral branches may become separated from the main cluster.

A good many small discohexasters occur, having a similar distribution to the large form just described. Some of these are doubtless stages in the development of the latter type, although the principal ray is often about equal in length to the terminals, as in Fig. 3, Plate **5**. The principal may bear one or two lateral rays. In a selected spicule of this character the principal rays and the terminals are both 40 μ long; in another such spicule the principal is 26 μ, the terminals 28 μ long. Together with these spicules occur discohexasters of a different type, one of which is shown in Fig. 6, Plate **4**. The principals and terminals in this spicule are commonly subequal in length, 16 to 24 μ long, but not infrequently the principal is perceptibly longer than the terminals. The brush-like clusters are relatively wide and include numerous, from 20 to 30, terminals. The principals are smooth, or bear one or two comparatively large tubercles, or sometimes a lateral ray. It is possible that this spicule is of foreign origin. But against this supposition speaks its distribution, as does also the fact that other small discohexasters occur, which are intermediate in structure between the types shown in Fig. 3, Plate **5**, and Fig. 6, Plate **4**. As an example of such intermediate forms I select a spicule in which the principal rays are 24 μ long; terminal rays 20 μ long; terminals 10–15 in a cluster; clusters intermediate in relative width between Fig. 3, Plate **5**, and Fig. 6, Plate **4**.

Caulophacus, sp.

Plate 5, Fig. 7.

At Station *3414*, the lower part of a stalk belonging to a species of *Caulophacus*, apparently not *C. schulzei*, was taken. The stalk (Fig. 7, Plate **5**), which is attached to the root spicules of *Hyalonema*, is firm, hard, and of a dark-brown color. The length of the fragment is 40 mm., the diameter of the upper broken end 4 mm. The axial cavity is very small, about 0.75 mm. in diameter. The base is an irregular mass elongated in the direction of the *Hyalonema* spicules, round which it has grown. Some of the *Hyalonema* spicules remain *in situ*, while others have been pulled out, leaving their impressions upon the *Caulophacus* base.

The dermal covering has been lost. Whether the few pinules and large pentacts adhering to the surface belong to the specimen is questionable. The diacts forming the chief support are arranged for the most part longitudinally, and are connected by synapticula. Scattered diacts protrude more or less radially from the surface to a distance of from 1 to 4 mm. The diacts taper slightly from the middle toward the ends, frequently exhibit an annular thickening in the middle, which is very slight in the large forms, but conspicuous in some of the smaller, and end in smooth pointed extremities. The diameter of the larger spicules is 24–30 μ, the length reaching at any rate 4 mm.

At the same station, two other *Caulophacus* stalks of a somewhat different appearance were dredged. Only the diact skeleton remains. One of the stalks is remarkable for its thickness, having a diameter at one end of 13 mm., the axial cavity being about 2 mm. wide and filled with mud.

ROSSELLIDAE F. E. Schulze.

Bathydorus F. E. Schulze.

1887. *Bathydorus* F. E. Schulze, 1887, p. 150.
1897. " F. E. Sch., Schulze, 1897, p. 14.
1898. " F. E. Sch., Ijima, 1898, p. 46.

Bathydorus levis F. E. Schulze.

1895. *Bathydorus laevis* F. E. Schulze, 1895, p. 57, Taf. VI. Figs. 1–10.
1902. *Bathydorus levis* " 1902, p. 78, Plate XIV. Figs. 1–10.

Bathydorus levis spinosus, subsp. nov.

Plate 5, Figs. 11-13; Plate 6, Figs. 1, 2.

Diagnosis. Body calyculate. Both dermal and gastral surfaces with scattered prostalia. Autodermal stauracts densely covered with sharp spines 1–2 μ high. Distal ray of autogastral hexact longer, and with longer spines, than the other rays. Oxyhexasters 80–100 μ in diameter.

Station 3382, 2 specimens; *Station 3399,* 1 specimen and a fragment.

Of the specimens taken at Station 3382, one is a thin, laterally compressed sac, Fig. 11, Plate 5, with a greatest horizontal diameter of 46 mm. and a depth of 25 mm. The wall is about 1 mm. thick, thinning toward the edge. The extreme lateral compression is doubtless unnatural. There is a marked concavity on one side of the sac, and the base of the sponge is somewhat pointed, projecting toward the concave side. The dermal surface of the basal portion is indented by an oblique furrow about 2 mm. wide and 6 mm. long, probably caused by the cylindrical body (*Hyalonema* root spicule?) to which the sponge was attached.

The second specimen from Station 3382, Fig. 1, Plate 6, is much broken, but fortunately the base is preserved intact. As in the other individual, the sac is pointed below and concave on one side. Nearly the whole of one lateral wall of the sac has been torn off. The opposite lateral wall is about 60 mm. wide and 2 mm. thick, thinning toward the free edge, only a part of which is natural.

The sac in the concave region to one side of the pointed base tightly grasps what is probably a *Caulophacus* stalk. The stalk in question is a fragment 30 mm. long and about 4 mm. thick. It is roughly cylindrical, hollow, and slightly curved. Only the skeletal framework remains, which consists of diacts, running for the most part longitudinally, and richly connected by synapticula.

The specimen from Station 3399 has the shape of a wide, shallow cup and is not laterally compressed. The cup, in which both base and edge are preserved, is 53–63 mm. wide and about 20 mm. deep; the wall 3 mm. thick near the centre and thinning out toward the edge. In the centre of the cup the wall is steeper than elsewhere, and thus an inner basin is marked off from a more peripheral region. The peripheral part of the wall flattens out somewhat, tending toward the horizontal plane, and in one region is recurved much as in Schulze's figure of *B. levis* (Schulze, 1902, Plate XIV. Fig. 1). The inner surface of the cup, in the peripheral region, is undulating, and the edge likewise undulating, as in Schulze's figure. Viewed from the under surface, the base of the cup forms a well-marked protuberance, to one side of which the sponge tissue has grown round three *Hyalonema* root spicules, remnants of which remain half buried in the wall. The fragments of root spicules lie close together, parallel to one another and about parallel to the horizontal axis of the cup. They are doubtless part of a *Hyalonema* root tuft to which the *Bathydorus* was attached.

The fragment dredged at Station 3399 is a plate-like piece 30 mm x. 25 mm. and about 2 mm. thick, including a part of the natural edge of the sponge, 40 mm. long.

In all the specimens both dermal and gastral surfaces exhibit fairly abundant although scattered prostalia, projecting obliquely or radially to a distance of from a few to 10 mm. The spicules are chiefly smooth diacts, but in part large smooth hexacts with unequal rays, only one ray of which projects. The rays of a single hexact may vary in length from 2 to 10 mm., the protruding ray being long. In addition both surfaces are abundantly covered with the ends of slender diacts projecting 1–2 mm.

Round the edge, numerous diacts project 1–2 mm., and scattered diacts protrude through all distances up to about 5 mm. These scattered spicules are pretty far, 5–10 mm., apart. The spicules project at all angles from the edge, and nowhere constitute anything so definite as a fringe.

On both surfaces of the sponge, the rounded apertures of small canals are abundant and plainly visible. The diameter of the canals is in general less than, although reaching, 1 mm.

The autodermal stauracts, Fig. 13, Plate 5, are abundant, the rays overlapping so as to form a meshwork. The rays are cylindrical, or taper very slightly toward the apex, there becoming suddenly rounded or pointed, and are densely covered with short, sharp spines. Basal diameter of the ray excluding the spines, which are 1–2 μ high, is about 5 μ. The rays are equal or subequal in length; total diameter of the spicule, 100–160 μ. A direct comparison with preparations of *B. levis* shows that in the latter species the stauracts are much less strongly spinose than in the form here described.

In the autogastral hexacts, Fig. 2, Plate 6, the rays are straight or slightly curving, the distal ray commonly more distinctly curved than the others. The tangential and proximal rays bear very small, sharp spines. The distal ray, which is longer than the others, bears longer spines, many of which project upwards. The tangential and proximal rays taper evenly to points; the distal ray is cylindrical, then tapering. All rays have a basal diameter of about 4 μ. Length of the distal ray, 110–140 μ; length of the proximal and tangential rays, which are subequal, 60–90 μ.

Schulze (1902, p. 80) mentions that in *B. levis* the spines on the distal ray of the autogastral hexact are often slightly different from those on the other rays. On the other hand, in the form here described, spicules occasionally occur in which the 6 rays are equally long.

The oxyhexasters, Fig. 12, Plate 5, are 80–100 μ in diameter. The smooth principals are 4–6 μ long. The delicate, roughened terminals, of which there are 2 or 3 to a principal, diverge strongly, are slightly curved, and taper evenly to points.

In the hypodermal pentacts all rays are smooth, tapering to points which are not very sharp; no trace of the distal ray. The proximal ray, which passes more than halfway through, often nearly through, the sponge wall, is 1.0–1.7 mm. x 30 μ; frequently accompanied by 2 or 3 diacts. The paratangential rays are 340–500 μ x 24 μ, overlapping and forming a meshwork, with meshes 340–500 μ in diameter.

The ends of the diacts are pointed, or rounded and often enlarged; roughened with microtubercles, which may cover the entire end or be restricted to a subterminal area. The slender diacts are commonly pointed and not enlarged at the ends, and are nearly cylindrical. The larger diacts obviously taper from the middle toward the ends. The diacts vary in length from 1 to 15 mm., in thickness from 7 to 60 μ. While most of them lie parallel to the sponge surfaces, numerous slender ones and the scattered large prostalia pass obliquely or radially through the wall. As in *B. levis*, the largest diacts are in the neighborhood of the gastral surface, where they frequently form tracts.

In addition to the large smooth hexacts already mentioned, one ray of which protrudes as a prostal spicule, smaller hexacts are occasionally found with equal or unequal rays, reaching 700 μ in length, spinose, and sometimes curved. It may be questioned whether they belong to the sponge.

Schulze's specimens of the type were taken in the southwestern part of the Bay of Bengal on Globigerina ooze, at a depth of 1997 fathoms. It is very easy for scattered prostalia to be lost in the handling of a sponge, and as Professor Schulze has suggested, perhaps such spicules were originally present in his specimens.

Staurocalyptus Ijima.

1887. *Rhabdocalyptus* F. E. Schulze, *pars*, Schulze, 1887, p. 155.
1897. " " " , Schulze, 1897, p. 33.
1897. *Staurocalyptus* Ijima, 1897, p. 53.
1898. " Ijima, 1898, p. 52.
1899. *Staurocalyptus* Ijima, Schulze, 1899, p. 47.

Staurocalyptus, sp.

Plate 6, Figs. 4-10.

At *Station 3370,* a small sponge was taken, which is completely macerated, but in which the shape has been preserved, owing to the fact that the parenchymal diacts are so interwoven with one another. There are no discoverable autodermal or autogastral spicules distinguishable from the parenchymalia, and the probability is that they have been completely lost. The specimen differs from the described species of the genus, but may turn out to be a young form. Owing to the absence of the autodermalia and autogastralia, the sponge cannot be adequately characterized, and I refrain from giving it a specific name.

The body, Fig. 6, Plate **6**, is a flattened sac 25 mm. high with a greatest transverse diameter of 15 mm.; wall about 4 mm. thick, gradually thinning out above to an oscular edge. Long prostal oxydiacts protrude from the upper end of the body, forming a collar. These spicules extend longitudinally through the lateral wall of the body, emerging above, at some distance below the oscular margin, which is thus left free of projecting spicules, as in *Aphorme horrida* F. E. Sch. (Schulze, 1899, p. 41).

The prostalia are the large oxydiacts just referred to and pentacts, which properly are hypodermal, but which may protrude. The oxydiacts measure 2 cm. x 150 μ to 3.5 cm. x 225 μ, are slightly curved, smooth, tapering evenly toward each end. The smaller ones run out to very fine points. In the larger ones the extreme ends are broken off.

The prostal and hypodermal pentacts have paratropal, paratangential rays, Fig. 5, Plate 6. The shaft is 6 mm. or more in length, 100 μ thick at the upper end, tapers evenly to a point, and is very faintly tuberculate, appearing smooth. The paratangential rays measure 2.5 mm. x 75 μ to 3.75 mm. x 85 μ, and are nearly straight or slightly curved; tapering evenly to points; minutely tuberculate. Small forms of the same spicule occur, with paratangential rays as short as 550 μ.——The tubercles on the paratangential rays are fine, closely set prickles, which in general project toward the apex of the ray, Fig. 7, Plate 6. They diminish in number toward the proximal end of the ray, and here may be nearly or quite absent (Fig. 5, Plate 6). In some spicules the tubercles are so fine that the whole ray appears nearly smooth. The tubercles are outgrowths of the superficial silicious layer, which is frequently cracked, and may peel off, leaving the ray smooth.

The parenchymal macroscleres are chiefly long slender diacts, more or less curved, extending in all directions through the body; many running parallel to the surface; others more or less radially to the surface and protruding slightly. Length extremely various, 4 mm. to about 1 cm.; diameter, 8–24 μ. The two ends of a spicule are unlike: one end sharp-pointed; the other end blunt-pointed, or rounded without enlargement, or dilated. Both ends are minutely spinose, the shaft smooth. Smaller oxydiacts, about 0.5 mm. x 8 μ, are also common in the parenchyma; with median enlargement and axial cross; both ends running out to fine points; feebly spinose along the whole length.

In the parenchyma the following additional macroscleres occur rarely: hexacts, with rays about 0.5 mm. x 30 μ, smooth, tapering evenly to points; tauactines and stauractines, rays smooth, tapering evenly to points, about 250 μ x 8 μ.——There are no discoverable hypogastralia.

Discoctasters are abundant in the parenchyma. Many conform to the type, having 8 principal rays, each of which bears usually 3 slender terminals; terminals minutely enlarged at the end; centrum with a rounded protuberance in the centre of each set of 4 rays. The principal ray is about 45 μ long; terminals about 60 μ long; centrum with a diameter of 20 μ.

That the octaster rays are secondarily produced, as Schulze (1893) has demonstrated, by the fusion of components, which themselves are derived from the rays of an original hexact, is well shown both in the typical and "abnormal" spicules of this species. The various facts described by Schulze (*l. c.*), such as the trilobed transverse section of the octaster rays, the ridges passing from the central protuberances out upon the rays, and the delicate row of lacunae, extending lengthwise through the latter, may all be observed in the typical spicules. The axial cross is plainly visible in the centrum, as Ijima (1897, p. 44) pointed out. It frequently happens that, as in some of the species described by Schulze, *e. g. Rhabdocalyptus mirabilis* (Schulze, 1899, Taf. XIII.), one or several accessory rays which end like the terminals are developed as outgrowths from the central protuberances (Fig. 8, Plate 6). It also happens not infrequently that the fusion of the originally separate components is very incomplete, in which case the octaster ray appears split to its very base, as in one of the rays of Fig. 10, Plate 6. In some cases there is almost no fusion, as in some of the rays of Fig. 4, Plate 6. Where the fusion is imperfect, and in addition several of the protuberances on the centrum are directly prolonged into rays, a very irregular spicule is the outcome, in which the octaster character is not conspicuous (Fig. 4, Plate 6). Irregular spicules of this kind are referred to by Schulze in several places (1887, p. 157; 1893, p. 6).

Oxyhexasters are abundant in the parenchyma. The principal rays are smooth, cylindrical, about 3 μ long. There are two terminals to each principal, nearly straight, strongly diverging, slender, and tapering evenly to the point, about 35 μ long. Oxyhexasters are common in which on one or more of the principal rays only one terminal is present. The remaining terminal and the principal ray may or may not make an angle with each other. In the latter case the division point between principal and terminal is not recognizable. When all six rays are of this character, a small hexact is produced such as has been designated by Ijima (1897, p. 45) a *hexactin-shaped oxyhexaster*. —— Microdiscohexasters were carefully looked for, but none were found.

FARREIDAE F. E. Schulze.

Farrea Bowerbank.

1864. *Farrea* Bowerbank, 1864, p. 204.
1887. *Farrea* Bwk., Schulze, 1887, p. 266.
1899. " " " 1899, pp. 106–109.

Farrea occa (Bowerbank) Carter.

1864. *Farrea occa* Bowerbank, 1864, p. 204.
1885. *Farrea occa* Bwk., Carter, 1885, p. 387.
1887. *Farrea occa* (Bowerbank) Carter, Schulze, 1887, p. 277.
1895. " " " " p. 67.
1899. " " " " p. 68.

Farrea occa claviformis, subsp. nov.

Plate 6, Figs. 3, 11-14; Plate 7, Figs. 1-3, 6.

Diagnosis. Habitus like that of the type. With oxyhexasters. Characteristic dermal clavulae, with smooth ovoidal heads. Characteristic gastral clavulae umbellate, with few (6–9) teeth.

Station 3425. Two fragmentary specimens.

The habitus, Fig. 3, Plate **6**, is like that of the type, but the projecting ends flare more. The tube diameter is 10–14 mm. The dictyonal framework is single-layered, and the radial tuberculate processes vertical, or nearly so, to the framework.

The specimens show some vaguely marked elevations, which are probably comparable to the tubular ridges described in this report for *Eurete erectum,* and interpreted as having been produced during the growth and division of the cup-like apertures.

In spite of the individual variation among the spicules, it may be seen that the dermal pentacts (Fig. 2, Plate **7**) are somewhat smoother than the gastral (Fig. 6, Plate **7**). Otherwise the two classes are alike. The five rays are of about the same size, and a rudiment of the distal ray ordinarily persists as a tubercle, which is pointed in some spicules, rounded in others. The precise degree and character of the curvature of the tangential rays, and of the tuberculation, and the shape of the ends of the tangential rays, vary slightly. On the outer surface of the tangential rays the tubercles are well developed, elsewhere nearly absent, except at the end of the ray. A common size of ray measures 280 μ x 12 μ. The spicules closely resemble those described by Schulze for the "Challenger" specimens of *F. occa,* differing in some details from the pentacts present in the specimen of *F. occa* which Schulze had from the Bay of Bengal (1895, p. 67).

The uncinates, Fig. 11, Plate 6, commonly show a difference between the two ends. At the external end, as over the middle part of the shaft, the spines are pretty long and nearly parallel to the shaft. Toward the inner (gastral) end they become minute sharp denticulations. The length of the spines varies considerably on different uncinates, and they may degenerate all over the spicule into denticulations. The uncinates may even become smooth, in which case I have found them to be slenderer than the common forms. A common size is about 600 μ long by 5 μ thick, excluding the spines. But spicules up to twice this size occur.

Oxyhexasters are abundant, and similar to those of the type (Schulze, 1887, Plate LXXI. Fig. 7). The principal ray is 20–24 μ long, and bears 3, 4, or 5 terminals, which are about half as long as the principal. Oxyhexasters occur here and there which differ from the common form in that the terminals are as long, or nearly as long, as the principals. Such spicules are somewhat larger than the common form, and usually there are only two or three terminals to a principal.

The dermal clavulae, Fig. 2, Plate 7, with rare exceptions, have smooth ovoidal heads, and are about 300 μ long. The stalk is slender and smooth, except near the point, where it is roughened. The spicules occur in the usual position, in groups surrounding the proximal rays of the pentacts. The number in a group is inconstant, always small (3–5); but some spicules may have fallen out. The exceptional dermal clavulae, which are very rare, are like the form common on the gastral surface.

In the type (Schulze, 1887, p. 283) the shape of the upper end of the dermal clavula varies from a many-toothed umbel, or a tuberculated swelling, to a smooth club. The first-mentioned shape is the predominant form.

The gastral clavulae are arranged, like the dermal, in small groups of 3 to 5, round the proximal rays of the corresponding pentacts (Fig. 6, Plate 7). The common form, Figs. 12, 13, 14, Plate 6, has an umbel with 6–9 teeth, which overarches a smooth swelling. Umbels with as many as 16 teeth occur, and occasionally a spicule is found in which the swelling is minutely tuberculate. In the latter cases observed the umbel had 14–16 teeth. The stalk is like that of the dermal clavula, but is shorter, — common length about 240 μ. Spicules are quite frequently found in which the umbel is degenerate, the teeth remaining as minute structures, Fig. 1, a, b, c, Plate **7**. Sometimes the merest rudiments of the teeth, so small that they are apt to escape notice, remain on the otherwise smooth head, and very occasionally a clavula with a perfectly smooth head is found. In certain cases all the teeth degenerate except one, which is fairly well developed.

A very few gastral clavulae of the type shown in Fig. 3, Plate **7**, were found. The umbel teeth are long and with a distinct spiral twist. The stalk is much longer than in the common gastral clavulae, and is slightly curved. In the spicule figured, the stalk bore a lateral spine which was absent in the others found. Only half a dozen of these spicules were found in as many preparations, and they would naturally be looked upon as foreign, were it not that they occupy the same position with respect to the pentacts as do the other clavulae. This spicule is closely similar to the peculiar clavula of *Farrea convolvulus* F. E. Sch. (Schulze, 1899, Plate XVI.), the stalk of which bears 3 to 5 lateral spines. Its very occasional occurrence here has the greater interest for the existence of a species in which the characteristic spicule is so closely similar.

In the type (Schulze, 1887), the predominant form of gastral clavula has a smooth anchor-like head with 4–8 long teeth. But forms having a terminal umbel with numerous teeth, which overarches a swelling, occur and may predominate.

Farrea clavigera F. E. Sch. (1887, p. 287, Plate LXXV.) resembles the subspecies here described in having smooth club-shaped dermal clavulae, but differs from it in habitus, in having anchor-like gastral clavulae, and in having a second peculiar form of dermal clavula.

Farrea occa is a widely distributed species. *F. convolvulus* F. E. Sch. was taken 32° 49′ N., 117° 27′ 30″ W., at a depth of 656 m.

Farrea mexicana, sp. nov.

Plate 7, Figs. 4, 5, 7, 8, 10, 11.

Diagnosis. Habitus like that of *Farrea occa.* With oxyhexasters. Characteristic dermal clavulae umbellate, with 12–16 teeth in the umbel. Gastral clavulae in part umbellate like the dermal; in part anchor-like with 4–5 teeth, the stalk usually with 2 lateral spines. Species close to *F. aculeata* F. E. Sch.

Station 3430, 1 fragmentary specimen.

The habitus, Fig. 7, Plate 7, is similar to that of *Farrea occa.* The tube diameter is 8 mm. The dictyonal framework does not differ from that of *F. occa.* In places it is one-layered, in other places two-layered. Small oxyhexacts with rays 60–80 μ long are in places fused with the framework. The fragment is obviously from the older part of a stock.

The dermal and gastral pentacts are alike (Fig. 8, Plate 7). The proximal ray is slightly longer than the tangentials, which commonly measure about 280 μ x 12 μ. The rudimentary distal ray forms a small rounded tubercle. In the majority of the spicules, the rays are smooth except at the ends. In others the tangential rays bear very weak tubercles over their whole surface. Occasionally spicules are found, in which the tangential rays on their outer surface bear the well-known strong spinous tubercles.

The uncinates commonly exhibit the same difference between the two ends which I have mentioned under *Farrea occa claviformis.* The spicules vary greatly in size. Forms, 720 μ x 5 μ, and larger ones up to twice this size, occur.

The oxyhexasters resemble those of *F. occa,* but are larger; and the terminal rays, of which there are usually 2 or 3 to a principal, are as long or nearly as long as the principal. The length of the latter is about 40 μ. There is occasionally a surprising difference in length between the principals of the same spicule.

In *Farrea aculeata* F. E. Sch., Schulze (1899, p. 70) says the oxyhexasters do not essentially differ from those of *F. occa.* He mentions that the number of terminals to a principal is 3, 2, or 1; and in the spicule figured, the principal ray measures 35 μ in length, while the terminals are about as long. Thus in the minute points of difference which the oxyhexasters of *F. mexicana* exhibit toward those of *F. occa*, there seems to be an agreement between it and *F. aculeata*.

The dermal clavulae are with few exceptions umbellate forms (Fig. 8, Plate **7**), having commonly 12 to 16 teeth in the umbel, occasionally less than 12 or more than 16. The stalk including the enlarged upper end is smooth except near the point, where it is roughened. The length of the spicule is about 320 μ.

On the dermal surface are found a very few of the anchor-like clavulae which are common on the gastral surface. Both kinds of dermal clavulae are in place, in the usual position round a pentact, the number actually present in a group being small, 3–6.

The gastral clavulae are in part umbellate, in part anchor-like forms. The former, which perhaps are the more abundant, do not differ from the type which is found on the dermal surface. The anchor-like forms occur in the usual position with respect to the pentacts. Frequently such a spicule is found alone, sometimes together with a few of the umbellate spicules. Where the spicule is alone, it is of course probable that the other members of the group have fallen out. In this spicule (Figs. 4, 5, 10, 11, Plate **7**), the stalk is about 500 μ long, smooth, practically straight, or slightly or strongly curved, becoming very slender and ending below in a point. It terminates above in a rounded knob, below which there is no conspicuous bulb-like swelling. The knob bears 4 or 5 curved strong teeth, which in some spicules, but not in all, have a slight spiral curvature (Fig. 11, Plate **7**). A short distance below the head, the stalk bears usually two curved lateral spines, sometimes only one, and occasionally none. The curvature of the spines themselves varies, sometimes being simple, again feebly spiral, while rarely the spines are straight. While the head ordinarily bears 4 or 5 teeth, spicules are occasionally observed with but 3 teeth (Fig. 5, Plate **7**). As regards length of the teeth and width of the umbel (anchor), the anchor-shaped spicule varies considerably. While always larger than the many-toothed umbellate spicule, it is sometimes only about twice as wide, and again fully four times as wide as the latter, across the umbel. The actual length of the teeth varied, in the numerous spicules measured, from 24 μ to 48 μ, and the width of the umbel (anchor) from 32 μ to 88 μ.

In the obviously closely related species *Farrea aculeata* F. E. Sch. (Schulze, 1899, p. 70), the dermal and gastral clavulae are alike, and essentially similar to the anchor-like forms above described. The number of lateral spines is 2–5, and they may be straight or curved. The teeth of the anchor never show a spiral curvature, as they do in some of the spicules of *F. mexicana.* Similar anchor-like clavulae with lateral spines are described by Topsent (1901, p. 466) for *Farrea weltneri* Tops., in which the hexaster is a discohexaster.

Farrea aculeata F. E. Sch. was taken 47° 29′ N., 125° 33′ 30″ W., at a depth of 1163 m.

Farrea, sp.

At *Station 3425,* 8 specimens, and at *Station 3430,* 2 specimens, of *Farrea* were taken. In these only the dictyonal framework is preserved, and a closer identification is therefore impossible.

Schulze (1887, p. 278) mentions that in *F. occa* he has occasionally found the terminal openings of the tubes covered in with porous plates. In one of the specimens here recorded, I find that two of the openings are nearly closed in by such reticula. In each case a small aperture, which is rounded and apparently natural, has been left near the edge of the original opening.

EURETIDAE F. E. Schulze.

Eurete Semper.

1868. *Eurete* Semper, 1868.
1887. *Eurete* (Semper) Carter, Schulze, 1887, p. 289.
1899. *Eurete* Semper, Schulze, 1899, pp. 106–109.

Eurete erectum F. E. Schulze.

1899. *Eurete erectum* Schulze, 1899, p. 72, Taf. XVII. Figs. 1–3.

At *Stations 3358, 3359,* and *3380,* 19 specimens were taken referable to this species. While they were all partially macerated, the free spicules had been retained. These specimens differ from the type and from one another in details, and fall into three well-marked groups which I designate as subspecies. The specimens from Station 3380 constitute one of these groups. Each of the other two groups includes specimens from both of the other two stations.

A dozen completely macerated specimens, agreeing with the above in habitus and dictyonal framework, were obtained at the above stations and at Station 3370. These probably also belong to *Eurete erectum*, which is obviously an abundant species in these waters. Schulze's specimens came from the same general locality. They were taken in the neighborhood of the Galapagos Islands, 0° 24′ S., 89° 06′ W., at a depth of 717 m. on a sandy bottom.

Eurete erectum tubuliferum, subsp. nov.

Plate 7, Figs. 9, 12; Plate 8, Figs. 1-3, 6.

Diagnosis. Sponge body differs from that of the type in that the axis is not dichotomously prolonged into branches at its upper end. Dermal pinules, gastral hexacts, and gastral pentacts resemble those of the type. With onychasters. Characteristic dermal scopulae are small forms with 3-4 distal rays, which are denticulate and which terminate in small smooth heads. The gastral scopulae resemble those of the type, but the distal rays are not covered with recurving spines, but are either smooth or minutely denticulate.

Station 3358, 3 specimens; *Station 3359*, 7 specimens.

As in the type there is a basal plate from which the slender hollow axis arises, but the plate is not included in all of the specimens. The axis, which at first is only about 7 mm. wide, gradually enlarges, becoming about 15 mm. wide, and soon acquires the spiral curvature characteristic of the species (Fig. 1, Plate **8**). In several of the specimens the upper end of the sponge is preserved, and it may be seen that the axis is not dichotomously prolonged into branches, as in the type, but remains single.

The degree of development of the lateral branches varies considerably. They may appear as simple cups with a slightly or considerably flaring wall. This is especially the case on the lower part of the stem, and all of the branches have this character on some of the fragments, which yet are large. The cup wall is often broken off short.

Very commonly, however, the branches are incompletely or completely divided, but not more than once. Various stages in the division are present. The opposite parts of the cup edge may simply project toward one another, as in Schulze's figures of *Farrea* (1887, Plate LXXII. Fig. 3). Or the growth may have continued until the opposite lips of the original cup are apposed, as in Fig. 12, Plate **7**, which represents in apical view the upper end of the specimen shown in Fig. 1, Plate **8**. With continued growth the apposed edges coalesce, and we then have a branch which opens to the exterior by two separate and distinct apertures. The shape of such branches is tubular with an aperture at each end. The character of the branches is well shown in Fig. 1, Plate **8**, and in Fig. 9, Plate **7**, which represents a detail of the opposite side of the sponge shown in Fig. 1, Plate **8**.

A comparison of different branches shows that before the lips of the original cup fuse, they become folded outward so as to present toward each other parallel faces (Fig. 12, Plate **7**). Fusion then takes place between these folds along their outer edges, and later, often imperfectly, along their inner edges. In this way hollow ridges or tubular structures open at the opposite ends, and at first communicating with the cavity of the branch, are formed. Such structures, once formed, indicate the line along which the cup lips have concresced (Fig. 9, Plate **7**). The fusion between the outer lips of the folds may take place at first in spots, and thus for a time the cavity of the ridge or tube communicates with the exterior through slits or a series of rounded pores, as in the ridge extending between the two concrescing cups of Fig. 12, Plate **7**.

The sponge at its upper end terminates in an expanded cup, which in the different specimens shows different stages in division. The division of the terminal cup (Fig. 12, Plate **7**) takes place in the same way as that of the lateral cups: the concrescing lips become apposed along a straight line and then bend outward.

All along the sponge, extending from the lateral branches on to the axis, are tubular structures or ridges similar to those formed in the division of the cups. One such is shown in Fig. 9, Plate **7**, extending at about right angles from the tubular ridge which itself extends between the terminal apertures of the branch. On the lower part of the sponge these structures are often insignificant in size, as if in process of disappearance, but in general they are conspicuous. They extend sometimes from the *edge* of a flaring cup on to the axis, and again as in the figures they lie at a distance from the cup edges. They are arranged spirally along the axis of the sponge, their long axes coinciding with those of the turns of the sponge. Obviously these structures are relicts left at successive stages of growth by the continually dividing terminal cup. The latest-formed such structure in one specimen is shown in Fig. 12, Plate **7**. It here has the character of a two-walled ridge which extends between the two cups in process of division, and about at right angles to the lines along which the lips of these cups are concrescing. The ridge, as I interpret it, marks the line along which the lips of the terminal cup have coalesced, in what may be spoken of as the preceding stage of growth.

The arrangement of the tubular structures or ridges indicates that when the terminal cup, which is inclined obliquely to the stem (Fig. 1, Plate **8**), divides, the lower half remains as a lateral cup, while the upper half, now the terminal cup, grows so as to add to the stem of the sponge. It moreover grows in the direction in which the cup lips last fused, but the next line of such fusion occurs at about a right angle to the last. The several steps in the gradual building up of the whole sponge from a cup-like young stage thus seem to be marked out by these relicts. The structures in question are indicated in Schulze's figure of this species (Schulze, 1899, Taf. XVII.). This method of continuous separation of lateral cups from the terminal with formation of a seam is probably universal in the family, and in my macerated specimens of *Eurete*, sp. traces of such seams are found. Also in some of the *Farrea* specimens, ridges are observable which correspond in position to the structures just described for *Eurete*, but they are vague and of themselves would be incomprehensible.

If *Eurete* and *Farrea* colonies are ontogenetically developed from cup-like young stages, as general considerations and the special structures above described suggest, then the small cup-like species of *Farrea* that have been described may be merely stages in the growth of larger complex colonies. Bowerbank (1875, p. 273, Plate XXXIX. Figs. 1, 4, 5) describes and figures several small cup or vase shaped *Farrea* skeletons from the West Indies. To these he gives the name of *F. pocillum*.

In this subspecies, as in Schulze's specimens, there is very little anastomosis between the lateral branches. The few instances involve a fusion between the oral lips of adjacent and bifurcated branches.

Schulze observed that in his specimens the dictyonal framework of the terminal cups for a certain distance from the edge was *Farrea*-like, consisting of but one layer of beams. In my specimens, the dictyonal framework of the terminal cups, like that of the lateral cups, includes in general two or more layers. And in parts of the extreme periphery, where the edge *seems* to be unbroken, I find two layers. I have also, however, found in the terminal cups quite small tracts, passing irregularly into the two-layered condition, in which the framework consisted of but one layer. Again in some of the lateral cups, in the stage of division corresponding to Schulze's figure of *Farrea occa* (1887, Plate LXXII., Fig. 3), I find that the rounded tongue-like outgrowths, which project toward one another, consist in part of but one layer of beams. The free edges of the lateral cups, in these dried specimens, have commonly a conspicuously thickened appearance, due to the great number of dermal pinuli which are here massed together.

In my specimens the dictyonal framework shows the usual difference between the gastral and dermal surfaces, and the radial processes on the latter surface are frequently bifid.

The dermal pinules (Fig. 3, Plate 8) closely resemble the corresponding spicules of the type. Very commonly all six rays are about equal in length, although the proximal ray or more rarely the distal ray may be the longest. The bushy distal ray has a relatively long, bare basal portion which is cylindrical and is always slightly thicker than the corresponding parts of the other rays. The proximal and tangential rays taper evenly toward the pointed ends, where they are roughened, elsewhere smooth. The measurements of a characteristic spicule are: distal ray, 160 μ long with a greatest thickness of 36 μ, and a bare basal part 50 μ long and 10 μ thick; tangential and proximal rays, 160 μ x 8 μ. The rays may only be 100 μ long, proximals and tangentials then having a basal thickness of 6–7 μ, the distal a basal thickness of 8 μ. In some spicules the bushy distal ray, the characteristic appearance of which is given in the figure, may be thin and nearly cylindrical, bearing spines which are considerably shorter and sparser than in the typical form.

The gastralia, Figs. 2 and 6, Plate 8, include both pentact and hexact forms. The former in most of the specimens are much the more abundant, while in two of the specimens they are scarcely more abundant than the hexacts. The two forms are alike except as regards the distal ray. In the pentacts, the distal ray is represented by a boss which is small and of an irregular, angular shape. In the hexacts the distal ray, which is of varying length, up to 120 μ, may be nearly cylindrical or considerably swollen. Characteristic conditions are shown in Figs. 2 and 6, Plate 8. —— The tangential rays, which measure about 250 μ x 16–20 μ, have large blunt or rounded teeth on the distal surface and sides, while the proximal surface is nearly smooth, having only a very few such teeth. The rays curve in very slightly, are often nearly straight, taper evenly and slightly toward the end, which is blunt or rounded and not enlarged.——The proximal ray as a rule is shorter than the tangentials, often about 200 μ long, of about the same thickness as the tangentials, tapering evenly to a point above which it is roughened, elsewhere smooth or with a few scattered minute prickles.

The uncinates vary greatly in size, and exhibit the same difference between the two ends which has been described for *Farrea occa claviformis.* They extend radially or obliquely, often through the entire tube wall. In the wall of the cups numerous large uncinates, commonly about 2 mm. long, are found running parallel to the surface and at right angles to the cup edge.

The discohexasters are of the onychaster type, and are scanty or only fairly abundant. Principal ray is 4–6 μ long; terminal rays, 24–30 μ long. The principal rays are smooth. The terminal rays are slender, taper toward the apex, and are roughened; capped by a minute disc about 3 μ in diameter, which is divided into 4 or 5 claw-like teeth. Spicules occur in which the roughening on the terminal ray is represented by exceedingly minute prickles. Other spicules occur in which one or several of the principal rays, or even all, bear but one terminal each. In such spicules, a "knee" usually marks the passage of the principal into the terminal, but this may not be present.

The common form of dermal scopula, Fig. 3, Plate **8**, has 3 or 4 distal rays, which are cylindrical, curved very slightly, covered with minute sharp denticulations, and which terminate in very small, smooth and rounded enlargements. The shaft at its upper end has a definitely circumscribed enlargement on which the rays rest; tapering thence to the point, above which it is roughened; elsewhere smooth. The shaft is 200–240 μ long, and 4 μ thick just below upper enlargement; rays, 40 μ x 2 μ.——Larger spicules are present in some abundance, in which the number of distal rays varies from 4 to 10. The rays measure 60 μ x 2 μ to 100 μ x 3 μ, and terminate in rounded heads which are usually small, about 5 μ in diameter, but sometimes large, about 8 μ in diameter. The rays are covered with very small sharp denticulations, which enlarge upon the head, sometimes sufficiently to appear as recurving spines. The shaft has a thickness of 6 μ and is somewhat larger than, although otherwise like, that of the typical dermal scopula.

The gastral scopulae, Fig. 2, Plate **8**, have 4–6 slender distal rays, 70–80 μ long, which terminate in spheroidal heads. The heads bear, round their equator and over their under surface, recurving spines. The upper surface of the head is smooth, or covered with minute prickles into which the recurving spines gradually pass. The rays usually ascend obliquely, and then diverge rather suddenly, but the precise curvature varies. The shaft is like that of the dermal scopulae, and about 300 μ long by 5 μ thick below the upper enlargement.

The gastral scopulae fall into two classes between which there are transitions. In the one the distal rays are smooth, and gradually enlarge from the base upwards, being 2 μ thick below, 4 μ thick above, then expanding into a large head, 12 μ in diameter, which bears strong recurving spines. In the other form, the distal rays are nearly cylindrical; roughened with minute denticulations; and provided with heads which are small, 8 μ in diameter, and feebly spinose. The first form predominates in the specimens from Station 3359, the second form in those from Station 3358.

It will be seen that in this subspecies there are two extreme types of scopulae, the small dermal form (Fig. 3, Plate **8**) and the gastral scopula, with smooth distal rays (Fig. 2, Plate **8**). The larger scopulae on the dermal surface, and the gastral scopulae with roughened rays, constitute intermediate forms. In the type (Schulze, 1899, p. 75) the dermal and gastral scopulae are alike, and resemble the gastral scopulae of this subspecies, but have spinose rays.

Eurete erectum mucronatum, subsp. nov.

Plate 8, Fig. 7.

Diagnosis. Like *Eurete erectum tubuliferum,* but with oxyhexasters instead of onychasters.

Station 3358, 4 specimens; *Station 3359,* 1 specimen.

In this subspecies there are oxyhexasters instead of onychasters. The oxyhexasters are abundant in some specimens, only fairly so in others. The difference is doubtless due to the extent of maceration. The spicules, Fig. 7, Plate **8**, vary somewhat in size in the different specimens. In the spicules of one specimen the principal ray is 4–6 μ long, the terminals 40–50 μ. In another specimen the principal ray is 4–6 μ long, terminals 32–40 μ. In a third specimen the principal ray is 6–8 μ long, terminals 36–48 μ. In yet another specimen, along with spicules in which the principal ray is 4–6 μ long and the terminals about 40 μ long, are many spicules with relatively long principals. In these the length of the principal reaches 8 μ, while the terminals are 28–32 μ long.——There are 2 or 3 terminals to a principal. The principal is smooth, the terminals faintly roughened. The terminals diverge considerably, and are nearly straight, or only slightly outcurving, delicate, and tapering to fine points.——Oxyhexasters occur in which some, or all, of the principals bear but one terminal each, a slight "knee" usually marking the passage of the principal into the terminal.

These sponges resemble in all other respects the specimens described as *Eurete erectum tubuliferum*, and which were taken at the same two stations as the above. While I have separated the two groups of individuals, and designated them as subspecies, it seems to me quite possible that they are merely classes of individuals which differ in respect to a quality of individual variability. Their detailed resemblance in respect to the other structural features suggests that this is the case.

Eurete erectum gracile, subsp. nov.

Plate 8, Figs. 4, 5, 8, 9; Plate 9, Figs. 1, 3, 5.

Diagnosis. Axial part of sponge body forms a *very elongated* spiral. Distal ray of the dermal pinules very thick. Tangential rays of the gastral pentacts and hexacts beset all over with minute sharp prickles. With onychasters. Characteristic dermal scopulae are small forms, in which the distal rays are minutely denticulate, and taper from the base to the apex, which is smooth and not enlarged. Gastral scopulae are large forms, 600–1500 μ long; distal rays slender and with large heads, or stout and tapering from base to apex, and without heads.

Station 3380, 4 specimens.

In these specimens the upper and lower ends of the sponge are not present. The axis, Fig. 5, Plate 9, forms a very elongated spiral, which varies but little in diameter, being 8–10 mm. thick over a length of 150 mm. The cups are much broken, but it may be seen that they are mostly undivided, and that they have a flaring wall. There are, however, some cases in which the cups are partially or completely bifurcated, and it may be seen that in the bifurcation of the cups the same peculiar ridges, or tubular structures, are produced that have been described for *Eurete erectum tubuliferum.* And extending from the cups onto the axis similar structures are found, as in the other subspecies. In the shape and appearance of these structures, however, this subspecies differs somewhat from the others, in that the structures are here strongly compressed ridges, which in side view appear triangular (Fig. 5, Plate 9). The longitudinal character of their arrangement, so conspicuous in the figure, is obviously correlated with the very elongated spiral character of the sponge body.

The dermal pinuli, Fig. 5, Plate 8, differ from those of the other subspecies, *tubuliferum* and *mucronatum*, in respect to the distal ray. This is noticeably thicker, with a more rounded outline, and the lower bare part of the ray is very short. The ray, which may be of the same length as the others, but is often shorter, is commonly about 50 μ thick, and has a bare basal portion about as long as thick, measuring 16 μ x 16 μ to 20 μ x 20 μ. The tangential rays are in general pointed, but exceptionally are rounded and enlarged at the ends, and like the other rays are somewhat thicker than in the two other subspecies. A characteristic spicule has these measurements: distal ray, 120 μ x 50 μ; proximal and tangential rays, 150 μ x 10 μ.——Exceptional forms are found in some of which the development of spines on the distal ray is so great as to obliterate the lower bare part; and others of an opposite character, in which the lower bare part of the ray is nearly as long as in the other subspecies.

The gastralia include pentact and hexact (Fig. 8, Plate 8) forms, which are alike except in respect to the distal ray. The tangential rays differ noticeably from those of the type and subspecies *tubuliferum* and *mucronatum* in that they are beset all over with minute sharp denticulations. This denticulation may be so fine that the ray appears nearly smooth. The proximal ray is also beset throughout its length with similar minute prickles. The tangential rays, which are very slightly incurved, commonly end, as does the proximal, in points, but exceptionally they are rounded and enlarged at the ends. In a characteristic spicule the tangential rays measure 200 μ x 12 μ, the proximal ray 240 μ x 12 μ.——In the pentact forms the distal ray is represented by a small rounded or angular boss. In the hexact forms (Fig. 8, Plate 8), the distal ray, which is 100–150 μ long, is in general more bushy than in the other subspecies, although it varies to a nearly cylindrical spinose shaft, somewhat thickened at the top.

In one of the specimens the hexacts greatly predominate, in the others the pentacts and hexacts are about equally abundant. In one of the latter specimens the spicules vary toward the condition of the type and the other subspecies, in that the tubercles on the tangential rays are strong prickles and are more abundant on the distal surface of the ray.

The uncinates do not differ from those of the other subspecies.

The hexasters are onychasters, Fig. 4, Plate **8**. The claws at the ends of the terminal rays are more distinctly developed than in subspecies *tubuliferum*, the diameter of the whole disc being about 4 μ. The principal ray is commonly 8 μ long, the terminals 28–32 μ long. Smaller sizes, with principal ray 6 μ and terminals 20 μ long, are present.

The characteristic dermal scopulae are small forms (Fig. 9, Plate **8**). The distal rays, 4 in number, are roughened with minute denticulations, are practically straight and taper conspicuously from the base to the apex, which is smooth, rounded, and not enlarged. The divergence of the rays varies, being sometimes so slight that the rays look nearly parallel. In different spicules the size of the terminal ray varies from a length of 50 μ with a lower diameter of 4–5 μ and an upper diameter of 2 μ, to a length of 70 μ with a lower diameter of 6 μ and an upper diameter of 3 μ. The shaft, about 300 μ long by 6–8 μ wide above, is smooth or nearly so, straight or slightly curved, and tapers evenly to the point. Above it passes gradually into the rays.——The spicule varies. The tapering of the rays may be slight, and a small head may be developed, in which case it is only the slight difference in the shape of the upper end of the shaft which distinguishes the spicule from the dermal scopula of subspecies *tubuliferum*.

Mingled with the dermal scopulae just described, and quite as common, are scopulae 600–700 μ long, with 4–6 nearly cylindrical roughened rays 70–100 μ long by 3–5 μ thick. The rays terminate in small and feebly spinose heads, 6 μ in diameter, or in large and strongly spinose heads up to 12 μ in diameter. This type of scopula is similar to the smaller forms found on the gastral surface. The characteristic dermal scopula (Fig. 9, Plate **8**), also resembles in shape one of the gastral forms (Fig. 1, Plate **9**), although it is very much smaller.

The gastral scopulae, Figs. 1, 3, Plate **9**, are large forms 600–1500 μ long, the commonest sizes ranging between 600 and 800 μ. The larger forms frequently penetrate the entire tube wall, even where the latter consists of 5 or 6 layers of beams. The shaft is 8–16 μ thick, pointed, smooth, or with a few denticulations. Above it has not a definitely circumscribed enlargement, but passes gradually into the rays. The rays, 3 to 6 in number, 100–120 μ long, are nearly straight and are covered with exceedingly small denticulations.—— With regard to the precise shape of the distal rays, the spicules vary between two extremes. At one end of the series are found scopulae (Fig. 3, Plate 9), in which the rays are cylindrical, 4–5 μ thick, passing above into large rounded heads 12 μ in diameter, which bear recurving spines. This type is like the corresponding scopula of subspecies *tubuliferum*, except in its greater size and in the comparative straightness of its terminal rays. The other extreme is represented by a scopula (Fig. 1, Plate 9), usually one of the longest, in which the terminal rays are very stout and taper conspicuously from below upward. The lower diameter of the ray is about 12 μ, the upper diameter 6 μ, and the ray ends in a smooth and not enlarged, rounded, or conical extremity. Immediately below the extremity the denticulations are enlarged and form short recurving spines.—— Between these two extreme types of gastral scopulae are found intermediate forms in which the distal rays taper slightly or considerably from the base upward, and end in strongly or very feebly spinose heads which vary from a very small size, 6 μ in diameter, to a large size, 12 μ in diameter. The extreme apex of the head may be smooth, or denticulations may be here developed.

Eurete, sp.

At *Stations 3370* and *3380,* 4 specimens belonging to *Eurete* were obtained. The specimens are completely macerated, the dictyonal framework alone remaining, and thus do not admit of a more precise identification.

MELITTIONIDAE Zittel.

Aphrocallistes Gray.

1858. *Aphrocallistes* Gray, 1858, p. 114.
1887. *Aphrocallistes* Gray, Schulze, 1887, p. 310.
1899. " " , Schulze, 1899, p. 110.

Aphrocallistes vastus F. E. Schulze (sp. ?).

1887. *Aphrocallistes vastus* Schulze, 1887, p. 317, Plate LXXXV.
1899. " " Schulze, 1899, p. 86, Taf. XVIII. Fig. 3.

Station 3370, 1 specimen.

The specimen is a plate-like fragment including only the dictyonal framework. I have compared the fragment directly with specimens and preparations of *Aphrocallistes vastus* F. E. Sch., and find an essential agreement between it and the dictyonal framework of this species. Nevertheless, owing to the absence of the free spicules, the identification must be regarded as uncertain.

The plate is about 5 mm. thick, and the radial canals something over 1 mm. wide. The skeletal beams are mostly 80–100 μ thick; meshes of the lattice-work frequently rectangular and measuring commonly 200 μ x 200 μ to 680 μ x 425 μ, larger sizes not infrequent. The axial canals are arranged in the several ways described by Schulze (1887, p. 318). In these points there is agreement with *A. vastus.* In some minor features there is not agreement. Thus the beams are smooth, and the spines (pegs) are shorter and stouter than is the rule in *A. vastus,* also less abundant. The specimen has apparently long been dead, and the axial canals are wide (0.2 to 0.3 diameter of the beams) and very distinct.

The "Challenger" specimens of *A. vastus* were from Sagami Bay, Japan. The "Albatross" specimens on which Schulze reports (1899) were taken "along the whole west coast of North America from the Aleutian Islands to the Bay of California" at 13 different stations.

COSCINOPORIDAE Zittel.

Chonelasma F. E. Schulze.

1887. *Chonelasma* Schulze, 1887, p. 320.

Chonelasma calyx F. E. Schulze (sp. ?).

Plate 10, Fig. 5.

1887. *Chonelasma calyx* Schulze, 1887, p. 326, Plate LXXXIX.
1899. " " Schulze, 1899, p. 78, Taf. XIX. Fig. 5.

Station 3354, 3 imperfect specimens in which only the dictyonal framework is preserved. The identification is therefore in a measure uncertain, although a direct comparison with *C. calyx* makes it probable that the "Albatross" specimens belong to this species.

As in many of Schulze's specimens of *C. calyx* from the west coast of America (Schulze, 1899, p. 79), the lower part of the body forms a stalk. The stalk is roughly cylindrical, about 10 mm. in diameter and up to 40 mm. long. It expands below to form a basal plate, the under surface of which is smooth. The vase-shaped body, into which the stalk passes, has a wall 2–4 mm. thick. In the best specimen the vase is somewhat cylindrical, beginning to flare in its upper part, where it is broken off. In this individual the cavity of the vase is crossed by an oblique septum, perforated by several large apertures (Plate **10**, Fig. 5). The septum is very thin, and is composed of delicate strands which form a coarse reticulum.

The skeletal framework at the outer surface is irregularly arranged so as to bound rounded apertures. On the inner surface a fairly regular crossing of circular and longitudinal fibres is obvious. This contrast between the two surfaces exists in *C. calyx*, but also in other species of *Chonelasma* (*C. tenerum* F. E. Sch., Schulze, 1887; *C. lamella* F. E. Sch., Schulze, 1887).

The nearly parallel trabecular plates (*Balkenzüge*) described by Schulze for *C. calyx* (Schulze, 1899, p. 78) as lying edgewise to the surface of the body and extending from below upward are distinctly marked in my specimens.

In the specimens of *C. calyx* from Japan described by Schulze (1887, p. 326) the dictyonal framework consisted "partly of perfectly smooth beams and partly of beams sparsely covered with tubercles," whereas in

Schulze's American specimens (1899, p. 81) the beams are almost everywhere abundantly covered with fine prickles. In my specimens, in the wall of the vase almost all of the beams are smooth, but beams abundantly covered with exceedingly fine prickles are occasionally met with. On the other hand, in the stalk beams densely covered with fine prickles predominate.

In my specimens, as in Schulze's American specimens of *C. calyx* (1899, p. 79), the dictyonal skeleton of the stalk (especially in its outer part) is far more compact than that of the vase wall, and in this region large numbers of the peculiar oxyhexacts are found, the rays of which bear small transverse spines.

The "Challenger" specimens of *Chonelasma calyx* were from Japan. The "Albatross" specimens described by Schulze (1899) were taken at 9 different stations off the west coast of North America from the Aleutian Islands to the southern end of Lower California.

Bathyxiphus F. E. Schulze.

1899. *Bathyxiphus* Schulze, 1899, p. 82, Taf. XVII. XVIII.

Bathyxiphus, sp.

Plate 10, Fig. 2.

Station 3380, 1 specimen.

The specimen includes only the dictyonal framework. The arrangement of the beams in the framework and the shape of the body are, however, so characteristic as to leave little room for doubt that the sponge belongs in the genus created by Schulze for specimens taken in the same general locality as this.

There is a basal disc about 55 mm. in diameter (Fig. 2, Plate **10**). From it a solid stem, which has a length of 120 mm., rises obliquely. The stem at its very base is irregularly cylindrical, soon becoming lenticular in section, with transverse axes of 12 mm. and 7 mm. respectively. The stem above becomes gradually more compressed, being quite flattened at its upper end, where it measures 15 mm. from edge to edge, and about 3 mm. in the short transverse axis. The flattened upper end is notched in the middle, and is thus divided into two very short flattened diverging lobes. These have rounded outlines, but as the specimen is somewhat waterworn, it is by no means certain that they represent the upper end of the perfect sponge. There is, however, a clear indication that the sponge bifurcates above.

The lateral edges of the lenticular, or flattened, stem are everywhere rounded, nowhere sharp. At the upper end, however, in the above-mentioned notch, the free edge becomes thin and comparatively sharp. The stem is slightly curved in a wave-like fashion both along its edges and its flattened faces, but very vaguely and in a less regular fashion than in Schulze's specimens of *B. subtilis.* The wave-like contours nevertheless suggest that the growth is a bilateral modification of the spiral form. It may here be mentioned that a strongly bilateral modification of the spiral form is exhibited by some of the macerated specimens, which I mention under *Eurete erectum,* p. 58. In one of these, over a tract 70 mm. long, the curves of the stem lie nearly in one plane, and the lateral cups form two linear series, which are distributed along the opposite curved edges of the sponge, the curved edge presenting a wave-like contour from the convexities of which arise the cups.

The dictyonal framework has the structure described by Schulze. In the middle of the compressed stem there are longitudinal beams with more or less transverse connectives, the system thus giving fairly rectangular meshes. The longitudinal beams on each side curve outward toward the edge of that side and the upper end, in some cases obviously branching acutely. Connectives extend transversely between these beams and at about right angles to them, and thus make an angle with that horizontal axis of the sponge which runs from edge to edge of the stem. Typically the connectives form continuous lines which extend from edge to edge of the stem, and are strongly arched toward the apex of the sponge, precisely as described by Schulze for *B. subtilis.* There are of course departures from this plan, owing to the fact that some connectives lie in the transverse axis of the stem, others extend outward and *upward,* and at some levels the connectives do not form continuous lines.

Away from the median plane, going toward each face of the stem, the skeletal meshwork becomes irregular. Near and at the surface, the beams are much slenderer and the meshes larger than farther in.

Abundant small hexacts are present. It should also be mentioned that a few hexact pinuli and scopulae were observed. Since these, however, resemble the corresponding spicules of *Eurete erectum gracile,* specimens of which were collected at the same station with the *Bathyxiphus*, it is probable that they belong to the former sponge.

Bathyxiphus subtilis F. E. Sch., the type on which the genus is based, was taken by the "Albatross" south of Guadeloupe Island off Lower California, Lat. 28° 57′ N., Long. 118° 14′ 30″ W., at a depth of 1251 metres on a mud bottom.

TRETODICTYIDAE F. E. Schulze.

Hexactinella Carter.

1885. *Hexactinella* Carter, 1885, p. 387.
1887. *Hexactinella* Carter, Schulze, 1887, p. 328.

Hexactinella labyrinthica, sp. nov.

Plate 10, Figs. 6, 7; Plate 11, Figs. 1–7.

Station 3405, 1 entire specimen and 3 fragments.

Diagnosis. Sponge body a labyrinthine mass of branching and anastomosing flattened or subcylindrical lobes. These are beset with numerous rounded oscula leading into short cloaca-like main canals. The dermal skeleton includes pentacts, with more or less radially disposed scopulae and *roughened oxydiacts.* The parenchymal microscleres are oxydiacts and discohexasters.

The entire specimen (Fig. 6, Plate **10**) forms a hemi-spheroidal mass which has a diameter of 60–80 mm., and is attached below to conglomerate. The lobes very commonly have a thickness of about 6 mm., and the sponge has the appearance of having been produced by a continued branching and anastomosing growth, which started from the centre of the lower or attached surface. The oscula are about 2 mm. in diameter, are bounded by a narrow border of oscular membrane, lie on the surfaces which face outward, and are not on special elevations. The cloaca-like main canals extend radially or obliquely into the interior for a short distance only, 3 or 4 mm. Into them open numerous efferent canals.

The surface of the sponge appears porous, owing to the very numerous afferent canals, the outer ends of which abut against the dermal membrane. The outer ends of these canals are in general rounded and vary in size up to 1 mm. in diameter. The dermal membrane covering them is riddled with pores (Fig. 7, Plate **11**). In spots, especially in the neighborhood of the periphery of the colony, where the lobes are attached to the substratum, afferent canals large enough to be noted by the eye are absent, and the surface has a homogeneous appearance, which is perhaps the earlier ontogenetically. The pores, which vary considerably in size, are thickly scattered over the whole dermal surface, not only directly over the conspicuous afferent canals, but in the regions between such, where the dictyonal framework and the flagellated chambers closely approach the surface (Fig. 7, Plate **11**).

A small tubularian hydroid, the polyps of which have four tentacles and are borne upon a slender, ramifying stolon, is present in considerable abundance in the tissues of this sponge. The polyps lie especially in the peripheral region, and cause no elevations or apparent malformations.

The tissues also contain (Fig. 7, Plate **11**) exceedingly numerous rounded or irregularly shaped masses up to 120 μ in diameter. These are frequently nearly or quite in contact, so abundant are they. Their histological condition does not admit of exact study, but it may be seen that they are composed of closely packed rounded bodies about 4 μ in diameter. They are doubtless collections of archaeocytes such as Ijima has recently described (Ijima, 1901).

It is difficult to carry out in this sponge the distinction between a dermal surface and a gastral surface. If we do adhere to the latter conception, it is obviously only the walls of the cloaca-like main canals which represent the gastral surface. But such walls are of course something quite different from the inner surface of a cup-shaped plate, such as, for instance, in *Hexactinella ventilabrum* is usually denominated the gastral surface.

The dictyonal framework is fine, far more so, for instance, than that of *H. ventilabrum* F. E. Sch. On parts of the surface the reticulate plates characteristic of the genus are obvious, their superficial edges being not at all or scarcely united. Elsewhere the superficial edges of the plates are united by skeletal strands. In this way a surface network is produced, enclosing rounded or elongated apertures and obscuring the system of plates. The reticulate plates are something less than 1 mm. to 1.5 mm. wide at the surface, and 1 mm. or less apart. They taper internally to an apex, meeting and fusing with one another, as they get farther from the surface. They are of varying thickness, in places consisting of but a single layer of beams, generally of a few (2 to 4) such layers. The individuality of the skeletal plates, both at and internal to the surface, is far more distinct in certain regions than in others, depending on the extent to which connectives have developed. The plates are always set edgewise to the surface, and in any particular part of the sponge body they may be seen, in the macerated skeleton, to extend in a very general way in one direction, which in some cases obviously corresponds to the long axis of the lobe. Owing to the labyrinthine habitus of the sponge body, it is impossible in other cases to determine which is the long axis of a particular part.

The arrangement of the constituent beams of the skeletal plate has a certain regularity. Beams directed radially to the surface of the sponge may be distinguished, between which lie connectives. The latter are frequently transverse, thus giving rise to rectangular meshes, Figs. 1 and 7, Plate **11**. The superficial ends of the radial beams form tapering spines of varying length, sometimes very short, frequently as long as 350 μ, often slightly irregular, and as a rule thickly covered with sharp microtubercles. The beams in general are sparsely covered with similar tubercles, and most commonly have a thickness of 20–30 μ. A similar difference in tuberculation between the ends of the radial beams and the general framework exists in *Hexactinella grimaldii* Tops. (Topsent, 1892, p. 34), and according to Topsent (1892) in *H. tubulosa* F. E. Sch.

From the nodes of the skeletal reticulum, on the free surfaces and edges of the plates, slender, sharp, tuberculated spines very generally project, Fig. 1, Plate **11**. Some of the very delicate connecting bars which extend between adjoining skeletal plates (lower left corner and at extreme right, Fig. 1, Plate **11**) make the impression of having arisen through the fusion of such spines.

Commonly the outermost tangential beams of the dictyonal framework lie at some considerable distance below the dermal membrane (Fig. 7, Plate **11**). This is not always so, for in places they nearly, and more rarely quite, reach the surface, aiding in support of the dermal membrane. The lining membrane of the cloaca-like main canals is likewise in places directly supported by beams of the framework, placed tangentially to this membrane.——The attached surface of the sponge lobes is comparatively smooth, the dictyonal framework here forming the familiar close meshwork or "cribellate plate" (Ijima) found in so many Hexactinellid sponges.

In spots at the surface the dictyonal framework is covered with collections of delicate hexacts and pentacts, partially fused with one another and with the framework (Fig. 7, Plate **10**). The spicule rays, which are often irregularly curved to a slight degree, may simply cross one another, or may be united by distinct masses of cement. The rays are as a rule noticeably thorny, and about 160 μ x 3–5 μ. In such spots the usual covering of dermal pentacts is absent or nearly absent.

At the same station at which these specimens were obtained, a species of *Tylodesma* (*T. vestibularis*) was taken, growing upon and through a dead Hexactinellid skeleton, which seems unquestionably to belong to *H. labyrinthica.* In this skeleton, reticular masses formed by the fusion of delicate spicules, like those just described, are abundant. The fusion, however, is more complete, and often so intricate that the individuality of the constituent spicules cannot be made out. The masses of spicules here are found chiefly in the interior, and in some cases form continuous layers, which like a partition wall separate one part of the sponge from another part.

In both cases the reticular masses obviously fall in the category of the peculiar structures found in so many Hexactinellids and described especially by Weltner: "An einer Reihe von Dictyoninen finden sich eigenthümliche Nester von Gitterwerken, zusammengesetzt aus Sechsstrahlern, [pentacts also in *Myliusia zittelii* Marsh.] welche ohne alle Ordnung zu einem Haufen miteinander verbunden waren" (Weltner, 1882, p. 56). In *H. labyrinthica,* the collections of these spicules suggest a pathological condition.

The dermal pentacts, Fig. 5, Plate **11**, vary a good deal in size (Fig. 6, Plate **11**). In the larger, the tangential rays measure about 250 μ x 18 μ, proximal ray about 380 μ x 20 μ. The distal ray is reduced to a boss from 50 μ to almost nothing in height. All rays are commonly pointed, sometimes blunt or rounded at the ends, and are covered with sharp microtubercles, which are, however, very feebly developed in the smaller spicules. A surprisingly frequent condition of the rays is shown in Figs. 5 *b* and 5 *c*, Plate **11**. The ray which may be tangential or proximal suddenly narrows once or twice before reaching its end. Over the larger inhalent canals, the pentacts commonly have proximal rays which are shorter than elsewhere (Fig. 7, Plate **11**).——The pentacts are very abundant, and the tangential rays overlap. While the arrangement of these rays is not strictly regular, square meshes are common, and frequently a smaller pentact is so placed in a square mesh as to divide the latter into four triangular areas (Fig. 6, Plate **11**). The covering of pentacts comes to an end at the margin of the attached surface of the sponge, and at the margin of the oscula, although in the lining membrane of the cloaca-like main canals a very few scattered pentacts are found.

The scopulae (Fig. 4, Plate **10**, Fig. 2, Plate **11**) vary in size, but in other respects are alike. The shaft tapers to a fine point. Above, nearer the rays, it is nearly smooth, while below it is distinctly roughened with sharp denticulations. Just below the rays is a terminal enlargement on which the rays are set. The rays are four in number, only very slightly divergent, roughened with minute though distinct denticulations which die away at the base. The upper ends of the rays are rounded and slightly enlarged. The extreme upper end is smooth. In the larger scopulae the shaft is about 580 μ long and 8 μ thick just below the upper enlargement; rays 80 μ long x 7 μ thick at the base. The smallest forms seen were about two-thirds the size of the largest.——The scopulae are in part scattered through the interior of the sponge, in part arranged radially or obliquely to the dermal membrane and to the lining membrane of the main canals. Scopulae also lie in or project into the rim of membrane which surrounds the oscula. A dermal scopula is usually found together with a few oxydiacts, all forming a loose sheaf associated with the proximal ray of a pentact. The scopulae, like the accompanying oxydiacts, may not reach, or may project slightly beyond, the dermal membrane.

The dermal oxydiacts are arranged radially or obliquely to the surface, singly or in small loose sheaves, often associated with the pentacts. The spicules are roughened, taper to fine points, and vary in size, the larger measuring about 600 μ x 5 μ. Smaller forms down to 200 μ x 2 μ are found. The larger are abundant. On these it may be seen that the roughening is of a definite character, Fig. 4, Plate **11**. The minute denticulations project obliquely from the shaft and in one direction, pointing when the spicule is in place away from the dermal membrane. Toward each end of the spicule, the denticulations lose their definite character, and it is not always equally distinct on all parts of the shaft. ——In the parenchyma are abundant oxydiacts, similar to the dermal forms, although the larger sizes are relatively less common.

In *Hexactinella ventilabrum* F. E. Sch., Schulze (1887, p. 331, Plate XCVI.) has described roughened oxydiacts, which he regards as possibly representing uncinates. The denticulations have not the oblique character I have just described. Topsent (1901) likewise finds in his *Eurete alicei* nicked oxydiacts, which he considers as a form of uncinate. The oblique character of the denticulations in the larger oxydiacts of *H. labyrinthica* inevitably suggests that they too are to be regarded as representing uncinates.

Discohexasters, Fig. 3, Plate **11**, are abundant in the parenchyma. The principal rays are smooth, the terminals roughened and exceedingly slender. A principal bears 3 or 4, rarely only 2 terminals. The buttons at the ends of the terminal rays are minute. The principals are commonly 5 μ long, the terminals 20 μ long, although somewhat smaller sizes are present.

Hexactinella ventilabrum Carter (sp. ?).

1885. *Hexactinella ventilabrum* Carter, 1885, p. 397, Plate XIV., Figs. 1–10.
1887. *Hexactinella ventilabrum* Carter, Schulze, 1887, p. 331, Plate XCVI.

Four fragmentary specimens from *Stations 3359, 3404, 3406*.

These specimens include only the dictyonal framework, and the identification is therefore in a measure uncertain, although a direct comparison with specimens of *H. ventilabrum* makes it probable that they belong to this species.

The largest piece is a plate about 120 mm. wide and 7–10 mm. thick. The plate is comparatively smooth on one surface, but very uneven on the opposite surface, owing to the development of irregular protuberances and ridges, which for the most part are about 10 mm. high. The dictyonal framework exhibits the reticulate plates, which are characteristic of the genus. They curve toward both surfaces, and are made up of beams, which are covered with very small, sharp microtubercles. Except at and close to the surfaces of the sponge, where they are conspicuously thickened, the beams have a thickness commonly in the neighborhood of 80 μ. The meshes more frequently are irregular in shape, but in places are square or rectangular. Selected and fairly typical meshes of this character measured 425 μ x 300 μ, 340 μ x 250 μ, 250 μ x 250 μ. Much coarser meshes exist. —— The distance between the reticulate plates is about 2 mm. The framework is thus a coarse one.

As in Schulze's specimens of *H. ventilabrum* (and in other species of *Hexactinella* also), there is a marked difference in the appearance of the opposite surfaces of the sponge. On the one surface the free margins of the reticulate plates may be seen, the surface network here being formed by these margins and by beams which extend between them. On the opposite surface the reticulate plates are covered in by an "evenly expanded fibrous network" (Schulze, 1887, p. 331).

The sponges had probably long been dead when taken, for the axial canals are wide and distinct, making it easy to observe the various ways in which the hexacts are combined to form the dictyonal skeleton. It may thus be seen that two parallel rays of different hexacts may fuse to form a beam; or the beam is formed of a single ray, which at its tip fuses with the side of the ray of another hexact, or crosses this ray, fusion occurring at the point of crossing. Far less common is the case where two or even three rays of the same hexact are so curved as to lie nearly parallel to one another and to fuse. Such a condition is found occasionally in the thicker beams at or near the surface.

Hexactinella ventilabrum F. E. Sch. has hitherto only been recorded from Japan.

Hexactinella tubulosa F. E. Sch. (sp.?).

1887. *Hexactinella tubulosa* Schulze, 1887, p. 328, Plate XCIII.

At *Station 3406* a small fragment was obtained, including only the dictyonal framework. The fragment, which is about 30 mm. long, is tubular, and represents the end of a cylindrical branch about 10 mm. in diameter. The skeletal plates are separated by an interval of about 2 mm. The resemblance of the fragment to a Japanese specimen of *H. tubulosa* in the Museum für Naturkunde in Berlin is so close as to make it exceedingly probable that the sponge belongs to this species. Through the kindness of Professor Wilhelm Weltner I was allowed to make preparations of the Japanese specimen, which I find is undoubtedly referable to Schulze's species, although the anastomosis between the skeletal lamellae is feebler than in the specimens described by Schulze (1887), and the lamellae are distinct at the dermal as well as at the gastral surface.

At *Stations 3380* and *3406* four other macerated fragments were obtained, including only the dictyonal framework. These represent some tubular species of *Hexactinella,* probably *H. tubulosa.* The diameter of the branches is 10–20 mm. The axial cavity is large as compared with the thickness of the wall. For instance, in a branch 20 mm. wide, the width of the axial cavity is 10 mm.——The skeletal reticular plates are about 2 mm. apart. At the dermal surface they are abundantly connected by anastomoses so as to produce a reticulum with rounded polygonal meshes about 2 mm. in diameter, agreeing in this respect with the specimens described by Schulze (1887, p. 329).

Hexactinella tubulosa F. E. Sch. has hitherto been recorded only from Japan.

Sclerothamnopsis compressa, gen. et sp. nov.

Plate 9, Figs. 2, 4, 6-8, 10, 11; Plate 10, Figs. 1, 3.

Diagnosis. Dictyonal framework a close reticulum not divisible into lamellae. Beams of the reticulum may give rise to fibres, which pursue a longitudinal course in places, curving outward to the surface. The entire framework has the shape of a branching axis. The main axis and the branches all lie approximately in one plane, and all are distinctly flattened. Free spicules not known with certainty.

At *Station 3406* five fragmentary and macerated specimens were taken of this remarkable sponge, which finds its nearest ally in *Sclerothamnus clausii* Marshall. The most perfect piece is represented in Fig. 1, Plate **10**.

The body of the skeleton consists of a branching axis, which is not cylindrical, but distinctly flattened. From the flattened surfaces of the axis the branches project obliquely upward, some of them reuniting with the axis above. The branches and the main axis all lie approximately in one plane, the whole sponge (fragment) thus acquiring a habitus, which is not bushy but flattened. The branches themselves are flattened and like the axis in planes vertical to that in which the sponge body spreads. The branches vary in size, some being nearly as thick as the axis, others thin and small. Neither the base nor the upper end of the sponge is included in the specimens, the largest of which measures 150 mm. in length, the transverse diameters of the axis being about 10 mm. and 20 mm.

The macerated skeleton appears as a dense stony mass, the surface of which is studded with the round apertures, mostly about 0.5 mm. in diameter, of small canals passing into the interior. Here and there cylindrical, canal-like spaces of considerable size, 3 to 6 mm. in diameter, pass in an obliquely longitudinal direction through the axis or branch, from one flattened face to the opposite (Fig. 2, Plate 9). Or, instead of such perforating canal-like spaces, the branch may exhibit elongated clefts (Fig. 2, Plate 9, Fig. 3, Plate 10), which likewise pass through from one flattened face to the other. The two structures probably belong in the same category.

The stony skeleton is the dictyonal framework of the sponge. This consists of a close reticulum (Fig. 11, Plate 9), which is not divisible into lamellae. In the peripheral region of the sponge, beams directed more or less radially to the surface, with intervening connectives, may be distinguished. The radial beams commonly terminate at the surface in bosses or spines, which are sometimes short and conical, more often slender and finger-like. The superficial bosses, like the beams themselves, are smooth. The meshes have rounded corners, are irregular in shape, but in the peripheral region tend toward a quadrilateral outline. The nodes of the reticulum are for the most part not conspicuously thickened, but sometimes they are. The thickness of the beams is very commonly about 50 μ.

In places the beams of the dictyonal framework are so arranged as to give the framework a fibrous character. The fibres which lie in the long axis of the stem or branch are visible here and there over the general surface. They may also be traced with some distinctness in longitudinal sections, which are cut either parallel or at right angles to the flattened faces of the skeleton. The fibres are distinct on the walls of the large canals or slits which perforate the sponge, and here they are especially conspicuous on the walls which are parallel to the *edges* of the flattened branches, and less conspicuous on the walls which are parallel to the *faces* of these branches. The longitudinal fibres are especially distinct in some of the very small and thin branches, Fig. 4, Plate 9, where they arch outward toward the surface of the branch.

Spinose hexacts (Fig. 10, Plate 9) are scattered in considerable number through the dictyonal framework. They are free, or fused with one another, at points where the rays cross. The rays are slender and beset with small, sharp spines, which are sometimes obsolete. In the same spicule the rays often differ in length, but a common size is about 100 μ long x 4–5 μ thick. The ends of the rays are pointed, or sometimes enlarged and rounded.

A very few pinules, having the peculiar character shown in Fig. 6, Plate 9, are present, some at the surface, others caught in the skeletal reticulum. The distal ray is stout, solid, and covered with exceedingly small, sharp scales, except at its lower end, which is smooth. The tangential and proximal rays are about cylindrical, slender, and smooth, except near the end, where the ray is roughened. The distal ray is 130 μ long, with a greatest thickness of 56 μ. The tangential rays measure 100 μ x 4–5 μ; proximal of same thickness as the tangentials, but longer.

Slender, smooth, nearly cylindrical oxydiacts, 6–8 μ thick, are found here and there lodged in the dictyonal framework. The spicules are always broken, but the length is often over 0.5 mm.

Oxyhexasters (Fig. 7, Plate 9) with smooth slender rays are present in some abundance in the skeletal framework, often occurring in clumps. The terminals, of which there are commonly two to a principal, diverge considerably, are very slightly curved, taper to fine points, and are larger than the principals. The principal ray is about 12 μ, the terminals about 24 μ long.

A very few scopulae (Fig. 8, Plate 9) are present, all of the same type. It is of course uncertain whether they belong to the sponge. The shaft is smooth, tapers gradually to a point, and measures 700 μ x 10 μ. There are four terminal rays, 130 μ long, with a basal thickness of 12 μ. The terminals are straight, smooth, taper conspicuously from the base to the apex, which is rounded and scarcely enlarged. The spicules, like the whole skeleton, have evidently lain long in the water, and the axial canals are very large and distinct. The latter, which are shown in the figure, are of some interest as bearing upon the morphology of the spicule. From the axial cross which lies immediately below the terminals, there is prolonged in one direction the canal of the shaft. On the opposite side canals are prolonged for a short distance into the terminal rays, and end in rounded extremities.

Schmidt (1880, p. 38) conceives the scopula as a modified hexact, and in cases where there are five distal rays interprets these and the shaft as representing the six hexact rays. Schulze (1887, p. 34) argues against this interpretation, and is disposed to regard the distal rays (teeth) as comparable with "the terminal rays of the rosettes." The arrangement of the axial canals in the scopulae here described supports Schulze's interpretation. The terminal rays of the scopula would seem to represent branches of that hexact ray which lies opposite the shaft. The ray in question, which would correspond to the principal ray of a hexaster, is reduced to a minimum, as sometimes occurs in hexasters. Thus the whole scopula corresponds, as Schulze (1887) suggests, to a diact with one long ray (shaft) and one exceedingly short ray, which is produced into branches.

The sponge here described offers many points of resemblance in habitus and dictyonal framework to *Sclerothamnus clausii* Marsh., the type specimens of which, owned by the Rijks-Museum in Leiden, I was permitted to examine. The more perfect specimen is a large and beautiful one. While this specimen is bushy as Marshall (1875) states, it is nevertheless as a whole compressed, one horizontal diameter of the colony being several times as great as the other. The branches themselves also are in places not cylindrical, but somewhat compressed. The dictyonal framework is very coarsely porous as compared with the dense compact skeleton of my species.

Sclerothamnus clausii contains (Schulze, 1887) the following free spicules: dermal hexacts, floricome-like hexasters, dermal scopulae, uncinates, scopula-like spicules with transverse spines on the shaft. The pinules (Fig. 6, Plate IX.) present in my species are very few in number, but they are so peculiar that it seems likely they belong to the sponge. The oxyhexasters, oxydiacts, and spinose hexacts are present in considerable numbers, and doubtless belong to the sponge. Thus there would seem to be a serious difference in the matter of the free spicules between *Sclerothamnus* and *Sclerothamnopsis*.

The Leiden specimens of *Sclerothamnus clausii* were obtained from an unknown locality. Steere's (Murie's) specimen came from the Philippine waters. The "Challenger" fragments were trawled Lat. 4° 31′ 0″ S., Long. 129° 57′ 20″ E., at a depth of 360 fathoms, on volcanic mud.

TETRACTINELLIDA Marshall.

CHORISTIDA Sollas.

THENEIDAE Sollas.

Thenea Gray.

1867. *Thenea* Gray, 1867, p. 541.
1888. *Thenea* Gray, Sollas, 1888, pp. 59, 95.
1894. *Ancorina pars* Lendenfeld, 1894, p. 96.
1894. *Thenea* Gray, Topsent, 1894, p. 375.
1898. " " Thiele, 1898, p. 21.
1902. " " Topsent, 1902, p. 10.
1903. *Ancorina* (*Thenea*) O. Schm., Lendenfeld, 1903, p. 53.

Thenea fenestrata (O. Schmidt) Sollas.

Plate 13, Figs. 2-4, 6, 7, 9.

1880. *Tisiphonia fenestrata* O. Schmidt, 1880, p. 71, Taf. X. Fig. 2.
1882. *Thenea muricata* (Bwk.) Gray *pars*, Vosmaer, 1882, pp. 6, 7, 13.
1885. " " " " , Vosmaer, 1885, p. 4.
1888. *Thenea fenestrata* (O. Schmidt) Sollas, 1888, p. 71, Pl. VIII. Figs. 1–8.
1903. *Ancorina* (*Thenea*) *fenestrata* (O. Schm.) Lendenfeld, 1903, p. 55.

Station 3400, 8 specimens; *Station 3413,* 3 specimens; *Station 3362,* 5 specimens.

The specimens are all small, the diameter ranging from 15 to 25 mm. Both upper and lower surfaces are convex, but the shape of the body varies considerably, being in some cases (Fig. 2, Plate **13**) strongly compressed in the vertical axis, in others (Fig. 9, Plate **13**) compressed in one of the horizontal axes, and again with all the axes about equal. The upper surface bears a single osculum, more or less centrally or very excentrically placed, at the apex of a protuberance. The osculum is commonly surrounded by a dense spicular fringe up to 3 mm. high, but the fringe is absent in some specimens. The color is grayish. The surface is comparatively even, and in general hispid to the eye, but appearing smooth on parts of some specimens. From the under surface several slender roots project, most of which are broken off close to the body.

The pore areas vary in number from two to four, and are separated by comparatively wide intervals. The width of the area (in the horizontal plane of the sponge) is often about equal to the height (Fig. 9, Plate **13**), but again much greater, as in Fig. 2, Plate **13**. The margin is whitish and tumid, projecting out as a thin membrane where the spicular fringe is well developed; the membrane including the bases of the fringe spicules. The fringe itself is in most cases well developed along the upper margin, feebly developed or absent along the lower margin of the area. But in a few areas it is well developed on both margins, and in a few is absent from both margins. The areas are depressed, and the pore membrane lining the area covers in a subdermal cavity which is continued into several afferent canals. The flagellated chambers are eurypylous, and measure about 50 μ in diameter.

Megascleres.

1. Dichotriaene; rhabdome, 3.5 mm. long with greatest thickness of 70 μ; protocladus, 180 μ x 50 μ; deuterocladus, 1.0 mm. long with basal thickness of 35 μ. Smaller forms are abundant, down to such as have a rhabdome, 2.2 mm. x 52 μ, protocladus, 125 μ long, deuterocladus, 440 μ long.

In most of the spicules, the rhabdome is thickest immediately below the cladome, thence tapering to the point. In some spicules, the rhabdome is slightly constricted immediately below the cladome, then expanding and subsequently narrowing and tapering uniformly to the point, as in the protriaene shown in Fig. 6, Plate **13**. The greater part of the rhabdome is quite slender, and somewhat curved. The protocladus is inclined more or less upward, thus making an angle of 80° to 45° with the rhabdome prolonged; angle commonly near 70°. The deuterocladus is straight, or more often slightly curved upward near the base, thence about straight.

2. Protriaene, Figs. 4, 6, Plate **13**; rhabdome, 3–4 mm. long with a greatest thickness of 50–60 μ; cladus, 400–700 μ long x 35–40 μ thick at the base.

The rhabdome exhibits a dilated portion below the cladome. The cladi make an angle of about 45° with the rhabdome, and are usually curved, rarely nearly straight. The curvature of the cladi varies considerably in character (compare Figs. 4 and 6, Plate **13**). —— The protriaenes are obviously modified dichotriaenes. Transitional forms to the dichotriaene (Fig. 7, Plate **13**) are rather more abundant than the perfect protriaene. In these transitional forms the relative lengths of protocladus and deuterocladus are very variable. —— The protriaenes, perfect and imperfect, are present in small number, and chiefly in the neighborhood of the pore areas and the osculum.

3. Anatriaene; rhabdome, 4 mm. x 12 μ; cladus, 260 μ long. The spicules range down to forms with rhabdome 2 mm. x 8 μ, and cladi 140 μ long.

The rhabdome is cylindrical, tapering gradually to the apex. The cladome is deep (the sagitta longer than the chord), but the precise shape of the spicules varies. The anatriaenes are only fairly abundant, occurring in the parenchyma and in the fringes surrounding the osculum and pore areas.

4. Oxea. The very numerous oxeas which are abundant in the body, roots, and fringes fall into four classes, which shade into one another. *a.* Large oxeas, 7.5 mm. x 70 μ to 4 mm. x 35 μ, smooth, tapering. Many are dilated in the middle region, and thus fusiform; others more cylindrical in shape. Abundant in the parenchyma and roots; smaller sizes in the fringe round osculum. *b.* Very slender oxeas, 3–6 mm. long x 10–20 μ thick; cylindrical, tapering at both ends. Common in the parenchyma and roots; chief spicule in the fringes round the osculum and pore areas. *c.* Comparatively short and stout oxeas, 2–3 mm. long x 50–70 μ thick; fusiform. Common in the parenchyma. *d.* Small oxeas, 650 μ to 1.0 mm. long x 8–10 μ thick; common in the parenchyma, especially in the peripheral region, where they project everywhere over the surface.

Microscleres.

5. Plesiaster. The spicule has a short, usually somewhat curved, axis with 2 or 3 rays at each end, and sometimes with a ray or two projecting from the axis. Forms with 4, 5, and 6 rays are all common, although the 4-rayed form is the predominant type. The rays are most minutely roughened, scarcely spinose. Rays commonly 35–60 μ long with basal thickness of 5–6 μ. Smaller forms with ray length down to 20 μ occur. The plesiaster is very abundantly scattered throughout the parenchyma.

Sollas for the "Challenger" specimens (Sollas, 1888, p. 72) gives the plesiaster rays as 60–90 μ long x 3.9 μ thick. The rays in the specimens studied are thicker and shorter.

6. Spiraster. The spicule varies toward the metaster condition. The common forms are shown in Plate **13**, Fig. 3 *a–c*, among which 3 *b* and 3 *c* approach the metaster type more closely than do the others.——The axis is smooth and cylindrical, varies in length so as to exhibit in projection one or two concavities on the same side; sometimes bent rather than curved. The rays are tapering, most minutely roughened, and minutely tylote. Total length of the spicule, 32–48 μ; ray length, 10–20 μ. Sizes close to a total length of 40 μ with ray length of 14 μ, predominate. The spicule is abundant in the parenchyma, dermal membrane, and especially abundant in the membranes of the pore areas.

Sollas for the "Challenger" specimens gives total length of spiraster 39.5–47.4 μ, ray length, 12–19 μ. The spicules figured by Sollas (1888, Plate VIII., Figs. 7 and 8) might properly be designated metasters or amphiasters, although Sollas says metasters are absent.

Thenea fenestrata has hitherto only been recorded from the Atlantic Ocean and Caribbean Sea. Schmidt's specimens were taken in Lat. 24° 36′ N., Long. 80° 5′ W., at a depth of 955 fathoms; off Bequia at depths of 1507 and 1591 fathoms. The "Challenger" specimens were taken in Lat. 1° 47′ N., Long. 24° 26′ W., at a depth of 1850 fathoms; Lat. 10° 9′ S., Long. 35° 11′ W., at a depth of 1715 fathoms.

Thenea echinata, sp. nov.

Plate 12, Figs. 1-9.

Diagnosis. Body flattened but thick, and with a rounded polygonal outline. Round the periphery are several separate pore areas. An oscular depression near the centre of the upper surface. Upper surface densely covered with radial oxeas, projecting 5 mm. Under surface bears only small, short, projecting oxeas. Roots evenly scattered over the under surface. *Megascleres:* dichotriaenes, protriaenes, anatriaenes, oxeas. *Microscleres:* spirasters; total length, 28–40 μ; ray length, 10–14 μ.

Station 3415, 3 specimens.

The body (Figs. 1, 9, Plate **12**) is flattened, of a rounded polygonal outline, and bears a number of peripheral pore-areas. About in the centre of the upper surface is a smooth whitish (collenchymatous) oscular depression, into which open a number of efferent canals. This depression is nearly round in one specimen, irregular in the others, and is without, or with only a very indistinctly developed special spicular fringe. The upper surface is densely covered with radially arranged long oxeas, projecting about 5.0 mm. beyond the surface, and holding much sediment. The under surface is covered with radially arranged small oxeas, projecting about 1.0 mm. Round the margin of the sponge the long spicules of the upper and the short spicules of the under surface intergrade. Evenly scattered over the under surface, which appears smooth as compared with the upper, are roots 1–2 mm. thick, and 6–10 mm. apart, which are broken off close to the body. The color of the interior and surface is brown, except where the whitish collenchyma shows, the upper surface appearing dark because of the mud held by the surface covering of spicules. The horizontal diameter of the specimens varies from 40 to 60 mm., the vertical diameter including the projecting spicules from 20 to 25 mm.

The pore areas vary in number from 4 to 7, are mostly elongated in the horizontal plane of the sponge, but in some cases are nearly circular. The height of the areas varies from 5 to 9 mm., the width from 5 to 25 mm. They are depressed, and show the usual tumid whitish border. In some areas the upper margin is provided with a well-developed fringe of spicules, projecting about 5 mm. In other areas the fringe is absent, unless, indeed, it be thrown back and merged in the general spicular covering of the upper surface. The under margin of the areas in general lacks a special spicular fringe, but here and there such a structure reaches a feeble state of development. —— The pores, 85–340 μ in diameter, are mostly open, and the pore membrane appears as a coarse reticulum (Fig. 9, Plate **12**). But in some cases the pores are partially or completely closed, the membrane appearing nearly or quite imperforate. In the latter condition it is white and opaque. The pore membrane closes in a subdermal space, from which large canals pass into the interior.

The ectosome is collenchymatous, and about 0.5 mm. thick. The body in general is excavated by numerous canals of comparatively large size. The collenchyma round the larger canals is scanty. The flagellated chambers are eurypylous and large; many spheroidal, and about 70 μ in diameter; others more or less compressed, often strongly so, and measuring about 80 μ x 40 μ (artefact?). In sections fine canals (Fig. 2, Plate **12**) may here and there be seen extending radially through the ectosome and opening on the surface by single apertures.

Megascleres.

1. Dichotriaene, Figs. 2, 7, Plate **12**. The rhabdome is 100 μ thick just below the cladome, tapering evenly to the point, often somewhat curved, and about 6 mm. long. The protocladus is straight, tapers centrifugally, and measures about 140 μ x 85 μ. The deuterocladi are in general curved, first out, then in, as in Fig. 7, Plate **12**, taper evenly to the point, and measure about 960 μ x 70 μ.

The deuterocladi may exhibit a simple outward curvature. The deuterocladi are not always equal. In the same spicule some may be long and curved, others much shorter and about straight. The dichotriaenes are pretty closely set over the general surface, the cladomes overlapping.

The dichotriaenes bordering the pore areas, both above and below, are crowded, and many have smaller cladomes than the spicules elsewhere, the deuterocladi being comparatively short and straight. Some spicules exhibit a marked modification toward the protriaene condition, the protocladi projecting strongly upward, while the deuterocladi are very short, Fig. 5, Plate **12**.

2. Protriaene, Fig. 4, Plate **12**. Among the modified dichotriaenes which are found round the pore areas, perfect protriaenes occasionally occur. In such spicules the cladi make an angle of 45° with the rhabdome prolonged, and measure about 0.5 mm. by 70 μ.

3. Anatriaene, Fig. 8, Plate **12**. The spicules must be very rare, since only two were found in a large number of preparations. These were both somal, and were alike in shape and similarly placed; both broken.—— The spicules project from the surface of the body, along with the oxeas. The rhabdome is about cylindrical, slender, 12 μ thick in its upper part. The cladome is deep; cladi about 200 μ x 12 μ, nearly straight, and tapering evenly to a point.

4. Oxea. a. Long, slender, nearly cylindrical oxeas, 6–7 mm. by 24–40 μ, project in closely set, diverging bundles over the upper surface (Fig. 2, Plate **12**). The arrangement in bundles is not well marked in some places, the spicules in such places being more diffusely scattered.

b. Much smaller, but similar oxeas, averaging 1400 μ by 10 μ, project in large numbers from the upper surface, between the basal parts of the larger spicules. Similar oxeas project in large numbers over the lower surface.

c. The oxeas of the parenchyma are chiefly arranged, along with the triaene rhabdomes, to form radiating somal bundles, Fig. 2, Plate **12**, but are also scattered. They are mostly long forms, varying from a slender, nearly cylindrical shape, 6–7 mm. x 20–30 μ, to a stouter, more fusiform shape, 6–7 mm. x 90 μ. Shorter, slenderer forms occur, but not abundantly, ranging down to 1.0 mm. x 10 μ.

d. The oxeas of the roots are as a class very long. Slender, nearly cylindrical forms, about 10 mm. x 30 μ, and stouter, more fusiform spicules, 10 mm. x 90 μ, are both common.

5. A number of very slender, nearly cylindrical spicules, clavate at one end, as shown in Fig. 6, Plate **12**, occur in the roots. The spicule just below the clavate end is 16 μ thick, narrowing then to 12 μ, then very gradually increasing in diameter for a length of 6 or 7 mm. to a thickness of 24 μ, at about which point all the spicules observed were broken across.

Microscleres.

6. Spirasters, Fig. 3, *a, b, c,* Plate **12**. Spirasters are abundant, but not crowded, throughout the parenchyma and ectosome, including the general dermal membrane, and thickly scattered in the pore membranes. There are no constant differences between the spicules of the several regions. Total length of the spicule, 28–40 μ; ray length, 10–14 μ. The larger sizes are more common in the parenchyma and ectosome than in the pore membranes.

The spiral axis is smooth, and varies in length, so as to exhibit in projection one or two concavities on the same side. The axis in different spicules varies in thickness. In some it is slender, 2 μ thick, and seems to be cylindrical in shape. Very commonly the axis is flattened and band-like, hence appearing wider in one part of the spicule than elsewhere (Fig. 3 *c*, Plate **12**), reaching in such parts a width of 4–5 μ.——The rays appear rather long and slender, are minutely roughened and minutely capitate, tapering, numerous, and closely set.

A number of deviations from the type are met with, represented by a few spicules found here and there. Among these a form approaching the amphiaster occurs, consisting of a straight bar, at each end of which rays are clustered in a spiral curve.——Spirasters also occur, in which the rays are longer, fewer in number, and less closely set along the axis than in the type. Such a spicule had a total length of 40 μ; rays 12 in number and 16 μ long.

Thenea lamelliformis, sp. nov.

Plate 12, Figs. 10–13; Plate 13, Fig. 1.

Diagnosis. Body a comparatively thin plate, irregularly polygonal in outline. Both surfaces hispid, with small oxeas projecting about 1.0 mm.; these abundant in places, scanty elsewhere. A number of marginal pore areas. Oscula scattered over upper surface. Slender rootlets scattered over under surface. *Megascleres:* dichotriaenes, anatriaenes, oxeas. *Microscleres:* spirasters; total length, 30–40 μ; ray length, 12–16 μ.

Station 3414, 2 specimens.

The body (Fig. 13, Plate **12**) is a comparatively thin plate, the habitus resembling that of *Thenea wrightii* Sollas (Sollas, 1888, p. 63, Plate VIII., Figs. 11–20). The outline of the plate is irregularly polygonal, and round the margin are a number of separate pore areas, — in the larger specimen eleven. Over the upper surface are scattered several — in the larger specimen eight — oscula, the openings of depressions into which debouch several efferent canals. The oscula have the usual white, tumid wall, and lack a spicular fringe. Some of them are nearly closed, appearing small and slit-like; others widely open, 5 mm. in diameter. The upper surface is comparatively flat, but the under surface is more uneven, and bears, scattered over it, a number of very slender rootlets. The rootlets are broken off short of the ends, but some measure 20 mm. in length; diameter at the base, 0.5 mm., the rootlet tapering toward the extremity. The body of the sponge measures 7–8 mm. in thickness, thinning away toward the edge, which is pretty sharp. The larger specimen has a greatest width of 72 mm.

The color is gray. The surface, wherever clean, looks somewhat gelatinous and translucent. It is hispid, with small oxeas, projecting for the most part not over 1.0 mm., but with these are intermingled here and there oxeas projecting 3–4 mm.

Between some of the pore areas the margin of the body is indented, the portions bearing the areas projecting and appearing as vaguely indicated marginal lobes (comp. Sollas, 1888, p. 63). The pore areas themselves are depressed, short in the vertical axis of the body, elongated in the horizontal plane, measuring in the latter direction 10–15 mm. There is every evidence that the margins of the areas are highly contractile (Vosmaer, 1882, p. 8). The margins are white, tumid, and in general without a spicular fringe. Nevertheless, in the case of some areas, a feebly developed fringe is present over a part of the lower edge, projecting 3–5 mm., and a dense flattened tuft of spicules projects from the upper edge of one of the areas. The pores are mostly open, measuring up to 300 μ in diameter. In some areas the pores are closed, the membrane at the bottom of the area then appearing not as a reticulum, but imperforate, white, and opaque. The subdermal cavity, roofed in by a pore membrane, connects directly with large canals passing into the interior.

The flagellated chambers appear in the sections flattened and about 80 μ x 40 μ, or spheroidal and 50–60 μ in diameter. I incline to think that the chambers naturally vary a good deal in size.—— Large canals are rather numerous in the body of the sponge. In the superficial region the arrangement of the sponge tissue is distinctly lamellate, the lamellae extending more or less parallel to the surface of the sponge, with flattened lacunar spaces between. This arrangement is confined to the superficial part of the body, but is found at both surfaces.

Megascleres.

1. Dichotriaene; rhabdome straight and evenly tapering to a point, about 5 mm. x 85 μ; protocladus projecting slightly upward, tapering very slightly, 220 μ x 60 μ; deuterocladus also projecting slightly upward, tapering evenly to a point, straight or slightly curved, 750 μ long.

At the upper surface of the body the dichotriaenes are abundant; less abundant at the lower surface. In both regions the rhabdomes are set obliquely to the surface, not radially. In very many cases the inclination is so oblique that the rhabdome comes to occupy a nearly tangential position.

About the margin of the pore areas some of the dichotriaenes show the usual modification, the cladomes becoming smaller than elsewhere, the deuterocladi in many spicules being short and straight. Among these occur spicules resembling those figured for *Thenea echinata* (Plate **12**, Fig. 5), and which are obviously close to the protriaene condition. No perfect protriaenes were observed.

2. Anatriaenes. Somal anatriaenes, Figs. 10 and 12, Plate **12**, are fairly abundant in the smaller specimen, rare in the larger. Rhabdome, 4–5 mm. by 10–12 μ above, becoming very slender and hair-like; curved. Cladi, 100–204 μ long, nearly straight or slightly curved, tapering evenly; cladome deep.

The somal anatriaenes accompany the dichotriaenes of the obliquely radial bundles. The rhabdome of the anatriaene is coiled in a loose spiral round that of a dichotriaene, the cladome of the former lying just below the cladome of the latter.

Radical anatriaenes, Fig. 11, Plate **12**, occur in considerable number in the smaller specimen; none found in the larger specimen. Rhabdome always broken, 20 μ thick above; cladi, 85–250 μ long; cladome deep. The cladi and rhabdome are somewhat stouter than in the somal spicules. The cladi vary a good deal in curvature as well as in length. In some spicules they are markedly incurved as in the specimen figured, in others nearly straight or only very slightly curved. The spicules occur in the spicular core of the rootlets.

3. Oxea. a. The common large form measures 9 mm. x 50 μ to about one-half this size; median enlargement with axial cross sometimes present, especially in the smaller sizes; spicule tapering evenly to each end. —— The spicules are abundantly scattered in the parenchyma, where they cross at all angles, sometimes running side by side so as to form bundles of two or a few. They also accompany the rhabdomes of the dichotriaenes, aiding in the formation of the obliquely radial skeletal bundles. They are also found singly or in bundles of two or three, lying tangentially in the dermal membrane on both surfaces.

b. Very slender oxeas, 6 mm. x 12–15 μ to one-half this size, form part of the obliquely radial skeletal bundles. The spicule is cylindrical, tapering gradually at each end to a fine point, and is curved usually two or three times in a wave-like manner. These oxeas are twined round the larger spicules of the bundles.

Similar oxeas, reaching a greater length, 9 mm., occur in the rootlets, where together with the other longitudinally arranged spicules they form a sort of core.

c. Small oxeas about 1 mm. x 10 μ project from both upper and lower surfaces in considerable number, forming in places a pretty thick furze. The spicules project obliquely or about radially. A few similar spicules occur scattered in the parenchyma. Others lie tangentially in the dermal membrane.

Microscleres.

4. Spirasters, Figs. 1 *a–e,* Plate **13**; abundant in the dermal membrane, pore membranes, and choanosome; somewhat less abundant in the ectosome; spicules of the several regions not distinguishable.

The smooth spiral axis exhibits in projection one or two concavities on same side. Axis sometimes appears cylindrical, more often is flattened and band-like. Rays are minutely roughened, minutely tylote, numerous and closely set along the axis. Total length of spicule, 30–40 μ; ray length, 12–16 μ.

Forms occur with fewer and longer rays than the typical spicules. In such forms noticeable gaps are left along the axis between the bases of the rays. The rays may become conspicuously few and long, as in the spicule shown in Fig. 1 *e*, Plate **13**, where the ray length is 18–20 μ, and the total length 44 μ.

The spirasters with few rays pass into metasters of an amphiaster character, the spicule bearing a few rays at each end of the axis and one or two rays at about the middle of the axis. Such spicules are infrequent.

The spirasters of this species closely resemble those of *Thenea echinata.*

Thenea pyriformis, sp. nov.

Plate 13, Figs. 5, 8, 10, 11.

Diagnosis. Body pyriform, with a ring of inconspicuous marginal pore areas. On the upper surface, a shallow oscular depression. Under surface bears numerous small conulose eminences, which point downward. Surface in general feebly hispid. *Megascleres:* Dichotriaenes, protriaenes, anatriaenes, oxeas. *Microscleres:* Plesiasters; rays, 40–60 μ x 4–5 μ. Metasters of varying shape; axis in the characteristic forms short and thick; spicule length, 28–30 μ; ray length, 10–12 μ.

Station 3414, 1 specimen.

The body is pyriform in shape (Fig. 5, Plate **13**), but compressed in one of the horizontal axes; 27 mm. high, 23 mm. wide in one horizontal axis and 15 mm. wide in the other. There is an irregular ring of separate pore areas, five in number, nearer the upper larger end of the body, but not all at the same level. The upper surface bears a single wide and very shallow oscular depression (Fig. 8, Plate **13**), which is somewhat excentrically placed. This depression appears as a smooth collenchymatous area, which includes the apertures of several efferent canals, and which is without a special spicular fringe except at one point, where the elsewhere indistinct margin forms a projection from which some spicules extend obliquely 2–4 mm. over the oscular area.

The color is gray. The upper surface is comparatively even, but below the level of the pore areas there are numerous rather vaguely marked conulose eminences pointing downward. The surface in general is feebly hispid with small oxeas, projecting obliquely for the most part about 1 mm., but over the lower part of the sponge the projecting spicules, pointing downward, are more abundant and are longer, reaching commonly a length of 3 to 4 mm. A few compact bundles of spicules, scattered over the lower surface, broken off close to the body, and measuring less than 0.5 mm. in diameter, probably represent rootlets.

The pore areas in general are indistinct, owing in part to the fact that they lack a clearly defined lower boundary, and in part because the margin scarcely differs in color and appearance from the rest of the sponge surface. The upper margin of the areas nevertheless forms a distinct ridge, which in some cases is drawn down so as to project obliquely over the area. There is no spicular fringe. The pore membrane lining the area presents the usual reticular appearance, except where the pores are closed. The pores themselves measure up to 180 μ in diameter.

The body of the sponge is not excavated by large canals, and is accordingly comparatively dense. Flagellated chambers measure about 40 x 30 μ in diameter.

Megascleres.

1. Dichotriaene; rhabdome, straight, tapering evenly, 5 mm. x 80 μ; protocladus, 280 μ x 70 μ, tapering distad very slightly; deuterocladus, 800 μ x 50 μ, tapering evenly and curved outward, then inward in the fashion so common in species of Thenea.

In the neighborhood of the pore areas, the dichotriaenes show the usual modification, the cladomes becoming smaller, the deuterocladi especially short and about straight.

2. Protriaene. Among the modified dichotriaenes round the pore areas a few perfect protriaenes, resembling the spicule shown in Fig. 6, Plate **13**, occur.

3. Anatriaene. Only a single spicule was found. It was a somal anatriaene resembling the smaller radical forms of *Thenea lamelliformis.*

4. Oxea. The very numerous oxeas fall into three classes which intergrade. Types of the three classes measure respectively 8 mm. x 70 μ, 8 mm. x 17 μ, 1.25 mm. x 20 μ.

5. *Oxytylotes* are occasionally met with. Their shape and size indicate that they are derived from the long stout variety of oxea.

Microscleres.

6. *Plesiaster,* Figs. 10 *b,* 10 *d,* Plate **13**. The spicule is very abundant in the parenchyma; rays commonly 4 or 5 in number, 40–60 μ by 4–5 μ, minutely roughened and tapering evenly to points; centrum and neighboring parts of rays smooth. Triactine, diactine, and monactine forms occasionally occur.

Smaller sizes with more numerous rays (Fig. 10 *e,* Plate **13**) occur intermingled with the larger characteristic forms. In these spicules, which offer a transition to the metasters, the rays measure about 20 μ x 2 μ.

7. *Metasters* are abundant in the general dermal membrane and in the pore membranes, and occur scantily in the parenchyma. The rays taper to points and are most minutely roughened, while the axis is smooth. The spicules differ among themselves a good deal, and fall into three groups which intergrade.

a. Typical metasters, Figs. 10 *c,* 10 *f,* 11 *a,* 11 *d,* Plate **13**, are fairly common. The rays may be numerous, as in 11 *a,* or few, as in 11 *d.* Total length of the spicule, 30–38 μ; rays, 12–14 μ x 2 μ.

b. The predominant type of metaster is one in which the axis is very thick and short (Figs. 10 *a,* 11 *c,* 11 *e,* Plate **13**). The rays may be few (Fig. 11 *e*) or many in number (Fig. 11 *c*). Spicule length, 28–30 μ; ray length, 10–12 μ.

c. The axis of the metaster may be greatly shortened, approaching the condition of a centrum (Figs. 11 *b,* 11 *f,* 11 *g*). Such spicules may be designated metaster-oxyasters. The ray length is about 8 μ.

Vosmaer (1902, p. 3) argues against the existence of transitional forms between spirasters and true asters (euasters). It seems to me nevertheless that the spicules here described may properly be considered as transitional forms between metasters and oxyasters, even if (this appeared not to be the case) such images as are represented in Figs. 11 *f* and 11 *g* are only *end-views* of spicules like 11 *b.*

d. The metaster is, rarely, found varying toward the amphiaster, as in Fig. 10 *g,* Plate **13**. The spicule may conveniently be designated metaster-amphiaster. It has a few rays at each end, and one or two rays on the axis. Spicule length, about 40 μ; ray length, about 18 μ.

Poecillastra Sollas.

1888. *Poecillastra* Sollas, 1888, p. 79.
1894. *Poecillastra* Sollas, Topsent, 1894, p. 383.
1894. *Pachastrella pars* Lendenfeld, 1894, p. 94.
1902. *Poecillastra* Sollas, Topsent, 1902, p. 10.
1903. *Pachastrella* (*Pachastrella*) O. Schm. *pars* + *Pachastrella* (*Nethea*) *pars* + *Sphinctrella* O. Schm. *pars* Lendenfeld, 1903, pp. 70, 73, 78.

Poecillastra tricornis, sp. nov.

Plate 13, Figs. 12–14; Plate 14, Figs. 1–8.

Diagnosis. Body plate-like. One surface somewhat convex, and bearing the pores. Opposite surface somewhat concave, and bearing the oscula. Main afferent and efferent canals similar; numerous and small; radial to corresponding surface; of the uniporal type, the aperture of the canal (pore or osculum) lying in the centre of a circular membranous area, and provided with a strong chone-like sphincter. *Megascleres.* Oxea. Triaene, with degenerate rhabdome (triod), chiefly ectosomal, but also in the interior. *Microscleres.* Microxea, annulated, 400–500 μ long. Microxea, nearly smooth, 120 μ long. Spiraster, dermal; spicule length, 20 μ; rays, 2–3 μ long. Metaster and spiraster, parenchymal; intergrading and very similar; spicule length, 20–26 μ; rays, 7–8 μ long.

Station 3404, one large specimen and two fragments.

The larger specimen is a plate 100 mm. wide, and in general 5 mm. thick, Fig. 8, Plate **14**. The free edge of the sponge describes about a semicircle. Along the remaining part of its periphery the plate has been broken across, probably not far from the line of attachment. In this region the plate is thicker than elsewhere, attaining a thickness of 10 mm. The plate is not quite flat, but is slightly folded, so as to produce wide, shallow depressions on both surfaces. One surface, designated the oscular surface, is throughout the peripheral region slightly concave, meeting the free margin of the sponge along a sharp boundary line. The opposite surface, designated the pore surface, is throughout the peripheral region slightly convex, and is evenly rounded off at the margin.

The color is whitish-brown, the consistency firm, the surface almost hard. Both surfaces of the sponge are smooth, save for a few scattered oxeas, which project radially or obliquely 2 to 20 mm. On both surfaces, beneath the dermal membrane, the tangentially placed spicules supporting it are partially visible.

The two surfaces of the sponge are much alike, both exhibiting, scattered evenly over the whole face, circular shallow depressions, each of which is lined by a smooth membrane pierced in the centre by a single aperture of varying diameter. The depressions on the oscular face (Figs. 6 and 8, Plate **14**) are 500–700 μ in diameter, and 1.0 to 1.5 mm. apart. The depressions on the pore face (Fig. 5, Plate **14**) are somewhat larger and farther apart than on the oscular face, measuring commonly 700–900 μ in diameter, and lying about 2 to 3 mm. apart, but are not so deep, being in places exceedingly shallow. The membranes lining the depressions on the oscular face are the oscular membranes, the apertures themselves, which are in various stages of contraction, representing the oscula. The membranes lining the depressions on the opposite face are the pore membranes, the apertures, which are likewise in various stages of contraction, representing the pores.

The main afferent and efferent canals are essentially alike. They have a diameter of 500–700 μ, and pass about vertically into the interior from the corresponding surfaces, on which each is covered in by a pore or oscular membrane respectively. Sections vertical to the oscular surface of the sponge, and passing longitudinally through the efferent canals, are shown in Figs. 3 and 7, Plate **14**. A section vertical to the pore surface, and passing through an afferent canal, is shown in Fig. 4, Plate **14**. A part of the oscular surface, showing three oscular membranes, is represented in Fig. 6, Plate **14**, and a part of the pore surface, including a pore area, in Fig. 5, Plate **14**.

The walls of the main afferent and efferent canals are collenchymatous, and exhibit numerous transverse circular ridges. These often project, especially in the neighborhood of the sponge surfaces, a considerable distance into the lumen of the canal, appearing as septa perforated by round apertures. Similar incomplete septa often separate the lateral branches from the main canal. The aperture in the septum may sometimes be very small, as shown in the lower half of Fig. 4, Plate **14**. In the neighborhood of such small apertures débris consisting largely of shells of Foraminifera is sometimes found collected. It may well be asked how heavy bodies of this kind are moved through sponge canals. The appearance of the internal septa suggests that in them as in the surface membranes the apertures may be closed and opened. Possibly the apertures open suddenly, and the contents are passed on from one chamber into another, either as a result of an existing difference of pressure on the two sides of the septum, or as a result brought about by simultaneous contraction of the canal wall.

The oscular membranes are distinctly outlined. They contain spirasters, and are without or with only a few scattered microxeas, while the dermal membrane in general is densely filled with microxeas. The majority of the oscula are closed or nearly closed, the membranes exhibiting near the centre a rounded patch which appears dark with transmitted light, and which sometimes includes a minute aperture (Fig. 6, Plate **14**). In radial sections through closed canals (Fig. 7, Plate **14**) it is seen that the oscular membrane is produced inward into a plug-like process which is marked by a dense axial streak of spirasters. The plug of course corresponds to the dark patch in the surface view of the membrane. The appearances indicate that the oscula are provided with strong sphincters, the contraction of which closes the osculum and produces the plug-like projection.——The pore membranes and pores (Figs. 4, 5, Plate **14**) are essentially like the oscular membranes and oscula.

Collenchyma is abundant throughout the sponge, and contains many granular cells with fine processes. It is, moreover, transversed by abundant fine fibres, which branch and anastomose (Fig. 1, Plate **14**).

The ectosome is collenchymatous, and distinctly developed, although it varies in thickness. Measured between the vertical canals, it is 350–400 μ thick at the pore surface, 510 μ thick at the periphery of the sponge 800 μ to 1.0 mm. thick at the oscular surface.

The flagellated chambers are eurypylous and about 50 μ wide. The chambers (Fig. 1, Plate **14**) show the peculiar structure known as Sollas's membrane, described by Sollas (1888, pp. xxxvi–xxxvii) and Dendy (1888, pp. 18–21). The fenestrae in the membrane have for the most part sharp boundaries. Through some of them the nuclei and protoplasmic masses on the boundary membrane of the chamber may be seen. The collar cells are not well preserved, but fine strands may be traced running from the boundary membrane to Sollas's membrane. The distance between the boundary membrane and Sollas's membrane varies considerably, and possibly when the distance is great the two membranes are not in their natural positions.

Megascleres.

1. Oxea. a. Smooth, slightly curved, or bent spicule, tapering at each end, 2.5 mm. x 85 μ to 5 mm. x 135 μ. Spicule is abundantly scattered through the parenchyma; also abundant just beneath the dermal membrane on both oscular and pore faces, here lying tangentially and together with the tangential rays of the triaenes supporting the dermal membrane.

b. Larger oxeas of the same character as above, reaching 25 mm. in length, project in rather small number from both surfaces.

c. Rhaphid oxea, smooth, cylindrical, 3–5 mm. x 12 μ; not very abundant; disposed without order in the interior, often but not always in bundles of two or three.

2. Triaene. Rhabdome, except in rare cases, reduced to a rounded knob (Fig. 13, Plate **13**), the spicule becoming a triod; exceptionally appearing as an elongated pointed ray, shorter than, or about the length of, the cladi. Cladi 1.0 mm. to 700 μ long, smooth, tapering to a point, and curving slightly in the direction of the reduced ray. The three cladi are usually but not always of about the same length, and are frequently slightly twisted or deformed.

The triaenes are very abundant just internal to the dermal membrane at both surfaces; here arranged in several layers (about three), with the cladi tangential to the surface. The cladi of adjoining spicules overlap, and together with the tangentially placed oxeas, they establish a hypodermal framework.—— The same triaene is also scattered sparsely through the interior along with the internal oxeas, becoming fairly abundant near the margin of the sponge body. In the interior the cladi are not arranged tangentially to the surface, but at various angles.

Microscleres.

3. Annulated microxea, Fig. 12, Plate **13**. Spicule, 400–500 μ x 8–16 μ, curved, and tapering at each end. Surface covered with minute annular ridges, which give the impression of being parts of a discontinuous spiral ridge. At the ends, the ridges give place to a mere granulation of the surface. Very abundant in the hypodermal region at both surfaces, and here for the most part tangentially placed. Fairly abundant in the interior, and here disposed without order.

4. Microxea, Fig. 14, Plate **13**. Spicule commonly about 120 μ long, slightly curved, tapering at each end. Surface nearly but not quite smooth, most minutely roughened. Abundant in the interior and in the hypodermal region. Possibly only a young form of the annulated oxea.

5. Spirasters of dermal membrane, Fig. 2 *a*, Plate **14**. Spicule length, 20 μ; rays, 2–3 μ long, numerous, blunt-pointed. Whole spicule smooth.

Spiral axis shows in projection two or three concavities on the same side. Very abundant in the dermal membrane of both surfaces.

6. *Metasters* of parenchyma, Fig. 2 *c*, Plate **14**. Spicule length, 20 μ; rays, 7 μ, tapering to points, pretty closely set along the curved axis. Whole spicule smooth. Abundant throughout the parenchyma. Spicules pass through transitional forms into the very similar spirasters of the parenchyma.

7. *Spirasters* of parenchyma, Figs. 2 *b*, 2 *d*, Plate **14**. Spicule length, 24–26 μ; ray length, 8 μ. Spicule resembles the metaster, with which it intergrades, but both axis and rays are longer, and the rays less closely set along the axis. Abundant in the parenchyma.

Poecillastra cribraria, sp. nov.

Plate 14, Figs. 9-12; Plate 15, Figs. 1-4; Plate 16, Figs 1, 3.

Diagnosis. Body plate-like. One surface slightly convex and bearing the pores. Opposite surface slightly concave and bearing the oscula. Main afferent and efferent canals similar; numerous and small; radial to the corresponding surface. Pores thickly and uniformly scattered; appearing to the eye to be localized in areas. Oscula, 70–200 μ in diameter, occurring singly or in small groups as perforations of the membrane roofing in a main canal. *Megascleres.* Oxea. Triaene, ectosomal, and with a rhabdome shorter than the cladi. *Microscleres.* Microxea, 180 μ long, surface minutely roughened. Spiraster, dermal; spicule length, 16 μ; rays, 2–3 μ long. Plesiaster and plesiaster-metaster, parenchymal; spicule length, 24 μ; rays, 12 μ long.

Station 3405, 1 specimen.

The specimen, Fig. 3, Plate **16**, is a fragment from the peripheral part of a plate-like sponge. The pore surface is slightly convex, and is evenly rounded off at the free margin of the sponge. The oscular surface is slightly concave, and meets the free margin along a sharp line. The two nearly straight edges in the specimen are broken edges, the curved edge representing the natural margin of the sponge. The fragment measures 40 x 25 mm., and is 5 to 9 mm. thick. The color is light brown. The sponge is firm but not hard, with both surfaces smooth though not strictly even.

The main afferent and efferent canals are very similar. They pass radially into the body from the corresponding surfaces, are 1.5 to 2.0 mm. apart, and have a diameter of 600 μ to 1.0 mm. Beneath the dermal membrane on both surfaces, between the larger canals, are everywhere abundant smaller spaces.

The entire dermal membrane of the pore surface (Fig. 4, Plate **15**) is riddled with the fairly evenly distributed pores, which have a diameter of about 75 μ. But the pores immediately over the ends of the larger canals form areas conspicuous to the eye, and thus, when the whole sponge is examined from the surface, the pores appear to have a localized distribution in small rounded or irregularly shaped areas.—— Some of the main afferent canals are formed by the confluence of small, elongated, tubular subdermal spaces.

On the oscular surface (Fig. 3, Plate **15**; Fig. 3, Plate **16**), the efferent canals are closed in by oscular membranes, which are commonly perforated by groups of small oscula up to about 10 in number. The groups are of irregular shape, and vaguely outlined, although conspicuous to the eye. With a lens it may be seen that many of them are branched, the arrangement indicating that the efferent canals themselves sometimes extend out beneath the surface in tangentially spreading branches. In the case of other canals the oscular membranes roofing them in are perforated by single similar apertures or by small groups of two and three. The individual oscula, whether arranged singly or in groups, have a diameter of 70 to 200 μ.

The oscular membranes are very thin, and in the immediate neighborhood of the apertures contain only spirasters and sparsely scattered microxeas. Between the apertures of a group the microxeas are more abundant, and occasionally a megasclere extends into or through the membrane of an oscular area.—— Between the separate oscula or groups of oscula which are visible to the eye, the dermal membrane, Fig. 3, Plate **15**, is studded with thin rounded areas 50–75 μ in diameter, representing the roofs of small spaces everywhere present beneath the membrane. These thin areas contain spirasters and sparse microxeas, and are frequently perforated. Thus the plan of the canal apertures on the oscular face is much like that on the pore face.

The choanosome, which looks rather dense to the eye, is permeated by abundant small canals, which reduce it to thin trabeculae. Collenchyma is scanty. The ectosome is thin and feebly marked; differentiated from the choanosome only by its pores and skeleton, and by the absence of flagellated chambers.

The choanosome contains an abundance of deeply staining cells similar to those described by Sollas (1888, p. 81) for *Poecillastra schulzei*. The cell body (Fig. 1, Plate **15**; Fig. 1, Plate **16**), which is spheroidal, oval, or rounded polygonal is about 20 μ in diameter, and is filled with closely packed spheres 3–4 μ in diameter. A nucleus can sometimes be made out. The cells are identical with some of the "cellules sphéruleuses" described by Topsent (1894, p. 284; Fig. 18 *s*, Plate XVI.).

The flagellated chambers (Fig. 1, Plate **16**) are eurypylous, opening by wide apertures into the efferent canals. The basal membrane on which the collar cells rest is perforated by several chamber pores, which place the set of spaces lying between the collar cells in communication with an afferent canal (Fig. 1, Plate **16**). The basal membrane in surface view (Fig. 2, Plate **15**) appears as a thin, finely granular membrane, which shows no cell boundaries. On it rest the cell bodies of the collar cells, appearing as angular masses each enclosing its nucleus.——The preservation is good, and the chambers show Sollas's membrane. This membrane (Fig. 1, Plate **16**) is distinctly fenestrated, and has an appearance suggesting a firm, dense structure. The collar cells appear as shown in the figure. The expanded lower part of the cell is granular, and contains the nucleus. Above, it is prolonged into a transparent homogeneous process, which at first is double-contoured, then for a short distance single-contoured, expanding and becoming double-contoured again where it passes into Sollas's membrane. In the case of some cells it may be seen that this process (doubtless the collapsed collar) passes into Sollas's membrane in such a way as to bound one of the fenestrae. I am thus able to confirm Sollas's observations (1888, pp. xxxvi–xxxvii), and may add that while the appearance of the chambers may not be entirely normal, it seems improbable that Sollas's membrane is an artefact.

The chambers vary a good deal in size, but are often 40–50 μ wide; frequently strongly flattened, the actual cavity of the chamber becoming shallow. The wall of the chamber, from the basal membrane to Sollas's membrane, is noticeably thick.

Megascleres.

1. Oxea. *a.* Fairly stout form, about 2.5 mm. x 40 μ; smooth, tapering at each end; commonly slightly curved or bent at the middle, sometimes nearly straight. Abundant in choanosome; here scattered in all directions, usually singly, but also in loose tracts of two or three. In the superficial region many oxeas are arranged radially or obliquely, often projecting slightly (Fig. 1, Plate **15**). Tangentially placed oxeas occur in considerable number beneath the dermal membrane of the oscular surface, and in small number beneath that of the pore surface.

b. Rhaphid form, about 3.5 mm. x 10 μ; smooth, nearly cylindrical, though tapering at the ends; slightly curved. Much less abundant than the stouter form, with which the spicule occurs intermingled.

2. Triaene, Fig. 10, Plate **14**. Rhabdome about 200 μ x 30 μ, straight, smooth, pointed. Cladi about 380 μ x 30 μ, slightly arched outward, smooth, tapering to points. Lying in the ectosome, the cladi extending tangentially beneath the dermal membrane. The spicules are only sparsely present at the pore surface; more abundant at the oscular surface, in places quite abundant, although forming only a single layer; most abundant round the free edge of the sponge, where the cladi may form in spots two or three layers.——Triaenes (Fig. 9, Plate **14**) are occasionally found in which one or two of the cladi are forked (imperfect dichotriaenes). Or one of the cladi is bent as if only one of the deuterocladi had developed. Such a spicule is shown in Fig. 3, Plate **15**.——In a large number of preparations, I found only a single triaene, and that, like those at the surface, in the interior of the sponge.

Microscleres.

3. Microxea, Fig. 11, Plate **14**. Spicule about 180 μ x 4 μ, slightly curved and tapering gradually toward each end; surface minutely roughened. The spicule may be symmetrically curved, or the curvature may be slightly irregular. Exceedingly abundant in the ectosome, and here chiefly tangential; also very abundant in the trabeculae of the choanosome.

4. Spiraster, Fig. 12 *a,* Plate **14**. Spiral axis showing in projection two or three concavities on the same side. Spicule length, 16 μ; rays, 2–3 μ and tapering to sharp points. Very abundant in the dermal membrane of both surfaces.

5. Plesiaster (Fig. 12 *b,* Plate **14**) and *plesiaster-metaster* (Figs. 12 *c,* 12 *d,* Plate **14**). Spicule length, 24 μ; rays straight, smooth, slender, tapering to points, 12 μ long. Axis smooth and short. The forms in which the axis bears only rays at the ends are designated plesiasters; number of rays commonly 5. When the axis bears rays at its ends, and one or two along its course, the spicule is designated a plesiaster-metaster; number of rays commonly 6–7. The two varieties are intermingled, and are abundant though not crowded throughout the choanosome.

Now and then spicules are found with shorter and more numerous rays and longer axis, the spicule representing a fairly typical metaster. In a representative spicule of this kind the axis was strongly curved; the rays, nine in number, 6–8 μ long.

Poecillastra cribraria stands close to *P. schulzei*, Sollas (1888, p. 79), the type specimens of which I have examined. The arrangement of pores and oscula is very similar in the two forms.

Note. The genus *Poecillastra* was created by Sollas (1888, p. 79) for certain plate-like sponges collected by the "Challenger." The preservation of these sponges was so good that Sollas was able to study their anatomy, and in consequence to define his genus in an unusually satisfactory manner. The characteristics of the new forms (*P. schulzei, P. crassiuscula, P. laminaris, P. tenuilaminaris*) were the following: The body is plate-like. On one surface are the pores, either evenly distributed or in closely set areas. On the other surface are the oscula, small and evenly dispersed. The main afferent and efferent canals are small, very numerous, and their openings are thickly distributed over the corresponding surfaces· Specialized pore areas, as in *Thenea*, and specialized oscular areas, as in *Sphinctrella*, are not present. The flagellated chambers are eurypylous. The megascleres are oxeas and tetraxons, the latter represented by orthotriaenes and calthrops, the two forms being very similar. The triaenes are localized at the surface, the calthrops scattered through the interior. *Both triaenes and calthrops may be "comparatively rare"* (*P. crassiuscula*). In the triaenes and calthrops the actines may be *"frequently rounded off into short rods or tubercles"* (*P. tenuilaminaris*). The microscleres are microxeas, spirasters, and metasters varying to plesiasters.

The similarity of the two species described in this report to the four "Challenger" species of *Poecillastra* is very close, and it is obviously necessary to include them in the same genus, if we take into consideration the entire structure. In respect to a *single* point, viz. the degeneration of the rhabdome, *Poecillastra tricornis* resembles the sponges grouped by Sollas (1888) and Topsent (1902) under *Nethea.* This genus has been a very doubtful one. Sollas (1888) erected it for *Nethea* (*Tisiphonia*) *nana* Carter (1880). Topsent (1902) adds to it *Nethea* (*Pachastrella*) *amygdaloides* Carter (1876) and *Nethea* (*Pachastrella*) *connectens* O. Schm. 1870. In all three sponges the canal system is unknown, and in the last the skeleton is imperfectly known. It is possible therefore that the group is heterogeneous. The new definition given by Topsent (1902, pp. 10–11), however, strengthens the genus, which may be a useful one. Topsent characterizes it as having but one sort of streptaster, and that a spiraster, which definition excludes my form. Lendenfeld (1903) retains *Nethea* Sollas as a subgenus of *Pachastrella,* a genus which, as conceived by Lendenfeld, is heterogeneous, including as it does forms with eurypylous (*Poecillastra* Sollas) and forms with aphodal (*Pachastrella abyssi* Schm., Sollas, 1888, Plate XI.) chambers. According to Lendenfeld's classification my species, *Poecillastra tricornis,* owing to the degeneration of the tetraxon rhabdome, would be separated from the above-mentioned "Challenger" species of *Poecillastra,* and would be classed along with the certainly very different *Nethea nana* Carter. I cannot but regard this part of Lendenfeld's classification as artificial.

In the absence of tetraxons from the interior, *Poecillastra cribraria* agrees with *Characella* Sollas. But this is a negative point of resemblance, which cannot be used to exclude the species from *Poecillastra,* since the tetraxons are rare in one of the type species of the latter genus. If *Characella* Sollas is maintained at all, it must be based, as Topsent (1902) points out, on some other and positive characters. In Topsent's classification, the microscleres especially are made use of for this purpose, and *Characella* is re-defined as having microxeas and amphiasters, which effectually excludes my species.

In re-defining *Poecillastra,* Topsent (1902, p. 10) has altered the original diagnosis of Sollas so as to make the genus include forms in which the calthrops are absent from the interior: "Triaenes inégalement développés suivant les espèces, souvent rares, localisés à la périphérie *ou épars en outre à l'intérieur* où ils simulent des calthropses." I would adopt this emendation. The existence of *Poecillastra tricornis* makes it necessary to add to the definition the following clause: An actine of the tetraxon may degenerate, the spicule becoming characteristically in some species a triod. This qualification is really implied in Sollas's definition, since he includes under *Poecillastra, P.* (*Pachastrella*) *amygdaloides* Carter, the tetraxon of which is a triod.——Topsent's definition includes a clause which must be modified: "Des microxes *épineux* par tout le corps." The microxeas are "roughened or minutely spined or smooth" in one of the type species, "roughened" in another, and apparently smooth in the others, since a spinous surface is not mentioned.

STELLETIDAE Sollas.

Penares Gray.

1867. *Penares* Gray, 1867, p. 542.
1888. *Papyrula* O. Schm., Sollas, 1888, p. 198.
1891. *Penares* Gray, Vosmaer, 1891.
1894. *Ecionema pars* Lendenfeld, 1894, p. 97.
1894. *Penares* Gray, Topsent, 1894, p. 356.
1900. *Penares* Gray, Thiele, 1900, p. 21.
1903. *Ancorina* O. Schm. subgen. *Penares* Gray + *Papyrula* O. Schm., Lendenfeld, 1903, pp. 60, 69.

Penares foliaformis, sp. nov.

Plate 15, Figs. 5-11.

Diagnosis. Entire body probably massive, with curved surface. Oscula? Cladomes of the dichotriaenes divide the surface into pore areas, about 0.75 mm. in diameter. In each pore area usually a single pore, opening into a short radial pore canal, which connects with a subspheroidal subdermal chamber. Flagellated chambers aphodal. Ectosome collenchymatous, and containing many fibre cells arranged tangentially. *Megascleres.* Dichotriaenes, varying toward triaene condition, with flattened, irregular, leaf-like cladomes, form a single layer at the surface. Oxeas, singly and in loose sheaves, in parenchyma; for the most part more or less radially arranged. *Microscleres.* Microrhabds of oxeate character, but with rounded ends, 160 x 8 μ to 60 x 5 μ; very abundant in the superficial layer of the ectosome. Oxyasters, 16–24 μ in diameter, in canal wall and intervening parenchyma.

Station 3404, 1 specimen.

The single specimen is a small, well-preserved fragment (Fig. 7, Plate **15**), including the surface and part of the interior. The surface has a spheroidal curvature, and the fragment a greatest thickness of 9 mm. The surface is hard, stony, and whitish-brown; the interior dense, firm, and slightly darker in color. The piece includes no oscula, and the shape of the entire sponge is problematical, although probably massive, with curved surface.

To the eye, or with a lens, the surface appears divided into minute polygonal areas about 0.75 mm. in diameter. These are the pore areas, which have a whitish appearance in the alcoholic specimen. They are separated by narrow, darker-looking bands, which represent the reticulum formed by the tangential rays of the dichotriaenes. Minute dark points are visible scattered in the dark bands, and less distinctly in the whitish areas. In the former they represent the points of union between the rhabdome and cladome of the triaenes. In the latter place they are actual apertures, the pores.

In each of the dermal areas embraced by the cladomes of the dichotriaenes there is usually a single pore (Fig. 11, Plate **15**). A few areas are without pores, and here and there a large area containing two or three pores occurs. The pores open into radial pore or ectosomal canals. These are uniporal, and open without chone-like constrictions into subdermal chambers (Fig. 9, Plate **15**), which again open without chone-like constrictions into narrow canals passing into the interior. The subdermal chambers are numerous, subspheroidal, connect with one, or sometimes two pore canals, and lie in the zone where the ectosome passes into the choanosome.

There is no highly specialized cortical fibrous layer, but there is an ectosome devoid of flagellated chambers, and about 200–500 μ thick. It consists of collenchyma, containing very numerous cells, which have a granular body and slender processes. In sections radial to the surface of the sponge, the cells appear spindle-shaped; the processes long, delicate, and fibre-like, frequently extending parallel to the surface. Such tangentially extending fibre-cells are sufficiently abundant throughout the ectosome to imprint a fibrous character upon it. In the immediate neighborhood of the subdermal spaces the fibre-cells are pretty thickly packed, and extend tangentially to the wall of the space.

The ectosome exhibits, in radial sections, small canals here and there, some of which are cut lengthwise, others obliquely, or transversely. "Bläschen," such as are present in *Penares* (*Ecionema*) *helleri* (Lendenfeld, 1894, p. 39), are not present. The ground substance of the ectosomal collenchyma consists chiefly of a homogeneous material, which includes some of the fine granules so abundant in the choanosome. The granules often show an arrangement in vaguely marked groups.

The mesenchyme of the choanosome is dense, although everywhere excavated by small canals and flagellated chambers. The ground substance consists of a homogeneous matrix strewn with fine granules. The granules are angular, less than 1 μ in diameter, and show with an immersion a highly refractive dot in the centre. They are in general very abundant; but are by no means evenly distributed, and tracts of comparatively clear matrix occur commonly. Cells with pseudopodia, and occasionally rounded egg cells (Fig. 5, Plate **15**) with large nucleus are found imbedded in the ground substance. The egg cells are surrounded by a fibrous layer, outside of which is a layer of ground substance, which contains but few granules. A similar clear layer lies round all cells.

Each flagellated chamber is provided with a special afferent as well as with a special efferent canaliculus (Fig. 5, Plate **15**). The two canaliculi are of about the same size. On focussing, it may be seen that the posterior wall of the chamber (boundary membrane) is perforated, the cavity of the afferent canaliculus thus connecting with the set of spaces lying between the collar cells. The chambers are 30–40 μ wide, and if the immediately adjoining part of the efferent canaliculus be included, are pear-shaped.

The chambers (Fig. 5, Plate **15**) have a distinctly developed Sollas's membrane, which is not very deeply concave. The collar cells, here as in *Poecillastra*, are surprisingly few. They are often broken across, one end clinging to the boundary membrane and one to Sollas's membrane. They are frequently unbroken, however, and especially good ones may be found in which the whole cell is doubly contoured, the lower half with the nucleus granular, the upper part clear and expanding so as to embrace a fenestra of Sollas's membrane.

Megascleres.

1. Dichotriaene, Figs. 9, 11, Plate **15**. Rhabdome smooth, tapering to point, 900 μ x 140 μ. Cladi flattened parallel to surface of the sponge; smooth, broad, leaf-like, and irregular. Frequently one of a pair of deuterocladi is reduced to a rounded protuberance. Less commonly one or two of the protocladi may show no sign of bifurcation. Axial canals distinct. Radius of cladome, from centre to apex of cladus, 700 μ; protocladus, 190 μ wide.

The spicules form a single layer at the surface of the sponge, cladomes tangential and supporting the dermal membrane. The cladomes overlap to some extent and frequently interlock, and in general are so connected together as to form a continuous dermal framework. The spicule approaches the shape of the lithistid phyllotriaene, *e. g.* in *Discodermia* (Sollas, 1888, Plate XXXII.).

2. Oxea. Spicule smooth, tapering sufficiently to appear fusiform; slightly curved or sometimes about straight. A characteristic size 2300 μ x 70 μ.——Present in parenchyma, singly, or more commonly in loose sheaves of 2 or 3 to about 6 spicules. For the most part arranged more or less radially, often very obliquely to the surface, and in general not extending into the most superficial region, but stopping about where the rhabdomes of the triaenes begin. In some cases they accompany the triaene rhabdomes. The sheaves and single spicules are abundant, but not at all crowded.

Microscleres.

3. Microrhabd, Fig. 8 *a–d,* Plate **15**. Spicule symmetrically curved, or irregularly bent, sometimes nearly straight. Swollen in middle region, tapering toward ends, which are not pointed but rounded. Exceptionally a spicule, one of the smaller sizes, with pointed ends is found. A faint annular ridge is frequently, but by no means always, visible in middle of the spicule; ridge occasionally well developed. Abnormal spicules with small lateral outgrowths near one end are of rather frequent occurrence. Size, 160 μ x 8 μ to 60 μ x 5 μ.

The spicule is thickly strewn in the superficial layer of the ectosome, lying in the dermal membrane over the triaene cladomes as well as in the pore areas. The spicule is also scattered in small number throughout the ectosome and superficial part of choanosome (Fig. 9, Plate **15**).

4. Oxyaster, Fig. 10 *a–c,* Plate **15**. Rays smooth, slender, conical, about equal in size. Centrum small, but usually perceptible. When the number of rays is large, they appear rather uniformly distributed around the centrum. When they are less in number, it is easy to see that they are not symmetrically distributed. The number of rays commonly varies from about 10 to 20, the spicules with fewer rays being the larger. Diameter of spicule, 16–24 μ; centrum, 2–3 μ in diameter.——Spicule present in some abundance in the walls of the canals, and rather sparsely scattered throughout the parenchyma.

5. Calthrops, Fig. 9, Plate **15**. Rays about equal, 100–170 μ long, smooth, tapering evenly from base to point. Such spicules are present in small number, scattered in superficial part of choanosome. Possibly they represent young stages of the triaenes. As is often the case with the triaenes, the axial canal is abnormally wide, and is open at the ends of the rays.

Under the name of *Stelletta pygmaeorum* O. Schmidt (1880, p. 70, Taf. IX, Fig. 9 *a, b, c*) has described a sponge from St. Vincent, 95 fathoms. Sollas (1888, p. 203) assigns the species, with a query, to *Ecionema* Bwk. Lendenfeld (1903, p. 67) records it among *species dubiae.* Schmidt's description, short as it is, indicates that the skeletal elements are very similar to those of the species here described.

MONAXONIDA Ridley and Dendy.

HADROMERINA Topsent.

POLYMASTIDAE Topsent (1898).

Polymastia Bowerbank.

1864.	*Polymastia*	Bowerbank, 1864, p. 177.	
1887.	*Polymastia*	Bwk., Vosmaer, 1887, p. 328.	
1887.	"	"	Ridley and Dendy, 1887, p. 210.
1896.	"	"	Lendenfeld, 1896, p. 222.
1896.	"	"	Dendy, 1896, p. 249.
1898.	"	"	Topsent, 1898, p. 101.
1900.	"	"	Topsent, 1900, p. 131.

Polymastia maeandria, sp. nov.

Plate 16, Figs. 2, 4-6; Plate 21, Fig. 1.

Diagnosis. Subspheroidal, firm, very light brown in color. Papillae in general low, rounded, wart-like; oscular papillae longer. Entire surface appears smooth, although covered with closely set bouquets of small tylostyles, 280 μ x 12 μ to 124 μ x 5 μ. Superficial covering of projecting tylostyles interrupted by bare pore areas of irregular shape, frequently long and meandering. Cortical layer of large spicules, 500 μ thick; not separated by a fibrous layer from the tylostyli of the surface bouquets; spicules of the layer for the most part tangential; chief spicule a fusiform tylostyle 850 μ x 38 μ to 765 μ x 32 μ. Skeletal bundles radiate from the interior to the surface; chief spicule, a fusiform style 1580 μ x 36 μ to 1020 μ x 28 μ.

Station 3405, one specimen.

Sponge body (Fig. 2, Plate **16**) is subspheroidal, about 20 mm. in diameter, attached by its under surface. In the neighborhood of the lower margin the surface is without mammillary protuberances. Elsewhere wart-like protuberances, not bearing oscula, are scattered over the surface at intervals of about 2 mm. Some are high enough to be hemispheroidal, others much lower; the width commonly about 2 mm., although ranging from 1 to 3 mm. In addition, the upper surface bears near the centre three oscular papillae, each with a terminal osculum which is nearly closed. The papillae are hollow, conical, with rounded tips, 2 to 3 mm. high, and about 3 mm. wide at the base. The thickness of the wall of the papilla exceeds the diameter of the included canal.

The whole surface, including the mammillary protuberances and oscular papillae, is quite smooth to the eye and the touch. The color is a very light brown, the surface lightest near the lower margin. The superficial stratum or cortex is about 700 μ thick, very dense and firm, lighter in color than the interior.

The pore areas (Fig. 1, Plate **21**) are free of spicules; irregular in shape; many long, narrow, and meandering; others rounded. Pores themselves not discernible in surface view, probably closed. Immediately below the dermal membrane of the pore area may be seen, on focussing, the rounded optical sections of small pore canals 20–30 μ in diameter. In radial sections there may be seen in the cortex numerous branching canals. These connect with the narrow pore canals, which extend outward in a more or less radial direction toward the surface. The cortical canals are especially conspicuous beneath the mammillary protuberances (Fig. 6, Plate **16**), where they communicate with the canals of the interior through narrow apertures, each of which perforates a protuberance which projects into the cavity of the internal canal (Fig. 6, Plate **16**). Very probably the protuberance is produced by the contraction of a sphincter guarding the aperture, the apparatus being chone-like.

The cortex or ectosome is collenchymatous. No flagellated chambers were observed in it. In the remainder of the sponge (choanosome) the chambers are thickly packed; mesenchyme of the choanosome, collenchymatous. The flagellated chambers are longer than wide, about 32 μ in transverse section. The collar cells are long and slender; the transparent collar longer than the opaque basal part of the cell; total length of the cell, including the collar, about 10 μ. Very frequently the central ends of the collars are connected in an irregular fashion, as if artificially glued together.

Spicules.

1. Style, Fig. 5 *b*, Plate **16**; smooth, straight, tapering toward both ends so as to be fusiform; pointed end sharp and slender; basal end simply rounded off without enlargement. Size, 1580 μ x 36 μ to 1020 μ x 28 μ. Abundant.

2. Tylostyle, Fig. 5*a*, Plate **16**; smooth, straight, stouter than the style; fusiform and sharp-pointed; basal end tapering more than the pointed end and capped with a distinct rounded head. Size, 850 μ x 38 μ to 765 μ x 32 μ. Abundant.

3. Tylostyle, Fig. 5 *c*, Plate **16**; similar in shape to the large tylostyle, with which it is connected through intermediate sizes. Size, 280 μ x 12 μ to 124 μ x 5 μ. Abundant.

Skeletal Arrangement.

The surface of the body, exclusive of the oscular papillae, is densely covered with the small tylostyles (spicule 3), which project about 80 μ. The spicules are arranged in diverging tufts ("bouquets" of Topsent), but the bouquets are so densely set that this arrangement is not obvious in surface view (Fig. 1, Plate **21**). The spicules project obliquely over the pore areas, and tend to obscure the boundaries of these areas (Fig. 1, Plate **21**).

The cortex beneath the layer of surface bouquets is filled with a felt-work of spicules, Fig. 6, Plate **16**, chiefly the large tylostyles (spicule 2). This cortical layer is about 500 μ thick, and the greater part of the spicules forming it lie more or less tangentially.

From the interior, near the centre of the attached surface, stout skeletal bundles radiate toward the surface, Fig. 6, Plate **16**. A typical bundle, midway in its course, measures 400 μ in thickness. The chief spicule in the radial bundles is the style (spicule 1). At the outer end of the bundle where it passes into the layer of surface bouquets, the constituent spicules of the bundle, which are arranged lengthwise in it, diverge somewhat.—— In the choanosome between the radiating bundles are some scattered larger spicules, and a considerable number of the small tylostyles.

The outer surface of the oscular papillae (Fig. 4, Plate **16**), like the general surface, is densely covered with the small tylostyles, which here project about 160 μ; spicules arranged in closely set bouquets. The inner, cloacal surface of the papillae is armed with a sparse layer of small tylostyles, which project radially or obliquely for a short distance into the cloacal cavity. Stout bundles of large spicules ascend vertically in the wall, lying about in its middle. A compact cortical layer of spicules, such as occurs elsewhere in the body, is absent, although large tylostyles are scattered in various positions through the papillar wall.

HALICHONDRINA Vosmaer.

HAPLOSCLERIDAE Topsent.

Petrosia Vosmaer.

1887. *Petrosia* Vosmaer, 1887, p. 338.
1887. " Vosmaer, Ridley & Dendy, 1887, p. 9.
1894. " " Topsent, 1894 *a*, p. 8.
1902. " " Lundbeck, 1902, p. 54.

Petrosia variabilis (Ridley).

1884. *Schmidtia variabilis* Ridley, 1884, p. 415, Pls. XXXIX., XLI.
1887. *Petrosia variabilis* Ridley var., Ridley & Dendy, 1887, p. 13, Pl. II., Fig. 12.
1892. *Petrosia variabilis* Ridley, Topsent, 1892, p. 68.
1901. " " " Topsent, 1901 *a*, p. 11, Pl. II., Fig. 9.

Petrosia variabilis crassa, subsp. nov.

Plate 17, Figs. 6, 9, 12; Plate 21, Figs. 2, 3.

Diagnosis. Form variable, subcylindrical, and branching, or more or less plate-like and partially incrusting. *Body stony; interior dense.* Surface smooth to the eye. Oscula, 0.7 to 1.0 mm. in diameter; rather numerous and scattered. Pores in the meshes of the dermal skeleton, one to a few in the mesh. Oxea, 510 μ x 32 μ. Spiculo-fibres of the main skeletal reticulum *300–600 μ thick, consisting of many rows of spicules;* superficial spicules of the fibre only loosely combined with the body of the fibre; meshes rounded and of a diameter about equal to thickness of the fibres. Dermal reticulum merely the outermost part of main skeleton, and not differing essentially from it.

Station 3405, four specimens.

Two of the specimens are subcylindrical sponges broken off below (Fig. 9, Plate **17**), branching above, the branches rounded off at the free ends. The two specimens are much alike, save that in one the elsewhere solid body is excavated for a length of 35 mm. in its lower part by an axial cavity, which has probably been bored out by the crustacean found therein. In the specimen figured, the length is 60 mm., diameter at the lower end 10 mm.

The other two specimens are of a very different habitus. One is an undulating plate which was obviously attached over a part, at any rate, of its smooth lower surface. The plate has a greatest length of 45 mm. and greatest thickness of 5 mm., thinning away toward the edges. The second specimen (Fig. 12, Plate **17**) starts from a similar plate-like expansion, with a smooth under-surface. It then becomes incrusting upon the branching cylindrical skeleton of an alcyonarian, creeping over the latter in several directions in the shape of narrow elevated bands, which are confluent with one another.

The color is a light yellowish-brown. The body is stony and incompressible, and the interior is very dense. The surface appears smooth to the eye, but is rough to the touch. With a lens the points of barely projecting radial spicules may be seen, distributed generally over the surface, in some places thickly enough to form a nearly continuous furze, in other places very scantily. Where the surface is uninjured it appears to the eye, or with a lens, perforate with abundant minute rounded apertures 0.3 mm. to 0.5 mm. in diameter. These which at first sight seem to be simple apertures, are the more conspicuous areas of membrane occupying the meshes of the dermal skeletal reticulum. They are more distinct in Fig. 9, Plate **17**, than in Fig. 12, Plate **17**, simply for the reason that the photograph from which the former figure was made, was taken from the partially dried sponge, while in the other case the photograph was taken from the sponge in alcohol.

The pores are rounded, 50–80 μ in diameter. They lie in the meshes of the dermal skeleton, one to a few in the mesh. In some of the meshes, the dermal membrane exhibits no pores. In the cylindrical specimens, rather numerous small rounded oscula, 0.7 to 1.0 mm. in diameter, are scattered over the body, showing a partial arrangement in longitudinal rows. In the two more or less plate-like forms, oscula similar to those on the cylindrical specimens are scattered here and there over the surface without regularity of arrangement.

Spicules.

Oxeas, Fig. 6, Plate **17**. Spicule smooth, slightly curved, cylindrical and then tapering at each end to a sharp point. Size, about 510 μ x 32 μ. Spicules are sometimes found divided at one end into three short diverging branches. Rarely the spicule assumes the shape of a strongyle or style.

Skeletal Arrangement.

The main skeleton (Fig. 3, Plate **21**, a section vertical to the surface) is a reticulum of thick spiculo-fibres which are frequently indistinctly outlined. The fibres are 300–600 μ thick, consisting of many rows of spicules, arranged for the most part about lengthwise in the fibre, and packed together in a fairly close fashion. The spicules are united by a small amount of spongin, which is insufficient, however, to give the fibre a compact character. The superficial spicules of the fibre are only loosely combined with the body of the fibre, and there are always some free spicules in the meshes. Individual fibres traceable only for short distances. Reticulum undeveloped in spots, such places being occupied by a confused mass of spicules. Meshes more or less rounded; diameter of the meshes about equal to thickness of the fibres.

In the cylindrical specimens longitudinal fibres are vaguely discernible in the axial region. In all the specimens fibres directed more or less radially to the surface, with tangential connectives, may be distinguished in the superficial region of the body.

The dermal membrane is supported by a reticulum (Fig. 2, Plate **21**), which is merely the outermost part of the main skeleton, and does not differ essentially from the latter. It consists of rather poorly defined fibres 400–600 μ thick, enclosing rounded meshes, the diameter of which about equals the thickness of the fibres. Many of the meshes are nearly free of spicules. Others are crossed by numerous scattered spicules, and partly by spicule tracts. Although there are scattered over the surface radially projecting spicules (only the points of which emerge), there are no projecting tufts of spicules, such as in many *Petrosia* species are produced by the continuation of the radial fibres.

On the smooth under surface of the two more or less plate-like forms, the spicules of the dermal skeleton are thickly and irregularly scattered, and not so arranged as to form a reticulum. In spots, however, this continuous layer of irregularly strewn spicules is interrupted by areas of dermal membrane free of spicules, and containing, each, one or a few pores.

Comparative. In the type specimen of *P. variabilis* taken by the "Alert," near Port Darwin, North Australia (Ridley, 1884, p. 415), the oxeas measured 400 μ x 19 μ. In the "Challenger" specimen of *P. variabilis* var. from the Philippine Islands (Ridley and Dendy, 1887, p. 13), the oxeas were 450 μ x 22 μ. In the "L'Hirondelle" specimens of *P. variabilis*, from the Azores (Topsent, 1892, p. 68), the oxeas were 530 μ x 33 μ. In the "Belgica" specimens of *P. variabilis*, from the Antarctic Ocean (Topsent, 1901 a, p. 11), the oxeas were 535 μ x 23 μ.

As to the skeletal arrangement of *P. variabilis* Ridley (1884) says, "Main skeleton — very loose primary lines of spicules, about three spicules broad, running irregularly towards surface, crossed by secondary tracts of similar character, 2 or 3 spicules broad, at right angles to the primaries and about

4 millim. apart. Dermal skeleton — extremely loose tracts of irregularly parallel spicules, 3 or 4 spicules broad, surrounding roundish or polygonal areas from .18 to .28 millim. in diameter."

I have examined the "Challenger" specimen of *P. variabilis* var., and add the following note. The body of *P. variabilis crassa* is much harder and much less cavernous, and the fibres of the main skeleton are much thicker than in the "Challenger" specimen. The surface, in general, of the "Challenger" sponge is distinctly reticulate to the eye. The obvious character of the reticulum, as compared with the condition in *P. variabilis crassa*, is due to the relative slenderness of the fibres and large size of the meshes. Over some parts of the surface, however, the reticulum is very indistinctly developed, the fibres being thicker and the meshes smaller than over the general surface. In such places fibres about as thick, and meshes about as small, as in *P. variabilis crassa* may be found.

Petrosia similis Ridley and Dendy.

1887. *Petrosia similis* Ridley and Dendy, 1887, pp. 9–12, Plates II. III.

Petrosia similis densissima, subsp. nov.

Plate 17, Figs. 7, 10; Plate 21, Figs. 4, 5.

Diagnosis. Sponge irregularly lobate; lobes short, subcylindrical branches, or merely rounded protuberances. Hard, almost stony. Surface appears finely reticulate and smooth to the eye. Oscula, 2–3 mm. in diameter, at or near the free ends of the lobes, leading into cloaca-like cavities. Pores in meshes of the dermal reticulum, 1 to 5–6 pores in a mesh. Oxea, 220 μ x 16 μ. Skeletal fibres compact, consisting of many rows of spicules with but little spongin; 80–180 μ thick. Very few spicules in the meshes of the skeletal reticulum. In the superficial region of the body, main skeletal reticulum regular, consisting of radial fibres with connectives; meshes here 170–250 μ in diameter. In the interior, main skeletal reticulum irregular, with meshes 200–500 μ in diameter. Dermal reticulum merely the outermost layer of the main skeleton; fibres, 170–250 μ thick; meshes, 170–250 μ in diameter.

Station 3405, 1 specimen.

The specimen is an irregular lobate mass, attached below to white conglomerate, upon which for a short distance it spreads out in an incrusting fashion. The mass is 40 mm. high, somewhat flattened; width of the flattened faces about 40 mm. In Fig. 7, Plate **17**, one of the flattened surfaces is shown. Some of the lobes are well marked, though short, subcylindrical branches; others, mere rounded protuberances. The transverse diameter of the branches, and the thickness of the whole mass in the short horizontal diameter, are about equal, and 7–8 mm. The sponge is doubtless to be looked on as a ramifying form with subcylindrical branches, the growth in this particular specimen being predominantly, although by no means exclusively, in one vertical plane.

The color is brown, passing here and there into terra-cotta, as if that were a remnant of the natural color. The sponge is hard, almost stony; the canals large enough to give the interior a lacunose appearance when cut across. To the eye or with a lens the surface appears finely reticulate, the reticulum most evident over the larger canals. To the eye and the touch the surface appears smooth, and in reality over much of it there are no projecting spicules. Nevertheless there are plenty of places where spicules project radially for a short distance in considerable number (Fig. 4, Plate **21**).

Rounded oscula, 2–3 mm. in diameter, are found at or near the ends of the branches and on the protuberances. They are the apertures of cylindrical cloaca-like cavities, the inner face of which both laterally and at the bottom shows the openings of efferent canals. The cloaca-like cavities are pretty deep, extending 4–8 mm. into the body of the sponge, but are not continuous with one another. The pores are rounded, 60–80 μ in diameter, and lie in the meshes of the dermal reticulum; 1 to 5-6 pores in a mesh. Pores are closed in some regions, but even then perceptible as rounded darker spots, the rest of the pore area appearing as lighter-colored trabeculae between the closed pores. This condition of the closed pores is sufficiently distinct to appear in a photograph (x 30). The flagellated chambers (Fig. 10, Plate **17**) are somewhat flattened, about 40 μ x 32 μ, and eurypylous.

Spicules. *Oxea,* Fig. 10, Plate **17**; smooth, slightly curved, cylindrical, and then tapering at each end to a point. Size, 220 μ x 16 μ.

Skeletal Arrangement. Main skeletal reticulum (radial section, Fig. 4, Plate **21**), in immediate neighborhood of the surface of the sponge, is regular, with radial and tangential fibres. In the interior, reticulum is irregular, and with larger meshes. Fibres of the main skeleton are in general compact, although in spots they lose their sharp boundaries and fade into one another. In such a spot there is no reticulum, merely a mass of thickly scattered spicules. Fibres, 80–180 μ thick, averaging a somewhat smaller size in the superficial region than in the interior. In the superficial region the connectives are sometimes as thick as the radial fibres, more often somewhat thinner. Meshes of the reticulum, rounded at the corners; in superficial region, 170–250 μ in diameter; in interior, 200–500 μ in diameter.

Spicules of the spiculo-fibres are closely packed in many rows, arranged lengthwise and cemented together by a very small amount of spongin, which does not form a coating over surface of the fibre. Spicules also project irregularly from surface of the fibres. There are almost no free spicules in the meshes.

Many radial fibres are prolonged a short distance beyond the surface, for the length or less than the length of a spicule, thus forming very small projecting tufts. In addition a few separate spicules project radially or obliquely, at points between the ends of the radial fibres, *i. e.* from the fibres of the dermal reticulum between the nodes. But over much of the surface these minute projections are lacking, surface being quite smooth.

The dermal membrane is supported by a reticulum (surface view, Fig. 5, Plate **21**) which is merely the outermost layer of the main skeleton. The fibres measure 60–120 μ in thickness; meshes, rounded-polygonal and 170–250 μ in diameter. As in the main skeleton, the fibres in general are compact and sharply outlined. Here and there spicules project from the fibres well into the meshes, or cross them, but in the meshes in general there are almost no free spicules. Usually in the nodes the crossing of spicule tracts is discernible.

Comparative. I have examined the type specimens of *Petrosia similis* Ridley and Dendy, and find that *P. similis densissima* stands closest to var. *compacta* (Ridley and Dendy, 1887, p. 12). The skeletal fibres of this variety are not nearly so compact as in *P. similis densissima.* This statement applies both to the surface reticulum and to the main skeleton as well. Ridley and Dendy (1887) correctly say that "the skeleton fibre is by no means so compact and well developed" as in *P. dura* (Nardo), whereas in *P. similis densissima* the fibres are fully as compact as in *P. dura* (Specimen No. 1818 in Berlin Museum f. Naturkunde, from Rovigno), and appear more so because there are fewer spicules scattered in the skeletal meshes than in the Mediterranean species. Owing to the comparatively indistinct outlines of the fibres in *P. similis* var. *compacta,* preparations of the dermal membrane and radial sections present a marked difference to corresponding preparations of *P. similis densissima.* Especially the internal skeletal reticulum, as seen in radial section, is confused and indistinct as compared with subsp. *densissima.*

Previously known distribution of P. similis. Petrosia similis: South of Cape of Good Hope (Lat. 35° 4′ S., Long. 18° 37′ E.) at depth of 150 fath.; between Kerguelen and Heard Island (Lat. 52° 4′ S., Long. 71° 22′ E.) at 150 fath. *P. similis* var. *massa:* between Strait of Magellan and Falkland Islands (Lat. 51° 35′ S., Long. 65° 39′ W.) at 70 fath. *P. similis* var. *compacta:* Philippine Islands (Lat. 11° 37′ N., Long. 123° 31′ E.) at 18 fath.

Pachychalina O. Schmidt.

1868.	*Pachychalina*	O. Schmidt, 1868, p. 8.	
1887.	*Pachychalina*	O. Schm.,	Vosmaer, 1887, p. 342.
1887.	"	"	Ridley and Dendy, 1887, p. 19.
1890.	"	"	Dendy, 1890, p. 353.
1894.	"	"	Dendy, 1894, p. 240.
1902.	"	"	Lundbeck, 1902, p. 5.

Pachychalina acapulcensis, sp. nov.

Plate 16, Figs. 7, 8; Plate 17, Figs. 1-5, 13.

Diagnosis. Sponge body an erect lamella, not simple, but a complex composite of erect lobes, many of which are flattened. Lobes intimately connected below, becoming more free and projecting above. Conuli, 3–6 mm. high on the upper portions and projecting edges of the lobes, nearly absent elsewhere. Dermal membrane finely reticulate to the eye. Color yellowish-gray. Sponge very compressible and flexible, yet firm and elastic. Oscula, 2–4 mm. in diameter, over the upper ends and projecting edges of the lobes. —— Oxea very commonly 85–90 μ x 3–4 μ, although larger (100 μ x 5 μ) and smaller (60–85 μ x 2 μ) forms are abundant. —— Skeletal bundles 0.5 to 1.0 mm. thick, formed of closely interlacing spiculo-fibres, ascend more or less vertically through the sponge body and give off oblique branches which terminate as axial bundles in the conuli. Skeletal network extending between the vertical bundles, on the whole irregular, although fibres directed more or less radially to the surface are everywhere distinguishable. Radial fibres in parts of the body, invariably in the conuli, extensively developed; in such places, forming with the approximately transverse connectives a fairly regular skeleton. Stronger fibres of reticulum, 50–80 μ; connectives, 15–30 μ thick; ultimate meshes often about 300 μ wide. Larger fibres well filled with spicules; spongin nevertheless forming a distinct sheath round the fibre. Spongin relatively more abundant in the connectives; spicules here forming from 1 to about 6 rows. ——Dermal reticulum composed of fibres 40–60 μ thick, forming meshes subdivided by fibres 15–30 μ thick; ultimate meshes, 150–350 μ in diameter; fibres like those of main skeleton. Abundant villi commonly about 120 μ high, made up of spicules and spongin, project from dermal reticulum.

Station recorded as "Acapulco," one specimen.

The sponge body is essentially an erect lamella, which is, however, curved so that the two ends of the lamella, shown at the right in Fig. 8, Plate **16**, are brought close together. Possibly the entire lamella in the natural state encircled some slender upright object. The lamella is by no means simple, but may be regarded as composed of numerous erect lobes, many of which are flattened, while others approach the cylindrical shape. The lobes are intimately connected below, becoming more free and projecting above. Many of them appear, moreover, as buttresses projecting from and only partially free from the faces, both inner and outer, of the general lamella. The result of this complex order of growth is that the underlying lamellate character of the body is made less distinct, the sponge appearing at first sight as a fruticose mass. The whole mass in the natural position is 110 mm. wide, with a greatest height of 170 mm.; the thickness of the constituent lobes varying, but in the neighborhood of 12 mm.

Numerous long conuli, covered with villi which are minute but distinct to the eye, are present on the upper portions and projecting edges of the lobes, nearly absent elsewhere. They are 3–6 mm. high, tapering to a point, slenderly conical, or somewhat flattened and spatula-like.

The dermal membrane appears to the eye as a fine reticulum, which only indistinctly allows the arrangement of the internal cavities and parenchyma to be seen. When cut across, the interior appears porous, with very numerous small canals mostly 0.5 mm. or slightly over in diameter. The color is a yellowish-gray. The sponge is very compressible and flexible, yet firm and elastic.

Oscula are scattered in some abundance over the upper ends and projecting edges of the lobes. They are rounded, 2–4 mm. in diameter, and for the most part lead very quickly each into several efferent canals. Pores rounded, 85–250 μ in diameter, in the meshes of the dermal reticulum; mostly one or two in each mesh. Interior of sponge is macerated, but in places the size of the flagellated chambers can be made out; chambers measuring 24 x 20 μ.

Spicules. Oxea, smooth, slightly curved, cylindrical, not suddenly pointed but tapering gradually at the ends (Figs. 3, 4, 5, Plate **17**). The variability in the size of the spicule is considerable. Much the commonest size is 85–90 μ x 3–4 μ. Longer and stouter spicules up to 100 μ x 5 μ are, however, not uncommon. Smaller slender forms 60–85 μ x 2 μ are found in the fibres and also scattered sparsely in the meshes of the skeletal reticulum, perhaps representing stages in the development of the larger spicules. Often the spicules in a particular fibre are of nearly the same size, thus in one fibre measuring mostly 85 μ x 4 μ, in another fibre mostly 85 μ x 2 μ.

Skeletal Arrangement. Coarse columns or bundles of spiculo-fibres (*l. b.* in Fig. 7, Plate **16**, and Fig. 2, Plate **17**) extend more, or less vertically through the body, branching as they go. The branches extend obliquely upward and outward, and terminate as axial bundles in the conuli (Fig. 13, Plate **17**). The bundles are well seen in a piece of sponge that has been macerated for some hours in cold caustic potash.

The skeletal network, connecting the columns together and extending between them and the surface, is on the whole irregular. But more or less radially directed fibres, extending out from the branching columns to the surface, may everywhere be distinguished. In some parts of the body (Fig. 2, Plate **17**) and invariably in the conuli (Fig. 13, Plate **17**) they are conspicuously developed, with connectives commonly about at right angles; the skeleton here becoming fairly regular. Elsewhere the radial fibres are sparsely developed (Fig. 7, Plate **16**), and are accompanied by or pass into other strong fibres, which pursue a very oblique or tangential course. The connectives in such regions are without order, and the network is irregular.

The vertical columns have not clearly defined boundaries, but their thickness is in the neighborhood of 0.5 to 1.0 mm. They are composed of coarse spiculo-fibres, 70–110 μ thick, together with finer fibres, all interlacing to form a close irregular network (*l. b.* in Fig. 7, Plate **16**, Fig. 2, Plate **17**). Here and there in the constituent fibres of the column, the spicules are less compactly arranged than elsewhere, and the fibres themselves merge into one another. In such spots the reticular nature of the columns is only vaguely apparent.——The stronger fibres of the general skeletal reticulum of the body, whether radial, oblique, or tangential, are 50–80 μ thick. The finer fibres or connectives measure 15–30 μ in thickness. In the conuli the radial fibres are slenderer than in the body, about 30–40 μ thick. The ultimate meshes of the skeletal network, as may be seen from the figures, vary a good deal in diameter; a common width being in the neighborhood of 300 μ.

The strong fibres of the general network (Fig. 3, Plate **17**) and of the vertical columns are well filled with spicules; spongin, however, abundant and forming a distinct sheath for the fibre. In the connectives (Figs. 4, 5, Plate **17**) the spongin is relatively more abundant and the spicules are not as closely packed as in the larger fibres, sometimes forming only an axial core. In the finest connectives, the spicules are arranged uniserially; in the coarser, in several series up to about 6. There are a few free spicules, all of the smallest size given above, scattered in the meshes of the skeletal reticulum.

The supporting reticulum of the dermal membrane (Fig. 1, Plate **17**) consists of stouter and finer fibres, like those of the main skeleton. Stouter fibres, 40–60 μ thick, form coarse meshes which are subdivided by finer fibres 15–30 μ thick; ultimate meshes squarish or polygonal with diameter 150 μ to 350 μ. In the larger fibres the spicules are arranged polyserially (about 10 rows); in the finer fibres uniserially or in two to a few rows. From coarse and fine fibres alike project abundant villi, many of them about 120 μ high and consisting of a bunch of spicules, 4 or 5 spicules thick, with considerable horny matter; others consisting of only 2 or 3 spicules. Some of the villi are prolongations of radial skeletal fibres; others are independent projections from the dermal reticulum.

Comparative. The species above described resembles in the lamellate character of its growth, and in some other respects as well, *Pachychalina spinilamella* Dendy (Dendy, 1889), a type specimen of which I have examined. The lamellate character, which is disguised in *P. acapulcensis*, is pronounced in Dendy's. The spicules in *P. spinilamella* are exceedingly slender, measuring about 0.126 by 0.0017 mm.

Oceanapia Norman.

1869. *Oceanapia* Norman, Rep. Brit. Ass., 1868 (1869), pp. 334–35 (generic diagnosis here given is quoted in Bowerbank, 1882, p. 171).
1870. *Rhizochalina* O. Schmidt, 1870, p. 35.
1882. *Phloeodictyina* Carter, 1882, p. 117.
1884. *Rhizochalina* Schmidt, Ridley, 1884.
1887. *Rhizochalina* Schmidt + *Oceanapia* Norman, Ridley & Dendy, 1887, pp. 32, 36.
1894. *Oceanapia* Norman, Dendy, 1894, p. 248.
1894. *Rhizochalina* Schmidt + *Oceanapia* Norman, Topsent, 1894 *a*, p. 10.
1902. *Phloeodictyon* Carter + *Rhizochalina* Schm. + *Oceanapia* Norman, Lundbeck, 1902, pp. 55–56.

Ridley (1884) merged *Phloeodictyon* Carter in *Rhizochalina* Schmidt. Ridley and Dendy (1887, p. 32) suggest that *Rhizochalina* (+ *Phloeodictyon*) and *Oceanapia* Norman should be united, and Dendy (1894) combines the two under *Oceanapia*, while Topsent (1894 *a*) retains the separate genera. Lundbeck (1902) thinks that the group Phloeodictyina (= *Oceanapia*, *sensu* Dendy) includes three separate genera, *Rhizochalina* Schm., *Phloeodictyon*

Carter, *Oceanapia* Norman, and that the group, moreover, is heterogeneous. He proposes therefore to give up the group, and to assign *Rhizochalina* to the *Chalininae, Phlocodictyon* to the *Renierinae, Oceanapia* to the *Gelliinae*. In this report I conceive the genus in the sense of Dendy.

Oceanapia bacillifera, sp. nov.

Plate 17, Fig. 8; Plate 18, Figs. 2–4.

Diagnosis. Only the fistulae known. These are yellowish-brown tubes, 50–80 mm. long and 8–12 mm. in diameter, with unobstructed cavity. Wall of fistula dense and firm, 0.5 to 2.5 mm. thick, with smooth outer surface and nearly smooth inner surface. Spicule, a smooth, cylindrical, distinctly curved strongyle, 360–380 μ x 24 μ. —— Wall of the fistula almost entirely filled with a dense skeleton, the greater part of which forms a vague reticulum, consisting of wide, loose spicular tracts, which bound small, rounded meshes. Spicules united by considerable spongin, and arranged tangentially to the surface of the sponge. In the innermost layer of the wall a few long spicular tracts occur. These give rise to a reticulum with long, narrow meshes, — meshes elongated in the direction of the long axis of the fistula. At the outer surface skeleton not reticulate, spicules here lying side by side, in any particular region parallel to one another.

Station 3404, two specimens.

Both specimens are fragments, including only the fistulae. These are yellowish-brown tubes (Fig. 2, Plate **18**), somewhat curved, and showing here and there low irregular protuberances, or ridges. The tubes are open at both ends, the larger measuring 80 mm. in length, with a transverse diameter of about 12 mm., the smaller 50 mm. in length, with a transverse diameter of about 8 mm. The wall is very firm and dense. Throughout the greater part of the larger tube it is extremely thin, 0.5 mm. thick, although in spots, especially near one end, it attains a thickness of 2.5 mm. In the smaller specimen the wall is thicker, the thickness ranging from 0.75 mm. to 2.0 mm. In both specimens the cavity of the tube is unobstructed, the outer surface quite smooth, the inner surface somewhat less so, and showing closely set whitish lines which course longitudinally, and, anastomosing, form a reticulum with narrow, elongate meshes. These lines represent the innermost layer of the skeletal reticulum.

No dermal membrane is present, the superficial layer of spicules being quite bare (surface view, Fig. 8, Plate **17**), except in spots, where they are covered by exceedingly thin patches of an incrusting species of

Hymeraphia Carter (the spicules of which are shown in Fig. 3, Plate **18**), differing in some few details from *Hymeraphia minima* Topsent (1892, p. 114, Plate **11**, Figs. 2–3).

Spicules. *Strongyle* (Fig. 8, Plate **17**), smooth, cylindrical, distinctly curved, ends evenly rounded off. Size, 360–380 μ x 24 μ.

Skeletal Arrangement. The wall of the fistula is supported by a dense skeleton, which appears as a confused mass of strongyles (Fig. 4, Plate **18**, a tangential section), arranged for the most part tangentially to the surface of the sponge, but lying in all (tangential) directions, united by considerable spongin, and interrupted here and there by rounded gaps. This mass of spicules may be regarded as forming a reticulum, which consists of vaguely outlined fibres, or tracts bounding small rounded meshes. The tracts are often 150–200 μ thick, the meshes somewhat less in diameter than the thickness of the tracts. Individual tracts are traceable only for short distances. Spicules of a tract arranged loosely and about lengthwise; united together with considerable spongin.

The dense skeleton occupies most of the thickness of the wall, extending nearly to the inner surface of the fistula. The innermost layer — about 100 μ thick — of the fistular wall contains a good many canals and granular cells, and comparatively little skeleton. What skeleton there is has the shape of vaguely defined tracts about 200 μ thick, which resemble those of the skeleton in general, but most of which pursue an approximately longitudinal course for considerable distances. The longitudinal tracts, together with similar connectives, give rise to a reticulum, the meshes of which are long and narrow.

The dense skeleton extends quite to the outer surface of the fistula, but in its outermost layer the reticular character is lost, the spicules here lying side by side, in any particular region parallel to one another (Fig. 8, Plate **17**, surface view).

In the region occupied by the dense skeletal reticulum, only the spicules and spongin are discernible in the present state of the sponge, and although maceration has undoubtedly gone on, there cannot in the natural condition be much soft tissue in this part of the fistula.

Comparative. As regards the shape of the spicules the fistulae here described most closely approach *Oceanapia singaporensis* Carter. In the type of this species (*Phloeodictyon singaporense* Carter, 1883, p. 326) the spicules are of two forms: oxeas and strongyles, the latter about $\frac{1}{4}$ the length of the former. The oxeas are chiefly confined to the spiculo-fibre of the interior, the strongyles to the surface layer. *Habitat*, Singapore.

Under the head of *Rhizochalina singaporensis* Carter var., Ridley (1884) describes specimens "in which a large proportion of the (usually acerate) spicules have both ends more or less rounded." "The largest adult spicules have nearly the same size as the acerates of *R. fistulosa*, viz., .3 x .0127 mm., but they vary immensely in length." *Habitat*, Prince of Wales Channel, West and Alert Islands, Torres Straits, 7 fathoms.

Ridley and Dendy (1887, p. 34) record under *Rhizochalina singaporensis* Carter a fistula taken by the "Challenger" (locality uncertain). I have examined this specimen, and in my preparations the spicules were nearly all strongyles. In the skeletal arrangement and color this specimen differs from *O. bacillifera.* —— The sponge identified by Lindgren (1898, p. 297, Taf. 19, Fig. 11 *a–b*) as *Rhizochalina singaporensis* Carter must, from the present standpoint of classification, be placed in another genus, since it has chelae.

In the color and general appearance the fistulae, here described as *O. bacillifera*, are very similar to fistulae taken off Bahia by the "Challenger," and referred, with a query, by Ridley and Dendy (1887, p. 34) to *Rhizochalina putridosa* (? Lamarck), but in these specimens the spicules are oxeas, and the reticulate character of the skeleton is strongly marked.

Gellius Gray.

1867. *Gellius* Gray, 1867, p. 538.
1887. *Gellius* Gray *pars*, Vosmaer, 1887, p. 349.
1887. *Gellius* Gray, Ridley & Dendy, 1887, p. 37.
1894. " " Topsent, 1894 *a*, p. 8.
1894. " " Dendy, p. 247.
1902. " " Lundbeck, p. 62.

Gellius perforatus, sp. nov.

Plate 17, Fig. 11; Plate 18, Fig. 1; Plate 21, Fig. 6; Plate 22, Fig. 1.

Diagnosis. Body may appear as a flattened plate-like mass, perforated by spaces which pass through from one surface to the other; or as an amorphous mass excavated by spaces which pass through the body in several planes, and divide it into a number of anastomosing lobes. Color ashy gray. Sponge firm and of cartilaginous consistency. —— Upper and lower surfaces differentiated. Upper surface roughened with closely set minute projections which reach 1 mm. in height, and consist of, or are supported by, tufts of spicules projecting from the dermal reticulum. Under surface as compared with the upper is smooth. —— Oscula small and scattered over upper and outer surfaces. Pores abundant in meshes of dermal reticulum of upper surface; scattered over lower surface, in places abundant.

Spicules : Oxea, 320 μ x 20 μ, with smaller sizes. Sigmata 18 μ long, abundant. Main skeleton a confused irregular reticulum of spiculo-fibres, with abundant free spicules scattered between the fibres. Fibres consist chiefly of spicules, with only a very small amount of spongin, and in general are not sharply separated from the scattered spicules. On the upper surface is a dermal reticulum of spiculo-fibres from which single spicules and tufts of spicules everywhere project. On the lower surface a dermal reticulum is developed in places, the membrane elsewhere containing only scattered spicules.

Station given as Panama, 4 specimens.

The largest specimen, Fig. 1, Plate **18**, is an irregular plate, the under surface of which has apparently been moulded over several rounded objects. The plate is 5 to 10 mm. thick, with a greatest width of 95 mm. Perforating spaces 4 or 5 mm. in diameter pass through the body, from the upper to the lower surface. The upper surface, which is the one figured, is very uneven, and from it project numerous lobes having the shape of low rounded or irregular elevations, often with a subterminal osculum. It is apparently the case that such elevations are primarily simple and independent, but in some instances in the course of lateral expansion they meet and fuse with one another, thus roofing in tunnel-like spaces which come to lie between the body of the plate and the fused lobes. On the under surface, too, especially near the periphery, some similar tunnel-like spaces have been formed, apparently by the fusion of lobes growing out from this surface.

Of the other specimens, two are fragments of similar plate-like masses, and may indeed have been broken off from the larger piece just described. In one of them the perforating spaces, passing through the body from upper to lower surface, are large, reaching 15 mm. in diameter. And the lobes projecting from the under surface, and fusing in the manner described, give the mass a thickness of 30 mm.

The remaining specimen has a different shape. It is an amorphous mass about 40 mm. in diameter, and consists of a few irregular but in the main subcylindrical lobes, 5 to 15 mm. thick, anastomosing in several planes and thus enclosing spaces which continue to pass quite through the body of the sponge, and have a diameter themselves of 5 to 15 mm. The upper and lower surfaces of the whole mass are readily distinguishable, resembling the corresponding surfaces of the flattened plate-like specimens.

On comparing the different specimens, and making some use of hypothesis, it becomes possible to describe the habitus of the species in the following way. The sponge has differentiated upper and lower surfaces. Primarily solid, in the course of growth it develops lobes, which may spread and fuse, not only in the horizontal plane, but in planes above and below the level of the original body. Thus spaces are partially enclosed which continue to pass through the body in various planes. The enclosed spaces may be small or large, and thus the whole mass comparatively compact or very cavernous. If the growth be predominantly in the horizontal plane, a flattened plate-like body results. When the growth is not predominantly in one plane, a labyrinthine mass of anastomosing lobes results.

Except in shape, the several specimens agree. The color is a light ashy gray. The sponge is firm, only very slightly compressible, and of a marked cartilaginous consistency.

The upper surface is in general roughened with closely set minute projections which vary a good deal in character. In regions (part of Fig. 1, Plate **18**), the projections are fittingly designated as villi, and consist of small tufts of more or less radially disposed spicules, a tuft including only 2 or 3 spicules. Round the base of such tufts the sponge tissue forms an elevation, and thus the projection is strictly conical, although very slender. Such villi are exceedingly abundant over parts of the surface, especially in the peripheral region of the sponge.—— The villi intergrade with the larger elevations with which the greater part of the surface is thickly covered, and which reach 1 mm. in height. These elevations, which may be referred to as conuli, taper toward the apex. In their distal portions at any rate, they are supported by the larger dermal tufts of spicules, and (hence) frequently appear branched. In places the conuli are especially low and feebly developed, such regions being almost smooth.

The under surface, as compared with the upper, appears in general smooth to the eye and the touch, noticeable villi or conuli appearing only here and there.

Fairly numerous round oscula, 1.5 to 2 mm. in diameter, are scattered over the upper and outer surfaces. They lead into deep main canals, and are especially developed on the prominences.—— To the eye the dermal membrane of both surfaces appears imperforate and opaque. In the meshes of the dermal reticulum of the upper surface numerous afferent canals the larger of which measure 80–120 μ in diameter, and which in many places are separated only by thin partitions 10–50 μ thick, abut against the dermal membrane. The pores on this surface, which in some places are closed, but in many regions are open, measure 20–40 μ in diameter, and lie thickly crowded in the meshes of the dermal reticulum. Those overlying the more conspicuous afferent canals seem with a low magnification to form rounded pore areas, which have about the same diameter as the canals.——The dermal membrane of the under surface is in places riddled with pores, but elsewhere pores appear only here and there, probably owing to closure.

Spicules. Megascleres. 1. Oxea (Fig. 11, Plate **17**), smooth, slightly curved; points usually sharp, occasionally rounded off, one end rarely strongylate. Spicule abundant. Common size is about 320 μ x 20 μ, although smaller sizes occur grading down to spicules only 150 μ x 2–3 μ. The latter are probably young stages in the development of the characteristic oxea.

Microscleres. 2. Sigmata (Fig. 11, Plate **17**), 18 μ long by something less than 2 μ thick, are abundantly scattered through the parenchyma and in the dermal membrane of both surfaces.

Skeletal Arrangement. In the main skeleton the oxeas are arranged in spiculo-fibres, and are also scattered without order between the fibres. The spiculo-fibres, which are often very loose and best described as tracts, form a confused irregular reticulum, the meshes of which differ greatly in size (Fig. 1, Plate **22**, a section vertical to surface). The fibres are of varying thickness, from 200 μ, representing about 10 rows of spicules (as seen in optical section), to 80 μ, or even thinner. They consist of spicules arranged for the most part lengthwise in the fibre, and held together by a very small amount of spongin. In the body of the fibre the spicules are pretty densely packed, becoming loosely arranged at the surface. Thus the fibres in general are not sharply separated from the scattered spicules.

The fibres may be fairly compact, and the spicules which are scattered in the meshes rather few in number. In such spots the reticular nature of the skeleton is obvious. In other spots the fibres are looser and the scattered spicules more abundant, and the reticular nature is obscured. In still other spots the reticular nature is practically lost, there being in such places only a confused mass of spicules. In the superficial region of the sponge, fibres may be distinguished which extend radially to the surface.

The dermal membrane of the upper surface is supported by a reticulum of tangential spiculo-fibres, 70–175 μ thick, which produce ridges on the surface. Meshes irregularly polygonal or rounded, and varying greatly in size, from 1 mm. to 200 μ in diameter (Fig. 6, Plate **21**, surface view). The meshes contain, as a rule, no or only a few free spicules. In the larger meshes some free spicules are generally present, and they are frequently combined to form slender tracts, 1 to about 3 spicules thick, which more or less perfectly subdivide the mesh (as in the centre of Fig. 6, Plate **21**). The fibres resemble the more compact fibres of the main skeleton. While the dermal reticulum on this surface is in general well developed, there are small areas here and there in which the fibres merge into one another, thus obscuring or obliterating the reticular character.

From the dermal reticulum of the upper surface, single spicules and tufts of spicules everywhere project freely. The latter range from very small tufts including only 2 or 3 spicules to tufts formed by the prolongation of radial fibres of the main skeleton (Fig. 1, Plate **22**), or by the oblique prolongation of dermal fibres (Fig. 6, Plate **21**), and which at the base have about the thickness of the fibre. The larger tufts are abundant, measure 350–500 μ in length, and commonly split distally into branches, each branch including from 1 to 2 or 3 spicules.

On the under surface a dermal reticulum similar to that of the upper surface is developed in places. Elsewhere such a reticulum is absent, the membrane containing only scattered spicules lying tangentially and crossing at all angles. The non-reticular condition seems to predominate at this surface. In the non-reticular regions there may be no projecting spicules, the membrane being quite smooth. Or single spicules, and less often small tufts of 2 or 3 spicules, project.

Comparative. The species here described resembles some others, assigned to *Gellius* by recent writers, in that the spicules are in parts of the sponge combined to form spiculo-fibres, which nevertheless are poor in spongin, and do not form a continuous fibrous skeleton as in *Gelliodes* Ridley. Among such species may especially be mentioned *Gellius flagellifer* Ridley & Dendy (1887; Lundbeck, 1902).

POECILOSCLERIDAE Topsent (1894).

Tylodesma Thiele.

1870. *Desmacella pars* O. Schmidt, 1870, p. 53.
1880. *Desmacodes* O. Schm. *pars* Vosmaer, 1880, p. 104.
1885. *Gellius* Gray *pars* Vosmaer, 1885, p. 28.
1887. *Gellius* Gray *pars* Vosmaer, 1887, p. 349.
1887. *Desmacella* Schmidt, Ridley & Dendy, 1887, p. 58.
1892. *Biemma* Gray + *Desmacella* O. Schm. *pars* Topsent, 1892, p. 80.
1894. *Biemma* Gray, Topsent, 1894 *a*, p. 11.
1902. *Biemma* Gray, Lundbeck, 1902, p. 82.
1903. *Tylodesma* Thiele, 1903, p. 944.

Thiele (1903, pp. 943–44) remarks that Schmidt, when he established the genus *Desmacella* (1870, p. 53), included in this genus, along with his several new species, *D.* (*Hymedesmia*) *johnsoni* (Bwk.), which was the type of *Hamacantha* Gray (1867, p. 538); that *Desmacella* is therefore a synonym of *Hamacantha*, and must be cancelled, as Vosmaer has already pointed out.

Thiele further calls to mind that Gray, in establishing the genus *Biemna* (1867, p. 538), names as the only certain species *Biemna* (*Desmacidon peachii* Bwk.); that this species is commonly assigned at the present time to *Desmacella;* and that the name *Desmacella* as used in the customary sense of to-day should be replaced by *Biemna.*

For the group of species included in the genus *Biemna* (*sensu* Topsent, 1892, 1894 *a*), Thiele proposes the name of *Tylodesma.*

Thiele's contention that *Desmacidon peachii* Bwk., which has been commonly assigned since 1870 (O. Schm. 1870, p. 77) to *Desmacella,* and similar sponges should again be designated as species of *Biemna* Gray, and that *Biemma sensu* Topsent (1892, p. 80) cannot be maintained, is, I think, incontestable. (Rules for Zool. Nomenclature in Verhdlg. v. Intern. Zool.-Congress, p. 966, Art. 2.)

The name *Desmacella* is strictly a synonym, and Vosmaer (1885, p. 28; 1887, p. 221) and Thiele (1903) are therefore justified in cancelling it. The new species described by Schmidt under this name (1870, p. 53) nevertheless constituted a new group, which was homogeneous and is identical with *Biemna* as defined by Topsent in 1892, and recently again defined by Lundbeck (1902). Ridley and Dendy (1887, p. 58) regard these species as "the types of the genus *Desmacella,*" and retain the name. Vosmaer (1880) designates them *Desmacodes,* but this name cannot be retained for them, since in the type of *Desmacodes* (*D. subereus* O. Schm., 1870, p. 54) the predominant megasclere is an oxea (*Spindelnadel*). Vosmaer later (1885, pp. 28–29; 1887, p. 349) merged *Desmacodes* Schm. in *Gellius* Gray, and accordingly one of Schmidt's species was designated by him *Gellius vagabundus*. But in *Gellius* (Gray, 1867, p. 538) the megascleres are diactinal, while in Schmidt's species they are tylostyles (*Stecknadeln*). In *Gellius*, therefore, the sponges will not go.

There is the more reason to follow the example of Ridley and Dendy, and retain the name *Desmacella* for the group, of which *D. vagabunda* Schm. and *D. pumilio* Schm. serve as types, since Schmidt himself later (1880, p. 82) removed *D.* (*Hymedesmia*) *johnsoni* (Bwk.) from the genus. Moreover, Schmidt's generic diagnosis was obviously made especially to fit his new species, and he refers to *D. johnsoni* as "ein sich isolirt habender Nebenzweig von *Desmacella*" (1870, p. 54). Nevertheless, the case is one in which the rules of nomenclature demand a new generic name, and I have adopted that proposed by Thiele.

Tylodesma alba, sp. nov.

Plate 18, Figs. 5-7; Plate 22, Figs. 2, 3.

Diagnosis. Sponge body massive or lamellate. Surface differentiated into pore and oscular regions, these regions occupying opposite surfaces when the body is lamellate, intermingling to some extent when the body is massive. In the oscular regions the dermal membrane is smooth, and imperforate save for scattered small oscula, which occur singly or in groups of 2 to 4. In the pore regions the dermal membrane is rough and exhibits numerous pore membranes perforated by 1 to a few pores. Sponge firm; color of surface white. —— *Spicules.* Tylostyles, 1275 x 36 μ to 290 x 8 μ. Sigmata, 64 to 22 μ long. —— Main skeleton loose, consisting of tracts of spicules and scattered spicules. Dermal membrane of the smooth nonporous regions densely filled with tangentially disposed tylostyles. In the rough porous regions more or less radially disposed tracts expand to form superficial brushes of small tylostyles, which project beyond the surface.

Station 3405, one entire specimen and a fragment.

The entire specimen has roughly the shape of a truncated pyramid, inverted so that the base of the pyramid is represented by the upper surface of the sponge, the truncated apex by the lower surface, which is attached to conglomerate. In Fig. 7, Plate **18**, the sponge is viewed obliquely so that the upper surface is plainly seen. This surface is polygonal with six sides, longer in one direction; unevenly concave, rising gradually toward the edge which is rounded and projects outward. The lateral surface of the sponge is divisible into six uneven faces, which slope suddenly away from the upper edge toward the contracted base. The height of the mass is 50 mm., its greatest width 75 mm. Behind the main body, when the latter is seen in the position of Fig. 7, Plate **18**, the sponge extends for a short distance in incrusting fashion over the conglomerate, and then rises up in the shape of a small nearly vertical lamella which is partially divided into two lobes and is about 5 mm. thick.

The upper surface of the main body is covered with a smooth dense membrane, which is quite imperforate save for the oscula. A similar membrane covers the ridges and prominent parts of the lateral surface and one surface of the lamellate continuation. The more depressed parts of the lateral surface of the main body, comprising the greater part of this surface, appear to the eye rough and comparatively porous, and one surface of the lamellate continuation has this appearance. Microscopic examination shows that in the rough regions the dermal membrane is plentifully perforated with pores. Thus the surface of the sponge is differentiated into pore and oscular regions, these regions occupying opposite surfaces where the body is lamellate, but intermingling to some extent where the body is massive.

The oscula measure 1 to 2 mm. in diameter, and are found scattered irregularly over the smooth regions, sometimes singly, but more often in small groups of two to four. In the rough regions numerous pore membranes roofing in canals are distributed irregularly. The membranes are rounded or irregularly shaped, perforated by one to a few pores, and measure from 2 to 3 mm. to a fraction of 1 mm. in diameter. The individual pores are mostly about 200 μ in diameter, with larger ones occurring less frequently.

The color of the surface is white, that of the interior light brown. The sponge is firm.——The flagellated chambers are rounded, 28 to 36 μ in diameter. The arrangement of the chambers and canals indicates that the chambers are eurypylous, although the actual openings cannot be made out.

Spicules. Megascleres. 1. Tylostyle, Fig. 5, *a–d*, Plate **18**; smooth, sharp-pointed, slightly curved; head well marked; tapering toward head end as well as toward point. Size varies from 1275 μ x 36 μ to 290 μ x 8 μ. Rarely the spicule appears strictly diactinal, bearing an enlargement at some point along its course, whence it tapers to a point at each end.

Microscleres. 2. Sigmata, Fig. 6, *a–g*, Plate **18**, scantily distributed through parenchyma, becoming fairly abundant in places. They vary greatly in size, ranging from 64 to 22 μ in length. The microscopic pictures afforded by the spicules differ a good deal in appearance, but the spicules all have essentially the same shape.

Skeletal Arrangement. The main skeleton (Figs. 2 and 3, Plate **22**, sections radial to the surface) is loose, consisting of irregularly disposed tracts of spicules and scattered spicules. The larger-sized spicules, 800 μ and upward in length, predominate. In the superficial region numerous tracts, extending more or less radially to the surface, are distinguishable. The spicules are cemented together here and there by very small amounts of yellowish and distinctly stratified spongin.

The dermal membrane of the smooth, non-porous regions is densely filled with tylostyles, disposed tangentially or slightly obliquely to the surface, and forming several layers (Fig. 3, Plate **22**; lower part of Fig. 2, Plate **22**). As in the main skeleton the larger-sized spicules predominate.

In the rough, porous regions, the radial or obliquely radial tracts expand to form superficial brushes of small tylostyles, which project beyond the surface (upper part of Fig. 2, Plate **22**). The spicules of the brushes measure for the most part 500 to 290 μ in length. Some of the brushes project radially from the surface, but many project so obliquely as to lie almost flat. The flat brushes, in which the spicules diverge widely, and which consequently present a fan-like appearance, point in all (tangential) directions, and in places cross one another to some extent.

Comparative. *Tylodesma alba* resembles in different points several of the species from the Florida coast briefly described by Schmidt (1870, p. 53) under the name of *Desmacella.* Thus, as in *Desmacella pumilio* O. Schm., the tylostyles are "theils geschichtet, theils in Fasern und ragen mit den Spitzen hervor." The smooth dermal membrane found over a large part of the surface corresponds to that described for *D. vagabunda* O. Schm. Flattened brushes of spicules similar to those present over the rough parts of the surface in *Tylodesma alba* are mentioned by Schmidt as characteristic of *Desmacella vicina*: "mit flachen, oft fächerigen Zügen von Stecknadeln."

In the fact that the pore- and osculum-bearing surfaces are differentiated, *T. alba* resembles *T.* (*Biemma*) *grimaldii* Topsent (1892), which apparently lacks the striking peculiarity common to *T. alba* and *T. vagabunda* O. Schm., *viz.* the smooth dermal membrane filled with tangentially arranged tylostyles.

Tylodesma vestibularis, sp. nov.

Plate 18, Figs. 8, 9; Plate 19, Fig. 1; Plate 22, Fig. 4; Plate 23, Figs. 1-3.

Diagnosis. Sponge primarily incrusting, but it may so grow as to completely incorporate the substratum, thus appearing massive. Surface exhibits numerous vestibular spaces, appearing as elongated cavities extending tangentially, and separated from the exterior only by the dermal membrane; opening at one end by an osculum. Transverse diameter of such spaces, 1 to 4 mm.; length, frequently 10 to 20 mm. Dermal membrane in general riddled with pores. Color, light yellowish-brown. Sponge moderately firm, but very brittle. —— *Spicules.* Tylostyles, 630 μ x 16 μ to 240 μ x 8 μ. Sigmata commonly 36 to 12 μ long. —— Main skeleton consists of scattered tylostyles and irregularly disposed short tracts of same spicule. In the superficial region numerous radial or obliquely radial tracts are distinguishable, ending at the surface in projecting brushes. The adjacent obliquely radial tracts, with their terminal brushes, are prolonged into the vestibular membranes, there occupying an approximately tangential position.

Station 3405, one specimen.

The sponge (Fig. 1, Plate **19**) is incrusting, below upon conglomerate, above upon the dictyonal framework of a *Hexactinella*, which agrees, in regard to the framework, with *H. labyrinthica mihi*, and very probably is this species. The thickness of the incrusting sponge, external to the conglomerate or Hexactinellid support, is about 1 mm., or often less. The conglomerate is in part a firm, solid mass; in part, of a very loose composition. Where the mass is loose, consisting of bits of shells, spines, annelid tubes, and Polyzoa, the sponge has grown into all the crevices between the component particles, and aids in holding them together. Above, the sponge does not form a mere incrustation upon the surface of the *Hexactinella* skeleton, but has incorporated the latter, having so grown through its interstices that the Hexactinellid framework is now found in the interior of the sponge, along with the proper Monactinellid skeleton (*vide* Fig. 4, Plate **22**, and Fig. 1, Plate **23**, sections vertical to the surface). Over a part of the surface the lobes of the supporting *Hexactinella* remain distinct, although they have been individually incorporated by the *Tylodesma*. But over most of the surface the primitively incrusting sponge has filled up the gaps between the *Hexactinella* lobes, thus assuming the character of a continuous amorphous mass. This mass is, however, excavated internally by some large cavities, which probably represent spaces between the *Hexactinella* lobes. The *Hexactinella* skeleton is in a measure disintegrated, and along with it the massive part of the *Tylodesma* has incorporated other fragments of a stony nature, most of which seem to be particles of echinoderm spines. The massive part of the specimen is 70 mm. wide, 30 mm. thick, and 40 mm. high.

The surface exhibits numerous vestibular spaces, appearing as elongated, irregularly tubular cavities, often branching, extending tangentially beneath the surface, and separated from the exterior only by thin dermal membrane. One of the largest of these spaces is shown in Fig. 1, Plate **19**, to the left. The transverse diameter of such spaces varies from about 1 to 4 mm. The length, which is often difficult to measure, owing to the meandering course of many of the spaces, is frequently 10 to 20 mm. At one end many, probably all, of the spaces communicate with the exterior through an osculum 1 to 4 mm. in diameter. (The surface of the sponge is injured here and there, and the natural apertures are not everywhere discernible with certainty.) The membranous covering of the spaces is moreover perforated here and there by apertures 85 to 200 μ in diameter, scattered singly, or in small groups. At the non-oscular end the vestibular spaces lose themselves in the more solid sponge tissue. The spaces are larger and comparatively far apart in the massive part of the sponge body, smaller and much more abundant where the sponge is spreading over a loose, broken substratum.

The surface of the sponge between the vestibular spaces appears to the eye dotted with small, round areas, about 0.5 mm. in diameter. These vary greatly in abundance, being in places 1 to 2 mm. apart, but again only scantily scattered. They are perforated membranes roofing in canals of corresponding size, which pass radially into the interior. The membranes for the most part contain several apertures, but sometimes only one, which probably are to be regarded as oscula.

The dermal membrane in general is riddled with thickly strewn pores, which vary considerably in size, the diameter ranging at any rate from 85 to 220 μ. Small subdermal cavities everywhere underlie the dermal membrane. —— The flagellated chambers are 32–36 μ in diameter, and are crowded together in regions which are separated by collenchymatous tracts, the latter traversed by the larger canals. The arrangement of the chambers in the trabeculae of the sponge indicates that they are eurypylous. —— The color is a light yellowish-brown, the membranes roofing in the vestibular spaces appearing translucent and darker than the general surface, when the body is immersed. The sponge, while moderately firm, is exceedingly fragile, owing to its great brittleness.

Spicules. Megascleres. 1. Tylostyle, Fig. 8, *a–c*, Plate **18**; smooth, very slightly curved, with small head. Spicule tapers slightly toward tylote end as well as toward pointed end, but in the smaller sizes the tapering toward the tylote end is scarcely perceptible. Size ranges from 630 μ x 16 μ to 240 μ x 8 μ. The smaller sizes — 240 to 350 μ in length — predominate in the surface brushes and the vestibular membranes; the larger, in the radial tracts and the loose skeleton of the interior.

Microscleres. 2. Sigmata, Fig. 9, *a–c*, Plate **18**. Length ranges from 45 to 10 μ; common sizes from 36 to 12 μ in length. The sigmata are abundant in the parenchyma and general dermal membrane; only scantily present in dermal membrane over the larger vestibular spaces.

Skeletal Arrangement.

In the deeper parts of the sponge which are occupied by the Hexactinellid skeleton, tylostyles are scattered separately and in slender short tracts, without arrangement. In the superficial region numerous radial or obliquely radial tracts extend toward the surface, there ending in projecting brushes composed of diverging short tylostyles (Fig. 4, Plate **22**; Fig. 1, Plate **23**). Spongin appears to be absent. At any rate, it was not to be observed either in balsam or glycerine sections or teased preparations.

While the surface in general is covered with the projecting brushes, between which small subdermal cavities very commonly lie, in the dermal membrane covering the vestibular spaces the surface skeleton has a different character. The obliquely radial tracts which are adjacent to such a space extend out into the covering membrane (Fig. 4, Plate **22**, section vertical to the surface; Fig. 3, Plate **23**, surface view of comparatively large vestibular space with some of the surrounding area), thus coming to occupy a tangential or nearly tangential position. In the case of the smaller and medium-sized spaces the tangential tracts, as they pass from the margin toward the middle of the vestibular membrane, preserve their individuality (Fig. 3, Plate **23**). In some cases, the whole tract occupies a tangential position, the terminal spicules spreading out fan-wise in the horizontal plane. In other cases, while the body of the tract lies tangentially, the terminal spicules form a diverging bunch which points obliquely upward much like the bunches of spicules found over the general surface. Both conditions appear in Fig. 3, Plate **23**.

In the tracts of spicules which extend out into the membranes covering the larger vestibular spaces, all of the spicules lie in a tangential or nearly tangential position. These tracts lose to a greater or less extent their individuality (Fig. 2, Plate **23**, surface view of part of a large vestibular membrane. The upper, left, and lower margins of the figure represent cut edges. The right curved margin represents part of the edge of an osculum. The left and lower margins are not far from the periphery of the entire membrane), in that they become loose and fray out terminally into free spicules, which are scattered in moderate number through the membrane. Some of the tracts are prolonged for considerable distances through the membrane as narrow stream-like bands, which eventually break up into free spicules.

Comparative. The spicules in *T. vestibularis* are pretty close to those of *T. corrugata* (Bwk.) (*Biemma corrugata*, Topsent, 1892), a parasitic form. Moreover, Topsent says the spicules at the surface are arranged in divergent bunches ("en bouquets divergents"). But Bowerbank describes (1866, pp. 242–3) and figures (1874, Plate XLIII., Fig. 3) the dermal membrane of this sponge (*Halichondria corrugata* Bwk.) as strongly reticulated, and vestibular spaces such as occur in *T. vestibularis* are not mentioned by either writer.

Lundbeck (1902, p. 82) describes in detail a *Tylodesma* (*Biemma rosea* Frst.) known in plate-like fragments, which bear the pores on one surface, the oscula on the other. With this well-marked species, which he so excellently describes, Lundbeck thinks it possible to identify another specimen of a very different habitus. This is a little sponge occurring as a thin incrustation on a Hexactinellid skeleton, and which Lundbeck regards as a young individual. In the description of this specimen Lundbeck does not go into details, and it may be questioned whether it belongs to *T. rosea.* Lundbeck's description of *T. rosea* in general would indicate that this particular specimen and *T. vestibularis* have some points of resemblance in addition to the parasitic habit.

Iophon Gray.

1867. *Iophon* + *Alebion* Gray, 1867, p. 534.
1887. *Iophon* Gray *pars*, Vosmaer, 1887, p. 354.
1887. *Iophon* Gray, Ridley & Dendy, 1887, p. 116.
1892. *Dendoryx* (*Iophon*) Gray, Topsent, 1892, p. 96.
1894. *Iophon* Gray, Topsent, 1894 *a*, p. 14.

Iophon chelifer Ridley and Dendy.

1887. *Iophon chelifer* Ridley & Dendy, 1887, p. 119, Plates XVI., XVII.
1893. *Iophon chelifer* R. & D., Lambe, 1893, p. 30, Plate II., Figs. 7, 7, *a–f.*
1896. " " " Lambe, 1896, p. 191.
1900. " " " Lambe, 1900, p. 23.

Iophon chelifer ostia-magna, subsp. nov.

Plate 20, Figs. 2, 4, 10, 11; Plate 24, Fig. 1.

Diagnosis. Body plate-like, 5 to 8 mm. thick, with rounded free edge bearing large oscula 4 to 6 mm. wide, which are the openings of correspondingly wide efferent canals. Color dark brown. Upper and lower surfaces alike. Small oscula mostly 300–500 μ in diameter, but reaching diameter of 2 mm., scattered abundantly over both surfaces, and also present at the free edge. Pores abundant, scattered throughout dermal membrane. —— *Spicules.* 1. Style, 440 by 20 μ, sparingly spinose. 2. Subtylote, 315 by 8 μ, ends feebly spinose. 3. Chelate bipocillus, 16–20 μ long; axis terminating at one end in 2 or 3 pointed teeth, at other end in a curved plate divided into 2 or 3 lobes. 4. Anisochela, 12–20 μ long, palmate. —— Main skeleton a loose reticulum with squarish meshes, the side commonly formed by a small fascicle of spicules. Continuous bundles more or less radial to the surface, distinguishable as in type.

Station 3384, two specimens.

The body (Fig. 4, Plate **20**) is plate-like, 5 to 8 mm. thick, but not very flat; the plate somewhat bent here and there, and with both surfaces made uneven by irregular depressions and elevations. Both specimens are fragmentary, but include a part of the natural free edge of the sponge. This is rounded off alike toward the two surfaces, and bears several large oscula, which are somewhat elongated in the horizontal plane of the sponge body, measuring in this plane 4 to 6 mm. These large oscula lead into efferent canals of corresponding width, which are about 10 mm. deep, passing inward in the horizontal plane of the body. Other smaller, rounded oscula, 1.5 to 2 mm. in diameter, are also present on this edge.

There is no discoverable difference between the two surfaces, which to the eye appear porous. The color is dark brown, and the sponge very fragile, owing to its great brittleness.

Collenchyma is found in some abundance at the surface in the shape of small, irregular, and vaguely defined areas, which in the uninjured sponge are inconspicuous, although evident in preparations. As in the other species of the genus, the skeletal reticulum is absent from such areas. In the intervening regions constituting the greater part of the surface, the skeletal reticulum lies beneath the dermal membrane in the usual way.—— Preparations of the surface show that there is no constant relation between the superficial collenchymatous areas and the presence of oscula. The latter, measuring commonly 300–500 μ in diameter, and occasionally reaching a diameter of 2 mm., are scattered abundantly over the surface, and occur both in the collenchymatous areas and in the intervening regions. Smaller apertures of all sizes, from 35 μ to 300 μ in diameter, are also scattered abundantly over the whole dermal membrane. The smaller are doubtless pores. It is not, however, possible in this sponge to distinguish, by their morphological characteristics alone, the smallest oscula from the larger pores, since there is such a perfect intergradation in size, and since the oscula and pores are both irregularly scattered.

The flagellated chambers in the present condition of the specimens vary in diameter from 24 to 32 μ. Some are spheroidal, others markedly compressed. Their arrangement indicates them to be eurypylous.

Spicules. Megascleres. 1. Style, Fig. 10, Plate **20**. Spicule about cylindrical, slightly curved, very sparingly spinose throughout its length; pointed end sometimes rounded. Size, 440 μ x 20 μ.

2. Subtylote, Fig. 11, Plate **20**. Spicule very slightly, sometimes not, enlarged at the ends; smooth, except at the extreme end, where it is feebly spinose. Size, 315 μ x 8 μ.

Microscleres. 3. Bipocillus 16–20 μ long, Plate **20**, Fig. 2, *a*, *c*, *d*. The curved axis terminates at one end in 2 or 3 pointed teeth, which project toward the opposite extremity. At the other end the axis terminates in a thin plate-like expansion with spherical curvature, divided by one or two narrow incisions into 2 or 3 lobes. Axis has a ventral keel, which disappears toward the toothed end. On each side of the keel, axis thins away, forming a lateral flange, which is sharply marked off from the terminal lobe of that side by a rounded incision.

4. Anisochela 12–20 μ long, Plate **20**, Fig. 2 *b*. Spicule of the palmate type, with a little spine at the small end.

Skeletal Arrangement. The main skeleton (Fig. 1, Plate **24**, a section vertical to surface, and extending from the surface to one of the large efferent canals. The right margin of figure represents surface of sponge. The left margin represents the canal wall) is a reticulum, formed of spinose styles. The reticulum is loose; meshes commonly squarish, though often subdivided obliquely into triangular meshes. Side of mesh equals length of spicule, and is commonly formed by several spicules (2, 3, 4, or even more), making a loose bundle. Continuous bundles, or tracts, more or less radial to the surface, are distinguishable. In places the reticulum might be described as made up of these tracts, with transverse connectives. At the angles of the meshes the spicules are united by spongin.

The dermal skeleton consists of the superficial layer of the main skeletal reticulum, and of abundant subtylotes. The latter are scattered without order, singly and in loose fascicles, both in the collenchymatous areas of the ectosome and in those parts directly supported by the skeletal reticulum.

The microscleres occur in the dermal membrane, in the walls of the larger canals, and in the parenchyma in general. They are only fairly abundant.

Comparative. The sponge just described closely resembles *Iophon chelifer* Ridley and Dendy (1887, p. 119). The bipocilli are not only chelate, but in general shape and in size are nearly identical with those of the latter species. The skeletal reticulum in both forms shows vaguely developed fibres, which extend more or less radially to the surface. The spinose styles and tylotes are of about the same size in the two forms.

Ridley and Dendy describe *Iophon chelifer* as "amorphous, massive, honeycombed," and add, "Exact form uncertain, specimen fragmentary." The "Challenger" specimens were taken lat. 35° 4′ S., long. 18° 37′ E., off the Cape of Good Hope; lat. 46° 41′ S., long. 38° 10′ E., off Prince Edward Island; lat. 46° 55′ S., long. 51° 52′ E., between Prince Edward and Kerguelen Islands; the depth varying from 150 to 550 fath.

I have examined the type specimens of *I. chelifer*, and I find that although they are amorphous there is some reason for regarding them as thin plates which, because of the irregular character of the growth, have assumed an amorphous character. Actually, however, they differ markedly in appearance from *I. chelifer ostia-magna.* While the skeletal resemblances between my subspecies and the type are very close, the chelate character of the bipocillus cannot be regarded as a feature indicative in itself of species-relationship, since in the very different *Iophon lamella*, the bipocilli are also chelate.

Lambe has recorded *Iophon chelifer* R. and D. from the Pacific coast of Canada (1893, p. 30), and from several localities off the Atlantic coast of Canada (1896, p. 191; 1900, p. 23). Lambe's specimens differ in habitus from mine, being "amorphous and honeycombed," or massive, perforate, and consisting "of an inosculation of short, stout, irregularly shaped, nodose branches, which coalesce, frequently to such an extent as to become amorphous" (1893, p. 30).

Iophon lamella, sp. nov.

Plate 20, Figs. 3, 7-9, 12, 13. Plate 24, Figs. 2-4.

Diagnosis. Body lamelliform, 5 to 12 mm. thick. Efferent canals, 1–2 mm. in diameter, open in abundance over both surfaces. The surfaces, upper and lower, are in a measure differentiated. Pores irregularly scattered throughout the dermal membrane, wherever it overlies the skeletal reticulum. *Spicules.* 1. Spinose style, 210–220 μ x 12–16 μ. 2. Tylote, 220–240 μ x 7–8 μ, ends minutely spinose. 3. Chelate bipocillus, 12–16 μ long; terminating at small end in two pointed teeth, at larger end in a bilobed plate. 4. Anisochela, 14–28 μ long, palmate. Main skeleton a uniform reticulum of spinose styles. Meshes commonly triangular. Side of mesh formed by 1, 2, 3, or occasionally more spicules.

Station 3405, five specimens.

The sponge body is lamellar but irregularly thickened, and sometimes considerably curved; the free edge not possessing special characters distinguishing it from the rest of the surface. The thickness varies from 5 to 12 mm.; greatest width, about 50 mm. The sponge is firm, and while easily broken is not especially brittle. The color is a light yellowish-brown. The upper surface of a specimen is shown in Fig. 12, Plate **20**, and the lower surface of the same specimen in Fig. 13, Plate **20**.

The surfaces of the plate-like body are in a measure differentiated. The one surface, designated as the upper, is more even and in general of a lighter color. The other surface, regarded as the lower, exhibits shallow, irregular, and large concavities, as if here moulded over an underlying object.

The appearance of the surface is extremely variable, although there is an underlying uniformity of character. This appearance is largely determined by the character of the main efferent canals, which conditions the arrangement of the oscula and superficial collenchyma. The main efferent canals are numerous, cylindrical, and pass radially into the body from both surfaces. The diameter does not exceed 2 mm., and commonly is 1 to 2 mm. The canals penetrate deeply into the body, and in many cases *pass completely through the body from one surface to the other.* The oscula are sometimes single apertures, but often the end of the canal is covered in by a fenestrated membrane, including a few, 3 or 4, apertures. When the canal passes completely through the body, at least one end seems always to be covered in with a fenestrated membrane.

Near the lower surface of the sponge several canals, which open independently on the upper surface, may unite and thus produce a *vestibular space* which is separated from the exterior only by the dermal membrane of the lower surface. Such vestibular spaces are abundant in some specimens on those parts of the lower surface which seem to have been moulded over an underlying object (Fig. 13, Plate **20**), and here appear as depressed membranous areas, which are usually elongated, often somewhat meandering. (In the figure they appear darker, the more solid sponge tissue between them reflecting the light better — the sponge being immersed.) They open by oscula, in the case of the larger spaces by several, which range from a small size to a diameter of 2.5 mm. In these specimens the vestibular spaces are found only on the lower surface.

The common type of osculum, represented by the single apertures or fenestrated membranes of the canals which open independently on the surface, is in some regions not surrounded by collenchyma (Fig. 12, Plate **20**), in other regions is so surrounded (Fig. 3, Plate **20**). The oscula again may not be depressed (middle part of Fig. 12, Plate **20**), or may be markedly depressed (Fig. 3, Plate **20**). The oscula, and associated canals, may in one portion of a specimen be so numerous as to honeycomb the sponge (left of Fig. 12, Plate **20**), and in another region (middle of same figure) be comparatively far apart. The oscula are in general more abundant on the upper surface.

In two of the specimens large parts of both surfaces present a striking modification, which may be referred to as the reticulate modification. In these regions the surface is comparatively smooth and exhibits collenchymatous areas of a rounded, polygonal shape and 1 to 2 mm. in diameter, separated by narrower tracts of the more solid sponge tissue (Fig. 2, Plate **24**). A small osculum, about 0.5 mm. in diameter, lies in the centre of the area, and this is surrounded by a few other, usually smaller, apertures, or by the ends of canals abutting against the dermal membrane and appearing as apertures. The oscula lead into canals of corresponding size which penetrate, radially or obliquely, deep into the body of the sponge, where they continue to be surrounded with collenchyma as at the surface. The mass of collenchyma surrounding the main efferent canal, as may be seen in sections taken vertically to the surface of the sponge (Figs. 3 and 4, Plate **24**, sections passing entirely through the lamellate body), passes through the body from one surface to the other, and is honeycombed by numerous smaller canals. The main efferent canal itself, on the other hand, which is well shown in the middle of the microphotograph, Fig. 3, Plate **24**, does not appear to pass through the entire thickness of the body. The collenchymatous tracts both at the surface (Fig. 2, Plate **24**) and in the interior (Figs. 3 and 4, Plate **24**) lack the skeletal reticulum, which everywhere permeates the intervening regions.

The kind of structure, which has just been described, is obviously to be regarded as a modification brought about by the excessive development of collenchyma round the main efferent canals, coupled with the diminution in diameter of these canals. The specimens exhibiting the reticulate modification are elsewhere like the other individuals, the body being penetrated by the common larger type of efferent canal, the surface appearing uneven, uniformly dense, without obvious collenchyma, and showing irregularly scattered oscula about 1 mm. in diameter.

The pores, measuring 60–150 μ in diameter, are scattered irregularly but thickly on both surfaces of the body over the solid tissue intervening between the oscula, vestibular spaces, or the reticulately arranged collenchymatous areas. The flagellated chambers have a shrivelled appearance due doubtless to the faulty preservation. They now measure about 20 μ in diameter, and their arrangement indicates them to be eurypylous.

Spicules. Megascleres. 1. Style, 210–220 μ x 12–16 μ, Fig. 8, Plate **20.** Spicule nearly cylindrical, slightly curved, spinose with small sharp prickles. The prickles are more abundant near the ends, less abundant in the middle. The extreme point is smooth. Rounded end and spinose region near the point sometimes slightly dilated.

2. Tylote, 220–240 μ x 7–8 μ, Fig. 9, Plate **20.** Spicule slightly

thicker in the middle, tapering toward each end. Heads small, minutely spinose over distal half. Frequently one or two prickles on shaft, close to ends. Precise character of end varies: end commonly enlarged and rounded, but sometimes enlarged and irregular; sometimes not enlarged.

Microscleres. 3. Bipocillus, 12–16 μ long, Fig. 7 *a* and *c*, Plate **20**. Curved axis shows a thickened median keel, which disappears toward small end of spicule. On each side of keel, axis thins away, forming a lateral flange which is sharply separated by a rounded incision from the terminal plate. Axis terminates at one end, the larger, in a thin plate-like expansion which has a spherical curvature, and is divided by a narrow median incision into two lobes. At the other end axis terminates in two pointed teeth, which project toward the larger end.

4. Anisochela, 14–28 μ long, Fig. 7 *b*, Plate **20**. The smaller sizes are the commoner. Spicule of palmate type; a little spine at the smaller end.

Skeletal Arrangement. Main skeleton a uniform reticulum of spinose styles. Meshes are commonly triangular, but the shape may be construed as due to the fact that a spicule or a small fascicle of spicules extends obliquely across a *squarish* mesh, acting perhaps as a brace. Side of mesh equal to length of a spicule and formed by 1, 2, 3 or occasionally more spicules. At the corners of the meshes the spicules are united by masses of spongin, which is colorless.

Dermal skeleton consists of the outermost layer of the skeletal reticulum, and of scattered tylotes. The latter are frequently found in loose fascicles or tracts, and occur throughout the dermal membrane.

The microscleres are present in the dermal membrane, and in the parenchyma. They are very abundant in the walls of many of the canals.

Iophon lamella indivisus, subsp. nov.

Plate 20, Figs. 14-16.

Diagnosis. Sponge distinguished from the type by the character of the bipocillus, which is not chelate. Bipocillus, 8–10 μ long, terminating at the large end in a curved plate of rounded outline, which is ordinarily not divided, terminating at the other end in a smaller plate with denticulate margins.

Station 3405, 6 specimens.

Along with the specimens of *Iophon lamella* were taken six other specimens, four of which are fragmentary, having the same plate-like habitus and the same general arrangement of the canals. The skeleton too is similar to that of *I. lamella* except in the matter of the bipocilli.

The upper surface of a specimen is shown in Fig. 16, Plate **20**, and the lower surface of the same in Fig. 14, Plate **20.** The efferent canals as in the type pass into the body from both surfaces, sometimes passing through from one surface to the other. As in the type the upper surface is lighter in color, and bears more numerous oscula than the lower surface. On the lower surface elongated vestibular spaces are extensively developed, appearing as furrows lined with smooth membrane. The flagellated chambers are of the same size as in the type.

The two good specimens differ from the type as regards the detailed appearance of the upper surface. The point is doubtless one of individual difference, and in the remaining specimens could not be determined. In these two specimens the upper surface bears abundant depressions, many of which are furrow-like. The efferent canals open in the depressions (Fig. 16, Plate **20**). Here and there several efferent canals, instead of opening separately, unite beneath the dermal membrane of this surface to form a vestibular space, essentially similar to those which are more conspicuously developed on the lower surface.

Skeleton. The *megascleres*, styles, and tylotes, are like those of the type, and the skeletal arrangement offers no points of difference.

Microscleres. 1. Bipocillus, 8–10 μ long, Plate **20**, Fig. 15, *a, c, d, e, f.* The curved axis terminates at one end in a thin plate-like expansion having a spherical curvature and a rounded outline. This is usually undivided, but occasionally spicules are found in which it is divided by a deep median incision into two lobes, as in *I. lamella.* At the other end the axis terminates in a smaller curved plate, which is pointed, and in which the free edge on each side of the terminal point is minutely denticulate. Axis itself, near the larger end of the spicule, flattens out on each side, forming a thin lateral flange, which is separated from the terminal plate by a rounded incision. The spicule is scantily present in the parenchyma, more abundant in the dermal membrane.

2. Anisochela, 12–28 μ long, Plate **20**, Fig. 15 *b.* Spicule does not differ from anisochela of the type, and is scantily present in the dermal membrane and parenchyma.

Comparative. The chelate character of the bipocillus makes a striking point of resemblance between *Iophon lamella* and *Iophon chelifer* R. and D.

But when a comparison is made between the three forms *I. chelifer ostiamagna*, *I. lamella*, and *I. lamella indivisus*, it becomes obvious that the chelate character is in itself not a guide to relationship. On the one hand, two sponges (*I. chelifer* and *I. lamella*) may occur which differ widely in most respects, but agree in having the chelate bipocillus. While on the other hand two sponges (*I. lamella* and *I. lamella indivisus*) occur agreeing in most particulars, but having the one chelate, the other non-chelate bipocilli.

Iophon indentatus, sp. nov.

Plate 19, Fig. 6; Plate 20, Figs. 1, 5, 6; Plate 23, Fig. 4.

Diagnosis. Sponge incrusting, 2–3 mm. thick, fragile, of brown color. Surface indented with polygonal collenchymatous depressions 0.5 to 1 mm. in diameter, separated by narrower ridges of more solid skeletogenous tissue. Oscula, 150–200 μ in diameter, occupy the centres of the depressions. Pores, 75 μ in diameter, scattered over the ridges. *Spicules.* 1. Spinose style, 220 μ x 14–16 μ. 2. Subtylote, 220 μ x 8 μ, minutely spinose at extreme ends. 3. Bipocillus, 8 μ long; smaller end, a curved plate with denticulate margins; larger end, an undivided curved plate of a rounded outline. 4. Anisochela, 14 μ long, palmate. Main skeleton a uniform reticulum of spinose styles. Side of the squarish or triangular mesh formed by 1, 2, or occasionally 3–4 spicules.

Station 3405, 3 specimens.

The sponges are all incrusting upon a *Gorgonia.* The incrustation is 2 to 3 mm. thick, extending in places in the shape of sheets which occupy the axils of the *Gorgonia* branches. The color is a rather light brown. Sponge fragile, easily torn and broken.

The surface (Fig. 1, Plate **20**) is indented with collenchymatous depressions of a polygonal or rounded polygonal outline, 0.5 to 1 mm. in diameter. These depressions, which appear to the eye translucent and gelatinous, are separated by considerably narrower ridges composed of the more solid sponge tissue. A small osculum, 150 to 200 μ in diameter, lies about in the centre of an area, and in some areas is surrounded by a few other smaller apertures. Between the collenchymatous areas, over the surface of the ridges, abundant pores measuring about 75 μ in diameter are irregularly scattered. The surface resembles that of the smooth, reticulate portions of *Iophon lamella* (Fig. 2, Plate **24**), but the collenchymatous areas are considerably smaller and less sharply limited than in the latter species.

The oscula lead into main efferent canals which penetrate deeply into the interior of the sponge, where they continue to be surrounded by a thick layer of collenchyma. The canals are of about the same diameter as the oscula. Some of them are, throughout the thickness of the sponge, radially directed to the surface, but more are obliquely inclined, often curving so that a section which is vertical to the surface of the sponge cuts them transversely. This is the case in Fig. 4, Plate **23**, which represents such a section taken through the *Iophon* and a part of the underlying *Gorgonia* axis.

The collenchyma surrounding a main canal in the sponge interior forms a roughly cylindrical tract traversed by the canal, and preserving approximately the diameter which it has at the surface of the sponge. These tracts cut the sponge body up into intervening regions permeated throughout their extent by the skeletal reticulum, which does not extend into the collenchymatous tracts themselves. The parts of the body permeated by the skeletal reticulum may be thought of as partitions between the collenchymatous tracts. These partitions more commonly have a thickness less than the diameter of the collenchymatous tracts, appearing in sections as thin trabeculae, as in Fig. 4, Plate **23**. Elsewhere, however, in the same specimen the skeletogenous partitions may appear as thick masses. As regards the arrangement of the main canals and the relative disposition of skeletogenous and collenchymatous tracts in the sponge interior, there is much resemblance between this species and the reticulate specimens or parts of specimens of *I. lamella,* but in the latter the main canals are more frequently radially directed, and both the collenchymatous tracts and intervening skeletogenous portions are thicker and probably on this account appear better defined in sections (Plate **24**, Figs. 3 and 4).

Spicules. Megascleres. 1. Style, 220 μ x 14–16 μ, Plate **20**, Fig. 5. Spicule spinose with small, sharp prickles, which are stronger and more numerous near the ends. Extreme point smooth. Slightly curved, nearly cylindrical, very slightly enlarged at rounded end and near the point.

2. Subtylote, 220 μ x 8 μ, Plate **20**, Fig. 6. Very slightly, scarcely at all, curved. Tapering a little from the middle toward ends, which are scarcely enlarged and most minutely spinose. Shaft in general smooth, but near the ends are a few scattered prickles.

Microscleres. 3. Bipocillus, 8 μ long, Plate **19**, Fig. 6 *b, c, d, e.* Curved axis at the smaller end terminates in a spoon-shaped expansion with denticulate margins. This expansion at the extreme end sometimes appears rounded, and sometimes angular. The difference in appearance is probably due to a difference in position, and the end is probably always angular. Toward the other end the axis develops the usual thin lateral flange, beyond which there is the usual incision separating the flange from the large terminal plate with rounded outline and spherical curvature. The denticulate plate is sometimes nearly equal in size to the larger plate. In minute details the spicule differs from the very similar bipocillus of *I. lamella indivisus* (comp. Plate **20**, Fig. 15).

4. Anisochela, 14 μ long, Plate **19**, Fig. 6 *a*. Spicule, of the palmate type common in the genus, with a little spine at the smaller end.

Skeletal Arrangement. Main skeleton consists of a uniform reticulum of spinose styles. Meshes squarish or triangular. The side of a mesh is equal to the length of a single spicule, and is formed by one, two, or occasionally three or four spicules. Spicules at the corners of the meshes are united by spongin.

Dermal skeleton consists of the superficial layer of the skeletal reticulum and of abundant subtylotes, which are scattered irregularly, often in loose tracts.

The microscleres are abundant in the dermal membrane; also present in considerable abundance throughout the parenchyma, especially in the walls of, and in the tissue immediately surrounding, the larger canals.

Comparative. Ridley and Dendy combine (1887, p. 117), under the name of *Iophon pattersoni* (Bwk.), a number of previously described species, and record under this head specimens taken by the "Challenger" off the coast of Patagonia and Tristan da Cunha. All of these forms have palmate anisochelae with pointed smaller ends, up to 30 μ long, and minute bipocilli. *Iophon indentatus* must be very similar, judging from Bowerbank's figures, in surface appearance to one of the species combined, *viz.*: *Halichondria nigricans* Bwk. (Bowerbank, 1866, pp. 266–68; Bowerbank, 1874, Plate XLV. Fig. 25) which occurs as a "massive" body and also incrusting. I have examined type specimens in the British Museum of this and the other Bowerbank *Iophons*, but the specimens are dried and old, and no longer permit the character of the surface and the canal arrangement to be studied. According to Ridley and Dendy (*l. c.*, p. 118) in *Halichondria nigricans* the spined styles measure 218 μ x 8 μ, the tylotes 195 μ by 3 μ, and are thus much slenderer than in *I. indentatus*.

Iophon indentatus also resembles in surface appearance *Alebion proximum* Ridley (Ridley, 1881, p. 114), another of the species combined by Ridley and Dendy. But the styli here are 158 μ x 9 μ, and thus much smaller than in my sponge. Moreover, the skeletal reticulum is described as composed of primary fibres, five to six spicules thick, running from the base to the surface and crossed by secondary bars approximately at right angles, — an arrangement not found in *I. indentatus*.

The "Challenger" specimens of *Iophon pattersoni* R. and D., which I have examined, differ markedly in surface appearance from my form. They are, as Ridley and Dendy describe them, massive and amorphous. I may add that they are honeycombed with comparatively large canals, which open over the whole surface. The spines and tylotes (R. and D., 1887) are considerably slenderer than in *I. indentatus*. On the other hand, I find the bipocilli are of about the same size as in my form, and have a similar shape, the smaller end being denticulate. But this point of resemblance probably means little, since minute bipocilli with denticulate small end also occur in *Iophon radiatus* Topsent (Topsent, 1901 *a*, p. 22, Plate III. Fig. 13) and in *Iophon lamella indivisus*.

Topsent (1892 under *Dendoryx* (*Iophon*) *nigricans* Bwk.) criticises *Iophon pattersoni sensu* Ridley and Dendy, and is disposed to regard it as a heterogeneous group, on the score that some of the forms which Ridley and Dendy combine, and which have been taken several times, are readily distinguishable. I must say that I find the published data for the union of these several forms inadequate. I therefore designate my sponge as a new species, although *Iophon pattersoni* as conceived by Ridley and Dendy is probably comprehensive enough to include it.

AXINELLIDAE Ridley and Dendy.

Phakellia Bwk.

1864. *Phakellia* Bowerbank, 1864, p. 186.
1880. *Phakellia* Bwk., O. Schmidt, 1880, p. 81.
1887. " " Vosmaer, 1887, p. 341.
1887. " " Ridley & Dendy, 1887, p. 169.
1894. " " Topsent, 1894*a*, p. 25.
1896. " " Dendy, 1896, p. 235.
1897. " " Lendenfeld, 1897, p. 114.

Phakellia lamelligera, sp. nov.

Plate 18, Fig. 10; Plate 19, Figs. 2, 3; Plate 25, Figs. 1, 3, 4.

Diagnosis. Sponge body a cup with much-fluted wall, fluting increasing toward margin of cup. Wall of cup lamellate, 2–3 mm. thick, strongly hispid on both surfaces. Color light brown.—— Inner or oscular face of cup studded with oscula 300–500 μ in diameter and about 1 mm. apart. Outer or pore surface studded with rounded pore-membranes 300–500 μ in diameter and about 1 mm. apart. Main afferent and efferent canals alike, 300–500 μ wide, and passing radially into the lamella from the oscula and pore-membranes, respectively. —— *Spicules.* 1. Oxea, 540 x 32 μ. 2. Style, 400 x 30 μ. 3. Style, 1275 x 28 μ. Skeletal framework a continuous reticulum made up of spiculo-fibres which have the shape of flattened bands or lamellae extending at right angles to the surfaces of the sponge.

Station 3368, 1 specimen.

Sponge body (Fig. 3, Plate **19**) is a folded lamella which has assumed the shape of a cup with a fluted wall. Cup is compressed from side to side, and is thus wider in one horizontal axis than in the others. The folds increase in extent from the base toward the free edge. Below, the cup narrows to a base which is composed of two short irregular peduncular portions, situated close together. Total height of cup, 63 mm.; greater horizontal diameter, 110 mm.; smaller horizontal diameter, 55 mm. Thickness of lamellar wall in lower part of cup, 3 mm. Wall is thinner above, about 2 mm. thick just below the free edge. Edge itself is comparatively sharp. Both inner and outer surfaces of the cup are hispid with closely set styles, which project about 1 mm. beyond the surface. Consistency firm, but sponge easily broken. Color, light brown.

The two surfaces are much alike, although one, the inner, is probably the oscular, and one, the outer, probably the pore surface. From both surfaces numerous main canals 300–500 μ in diameter and about 1 mm. apart pass radially into the body. They penetrate deeply into the body, the canals of opposite surfaces interdigitating as in *Phakellia ventilabrum* (Ridley and Dendy, 1887, Plate XLIX. Fig. 3). The canals debouching on the inner surface, efferent canals, open for the most part by single oscula nearly as wide as the canals themselves, and bounded by a narrow rim of oscular membrane. Rarely, instead of a single osculum there is a fenestrated membrane, including two or three apertures. Between the oscula the dermal membrane of this surface is perforated by scattered apertures of small size, 75–150 μ in diameter, resembling pores in appearance. Such small apertures are in some places abundant.

The corresponding canals of the opposite surface, afferent canals, are roofed in by pore-membranes, which in some instances are perforated by from one to a few (3 or 4) pores. But in many cases the membranes are imperforate, the pores doubtless being closed. The open pores have a diameter ranging from 75 to 200 μ. The dermal membrane of this surface between the apertures of the large canals is doubtless, in the natural state, perforated by abundant, irregularly scattered, pores. At any rate very numerous short radial canals, 75–150 μ in diameter, abut directly against it. The circular areas of thin membrane covering in such canals are mostly imperforate, but in some cases show an open pore.

The flagellated chambers are rounded, 32–40 μ in diameter, and their arrangement in the sponge trabeculae indicates them to be eurypylous.

Spicules. 1. Oxea, 540 μ x 32 μ, with smaller sizes, Plate **19**, Fig. 2, *a*, *b*, *f*, *g*. Spicule may be nearly straight (*f*), strongly bent (*b*), slightly bent (*g*), or evenly and slightly curved (*a*). It is smooth and tapers from the middle to the moderately sharp or rounded points.

2. Small style, 400 μ x 30 μ at the base, Plate **19**, Fig. 2, *c*, *h*, *i*. Spicule is smooth and tapers evenly from rounded base to the sharp point. It may be straight (*h*), slightly bent near the base (*i*), or sharply bent near the base (*c*).

3. Large style, 1275 μ x 28 μ at the base, Plate **19**, Fig. 2, *d*, *e*. Spicule is smooth, and tapers evenly from rounded base to the sharp point. It may be nearly straight (*e*), or conspicuously bent (*d*).

Skeletal Arrangement. Wall of sponge is supported by a continuous skeleton, Plate **18**, Fig. 10, consisting of a reticulum of spiculo-fibres, which are flattened at right angles to the surface of the sponge, and thus have the character of bands or lamellae, Plate **25**, Fig. 1. The meshes are elongated in the direction of radii extending upward from the base toward the free edge of the sponge. Thickness of skeletal lamella (*i. e.* its narrower cross diameter), about 375 μ. Meshes of the reticulum frequently about 1800 μ x 500 μ. The reticulum may be regarded as a system of upwardly extending, branching fibres, the flat surfaces of which are connected together by anastomoses.

The flattened skeletal lamellae vary in character. They may extend nearly through the sponge wall from one surface to the other, or only a part of the way (Plate **25**, Fig. 1). The lamellae may be quite unbranched in the plane in which they are flattened (Plate **25**, Fig. 4), or they may be branched in this plane (Plate **25**, Fig. 3). In some cases the lamella is so branched as to be vaguely divisible into a main fibre and secondary fibres extending out from it to the surface. The lamellae in the upper part of the sponge are more commonly branched in the plane of flattening than is the case in the lower part of the body.

The skeletal lamellae are composed largely of oxeas (Spicule 1), closely packed and interlaced. From the general surface of the lamella project abundant short styles (Spicule 2), while from the edges of the lamellae that are adjacent to the surfaces of the sponge, numerous long styles (Spicule 3) project (Plate **25**, Figs. 1, 3, 4). It is these latter spicules which protrude beyond the surface of the sponge and give to the latter its hispid character. —— The spicules of a lamella are united together by pale spongin. The spicules and spongin do not form a continuous solid mass. Nevertheless the spicules are so crowded that only small rounded gaps are left unoccupied by either spicules or spongin.

The peduncular part of the sponge is occupied by a strong massive skeleton with which the skeletal lamellae are continuous. This peduncular skeleton has the same character as one of the skeletal lamellae. It consists of closely and irregularly strewn spicules, chiefly oxeas, so cemented together by spongin as to produce a nearly continuous mass, which is excavated only here and there by areolae. The spongin is more abundant than in the skeletal lamellae.

Comparative. The arrangement of the skeletal framework in this species is very different, although derivable from that in the well-known *P. ventilabrum* (Johnston). In the latter only the middle plane of the lamella, which may be 4 mm. thick, is occupied by the reticulum of longitudinal fibres. From these, long loose bundles of spicules pass radially to the opposite surfaces (Bowerbank, 1864, p. 367, Plate XXXIII.). In *P. lamelligera* a flattened skeletal lamella may be regarded as the equivalent of a longitudinal fibre, on which the radial outgrowths are so thick as to be continuous.

In *P. folium* O. Schm. from the Florida coast (O. Schmidt, 1870, p. 62), the entire thickness of the lamella is occupied by the reticulum of longitudinal fibres as in *P. lamelligera.* But the lamella is thin, about 1 mm. thick in the piece examined (from a specimen in the Museum of Comparative Zoölogy), and the spiculo-fibres are slender and not flattened. The spiculation in Schmidt's species is very similar to that of *P. ventilabrum.*

Auletta O. Schmidt.

1870. *Auletta* O. Schmidt, 1870, p. 45.
1882. *Auletta* Schm., Vosmaer, 1882, p. 41.
1887. " " Vosmaer, 1887, p. 341.
1889. " " Dendy, 1889, p. 92.
1894. " " Topsent, 1894 *a*, p. 25.

Auletta dendrophora, sp. nov.

Plate 19, Figs. 4, 5, 7; Plate 25, Fig. 2.

Diagnosis. Sponge arborescent, produced by the continued branching of an originally simple cylindrical body. Terminal branches, "persons," 5 mm. in diameter and 15–20 mm. high, with terminal oscula. Paragastric cavity cylindrical, about 1.5 mm. in diameter, and continuous throughout the colony. Obliquely branching radial canals extend from the paragastric cavity toward surface. Pores, irregularly scattered between the projecting tufts of spicules, open into subdermal chambers. Color, light yellowish brown. —— *Spicules.* 1. Strongyle, slightly curved once or oftener, commonly 400–600 μ x 18–20 μ. 2. Style, common size in longitudinal fibres, 600 μ x 22 μ; common size in radial fibres, 360 μ x 18 μ. 3. Style, 170 μ x 8 μ. Skeletal framework consists of longitudinal spiculo-fibres with transverse connectives, and of radial fibres, which extend from the longitudinal fibres to the surface, there ending in projecting tufts of spicules.

Station 3405, 2 specimens, one fragmentary.

The sponge, which may be regarded as a continually branching cylinder, consists of a short vertical stalk, above which the branches spread outward and upward, fusing with one another to a considerable extent over their lateral faces. In the perfect specimen (Fig. 7, Plate **19**), the stalk is 10 mm. high and 8 mm. thick, and was obviously attached by its somewhat expanded and concave lower end. The total height of the specimen is 55 mm. and the greatest breadth 75 mm. From the apex of the stalk the branching has not extended symmetrically in all directions. If a vertical plane be passed through the stalk and the direction of greatest width, the branching will be found to have taken place in this plane and to one side of it, but scarcely at all toward the opposite side. The colony thus, when viewed from above, presents roughly a semicircular outline, and when viewed from the side, presents one flattened face, which is the face shown in the figure.

The growth is of such a character that a branch tends to produce several upright terminals, one after another, approximately in the same plane. This is much more marked in the case of some branches than in others. Where it is marked the partial fusion of the terminal branches over their lateral faces results in the formation of imperfect, vertical lamellae, which, however, are only indistinctly developed as such. The terminal branches are cylindrical, rounded at the free end, where there is a depression occupied in a few cases by an open, circular osculum, but in general by an oscular membrane, which in the present condition of the sponge is imperforate. When the osculum is widely open, it occupies the whole of the depression, and is 2 mm. in diameter. The oscular membranes doubtless represent closed oscula.

The terminal branches are about 5 mm. in diameter, and for the most part 15 to 20 mm. high. Their axial (paragastric) cavities, opening above by the terminal oscula, are continuous below with one another and with the axial cavity traversing the rest of the colony. This cavity throughout the colony has a fairly uniform diameter close to 1.5 mm. The wall of the colony is about 2 mm. thick, in some of the terminal branches thinning down to 1.5 mm.

Color, a very light yellowish brown inclining to ashy. The sponge is tough, firm, and in some measure compressible, flexible, and elastic. The surface is covered with the projecting tufts of spicules belonging to the radial spiculo-fibres. These are just perceptible with a lens, barely so to the touch.

The pores in general are closed, but in places are open. They are in such regions scattered abundantly and without regularity of arrangement over the dermal membrane between the projecting tufts of spicules, and measure 50 to 80 μ in diameter. The pores open into subdermal chambers which in large number underlie the dermal membrane. The subdermal chambers, when seen from the surface, present a lobulated appearance, owing to the fact that they consist of several spheroidal subdivisions freely connecting and often so arranged that the chamber itself is considerably elongated in the tangential direction. The width of the chambers is approximately the space between adjacent dermal tufts of spicules. In Fig. 5, Plate **19**, which represents part of a section radial to the surface, a characteristic subdermal chamber, *s. c.*, is shown, which has been cut lengthwise. It connects with a radially extending afferent canal.

Into the paragastric cavity radial efferent canals open, which lie between the radiating skeletal bundles. These canals, as they are traced toward the surface, branch obliquely. The rounded internal openings of the radial canals measure 250–425 μ in diameter, and are conspicuous in face views of the wall of the paragastric cavity (Plate **19**, Fig. 4). Flagellated chambers not recognizable. A small commensal annelid is present in the canals in the neighborhood of the surface of the sponge.

Skeletal Arrangement. The inner part of the sponge wall, next the paragastric cavity, is strengthened by a framework of spiculo-fibre, consisting of main longitudinal fibres 100–300 μ wide with slenderer connectives (Plate **19**, Fig. 4, face view of wall of paragastric cavity; Plate **25**, Fig. 2, longitudinal section through sponge wall). The longitudinal fibres give off branches, which extend radially through the sponge wall (Plate **25**, Fig. 2). The radial fibres themselves may branch once or twice before reaching the surface. They or their branches end in tufts of spicules, which project a short distance beyond the surface. The spicules of a fibre are united by a small amount of colorless spongin.

Spicules. *1. Strongyle* (Plate **19**, Fig. 4), curved once or oftener; smooth; usually but not always tapering slightly toward the rounded ends; degree of attenuation not always the same for the opposite ends of a spicule. Size, commonly 400–600 μ x 18–20 μ. Smaller sizes down to 280 μ x 12 μ, and larger sizes up to 800 μ x 20 μ are common. Exceptionally stout spicules, for instance, one measuring 714 μ x 26 μ, and exceptionally slender spicules, for instance, one measuring 680 μ x 14 μ, are sometimes met with.

This is the chief spicule in the longitudinal fibres and connectives. It is also present in the radial fibres, though here less abundant than the style. One or two of these spicules may sometimes be found passing between the deeper portions of the radial bundles, as feeble connectives.

2. Style (Plate **19**, Fig. 5), smooth, straight, or somewhat curved at the base, sharp-pointed; sometimes attenuated at the rounded end. Present in the longitudinal fibres, but not very abundant; here commonly about 600 μ x 22 μ, but larger forms up to 850 μ x 24 μ are found.

The style is the chief spicule in the radial fibres, projecting obliquely upward and outward from the fibre (Plate **25**, Fig. 2). At the end of the fibre styles project beyond the surface forming a tuft. The common size in the radial fibre is about 360 μ x 18 μ, although somewhat smaller ones and larger ones up to 730 μ x 20 μ are present.

3. Small style (Plate **19**, Fig. 4; Plate **25**, Fig. 2), commonly bent near the base. Rounded base of spicule may be either not attenuated or attenuated. Occasionally the base is pointed, the spicule thus becoming an oxea. Common size, about 170 μ x 8 μ.

The spicules project out at right angles from the longitudinal fibres and connectives, and from the deeper parts of the radial fibres. They are thus true echinating spicules, but not nearly so conspicuous as in the *Ectyoninae.* They are not present in great abundance anywhere, and transitions between them and the larger styles occur.

Comparative. The species just described is close to the type of the genus, *Auletta sycinularia* Schm. (O. Schmidt, 1870, p. 45, Taf. IV. Fig. 5) from the Florida coast, a specimen of which in the Museum of Comparative Zoölogy I have examined. In *A. sycinularia* the terminal branches are slenderer than in my species, and the wall much thinner. The wall is so thin that *the superficial radiating tufts of spicules arise directly from the longitudinal fibres,* there being no radial fibres, as in *A. dendrophora.* In the specimen examined, a typical terminal branch measures 2.5 mm. in diameter, and the wall is 0.5 mm. thick. The two species contain the same classes of spicules.

In habitus *A. dendrophora* exhibits a point of resemblance to *A. aurantiaca* Dendy (Dendy, 1889, p. 92, Plate V. Fig. 13) in that fusion occurs between the lateral surfaces of the terminal branches. But the fusion is slight in my species, whereas in Dendy's the fused branches form "lamellae like panpipes." The two species differ markedly as regards the skeleton. —— The lateral fusion of the branches is carried very far in what seems to be the first *Auletta* described, *viz.*: *Spongia lyrata* (Esper, Fortsetz, II. 42, tab. LXVII. Figs. 1, 2) from Ceylon. Esper's figures and the account of the skeleton given by Ehlers (1870, pp. 23, 31) indicate that this sponge is an *Auletta.* Ehlers provisionally places the sponge, which has styles and oxeas, in *Raspaigella* Schm. Lamarck (1813, p. 382), referring to Esper's sponge, says he has a specimen in his cabinet from the collection of M. Turgot, and gives with a query the Indian Ocean as the locality.

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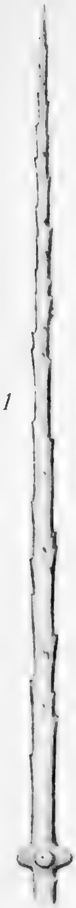
PLATE 1.

PLATE 1.

Fig.	1.	*Hyalonema pateriferum.*	Spinose diact from marginal fringe; x 400.
"	2.	" "	Pinule from oscular (gastral) surface; x 400.
"	3.	" "	Dermal pinule; x 400.
"	4.	" "	Mesamphidisc; x 600.
"	5.	" "	Macramphidisc; x 400.
"	6.	" "	Macramphidisc; x 400.
"	7.	" "	Macramphidisc; x 400.
"	8.	" "	Micro-oxyhexact; x 600.
"	9.	" "	Micro-oxyhexact; x 600.
"	10.	" "	Amphidisc with 4-rayed umbels; x 400.
"	11.	" "	Amphidisc with 4-rayed umbels; x 400.
"	12.	" "	From a photograph; $\frac{1}{1}$.
"	13.	" "	From a photograph; $\frac{4}{10}$.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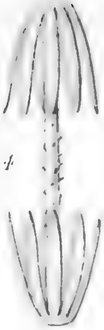
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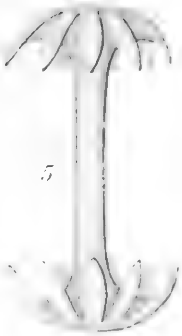
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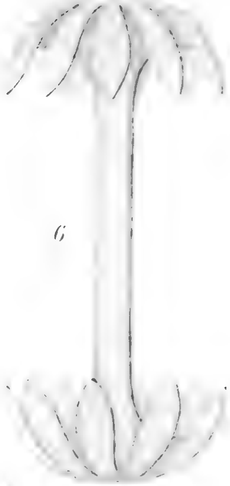
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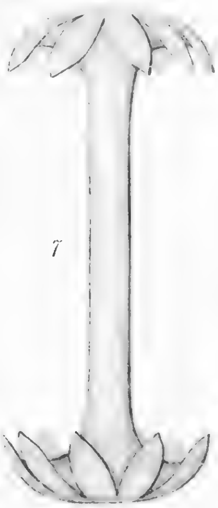
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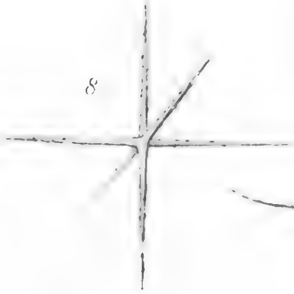
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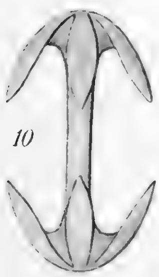
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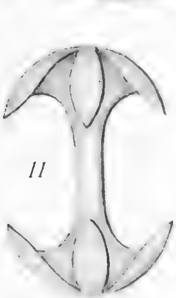
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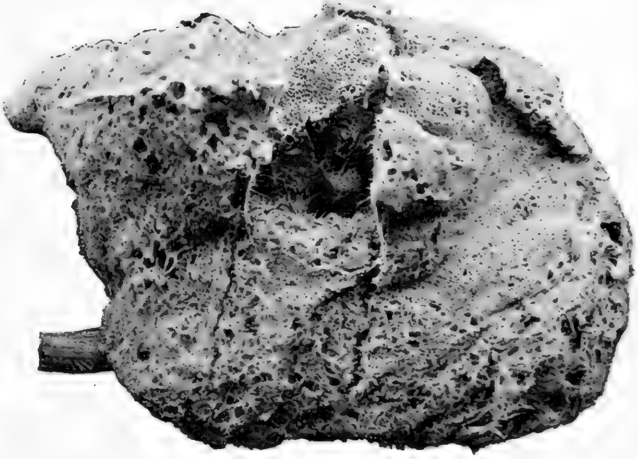
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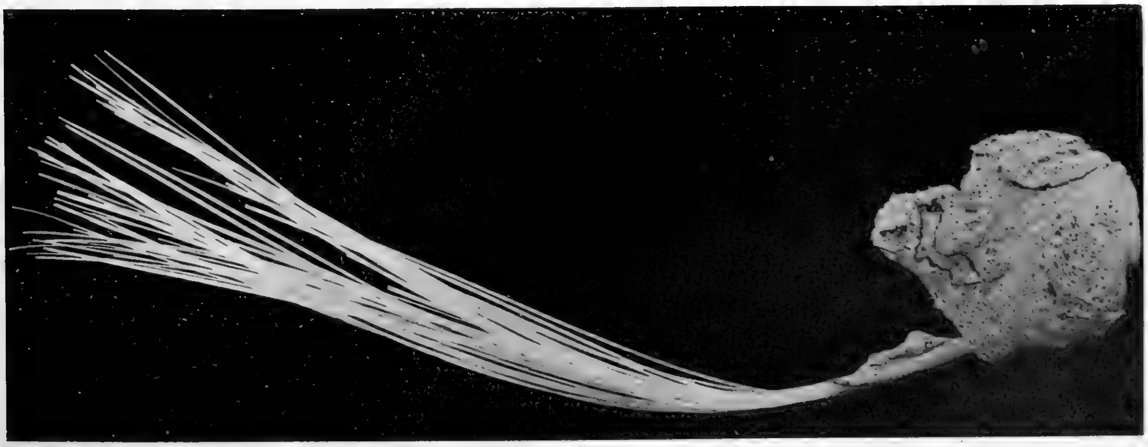
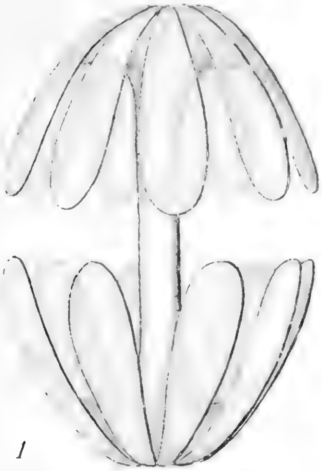


PLATE 2.

Plate 2.

Fig.	1.	*Hyalonema bianchoratum.*	Macramphidisc ; x 300.
"	2.	" "	Dermal pinule ; x 100.
"	3.	" "	Dermal pinule ; x 100.
"	4.	" "	Dermal pinule ; x 100.
"	5.	" "	Macramphidisc ; x 300.
"	6.	" "	From a photograph ; $\frac{1}{1}$.
"	7.	" "	Mesamphidisc ; x 300.
"	8.	" "	Macramphidisc ; x 300.
"	9.	" "	Micro-oxyhexact ; x 300.
"	10.	" "	Micro-oxyhexact ; x 300.
"	11.	" "	Micro-oxyhexact ; x 300.
"	12.	*Hyalonema, sp.*	Micro-oxyhexact ; x 300.
"	13.	" "	Macramphidisc ; x 300.
"	14.	" "	Mesamphidisc ; x 300.
"	15.	" "	Mesamphidisc ; x 300.
"	16.	" "	Macramphidisc ; x 300.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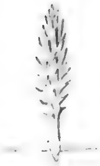
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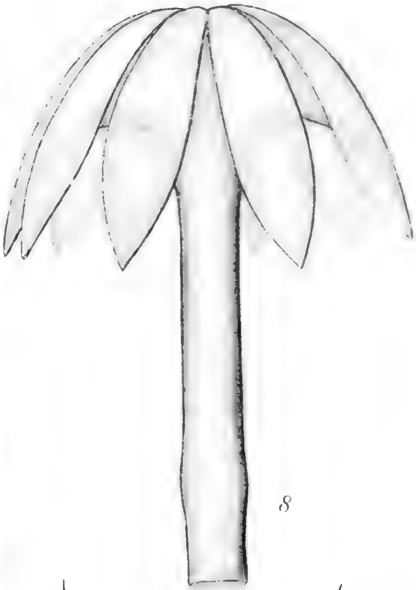
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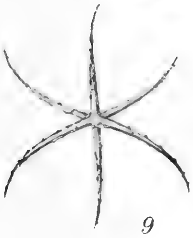
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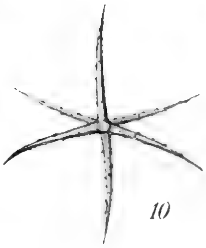
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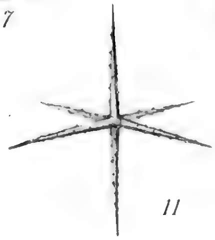
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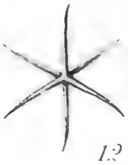
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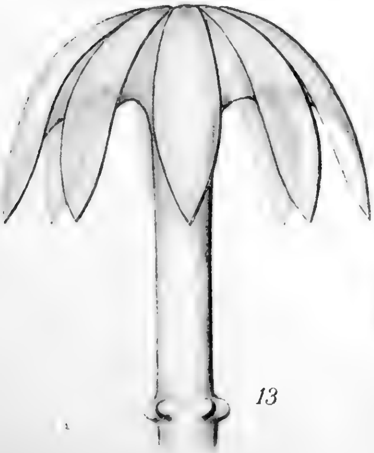
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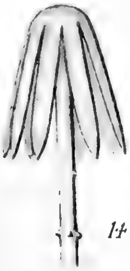
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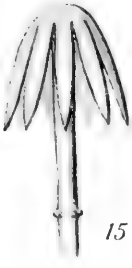
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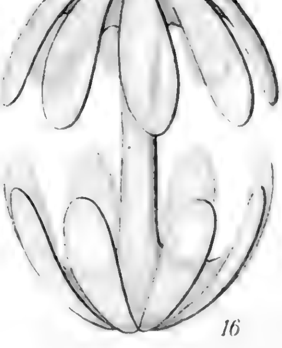
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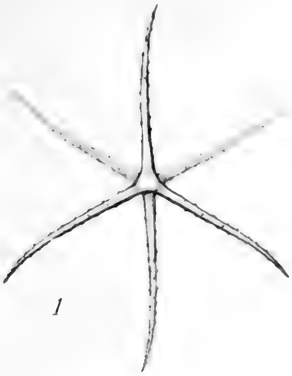
H. V. Wilson and Ew. Rübsamen, del.

PLATE 3.

PLATE 3.

Fig.	1.	*Hyalonema pedunculatum.*	Micro-oxyhexact; x 600.
"	2.	" "	Macramphidisc; x 400.
"	3.	" "	Micro-oxyhexact; x 600.
"	4.	" "	Dermal pinule; x 400.
"	5.	" "	From a photograph. Lateral part of body sliced away on one side; ¼.
"	6.	" "	Mesamphidisc; x 600.
"	7.	*Regadrella delicata.*	Part of margin bounding oscular (sieve-plate) area, with adjoining lateral body wall. Dermal surface. The slender parenchymal diacts are represented, for the sake of clearness, as less numerous than in nature; x 14.
"	8.	" "	Another part of upper margin, with adjoining lateral wall. Dermal surface. Slender, parenchymal diacts omitted except near margin, and there represented as less numerous than in nature; x 45.



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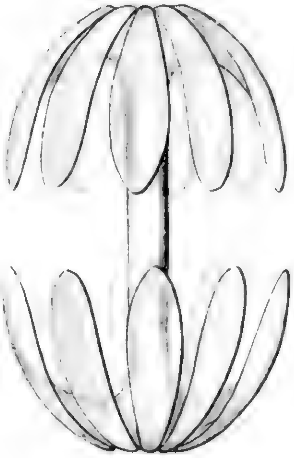

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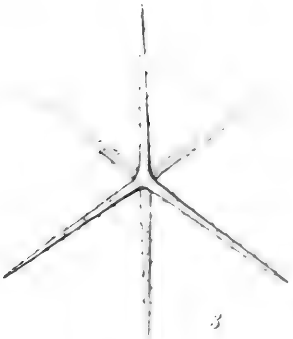

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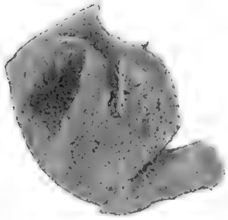

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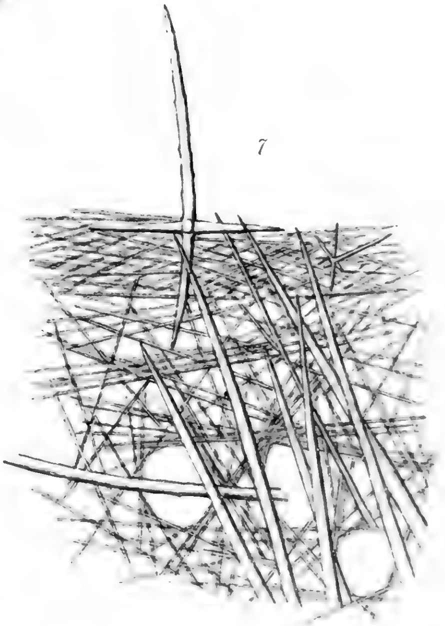

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PLATE 4.

Plate 4.

Fig. 1. *Caulophacus schulzei.* Unusual type of pinulus; x 150.

" 2. *Regadrella delicata.* Part of upper margin with adjoining lateral body wall. The slender parenchymal diacts of the body wall represented as less numerous than in nature; x 14.

" 3. *Caulophacus schulzei.* From a photograph. Upper body and stalk fastened together with pin; $\frac{1}{1}$.

" 4. *Euplectella, sp.* From a photograph. Lateral wall sliced away to show septa; $\frac{1}{1}$.

" 5. *Caulophacus schulzei.* Discohexaster; x 250.

" 6. " " Small type of discohexaster; x 250.

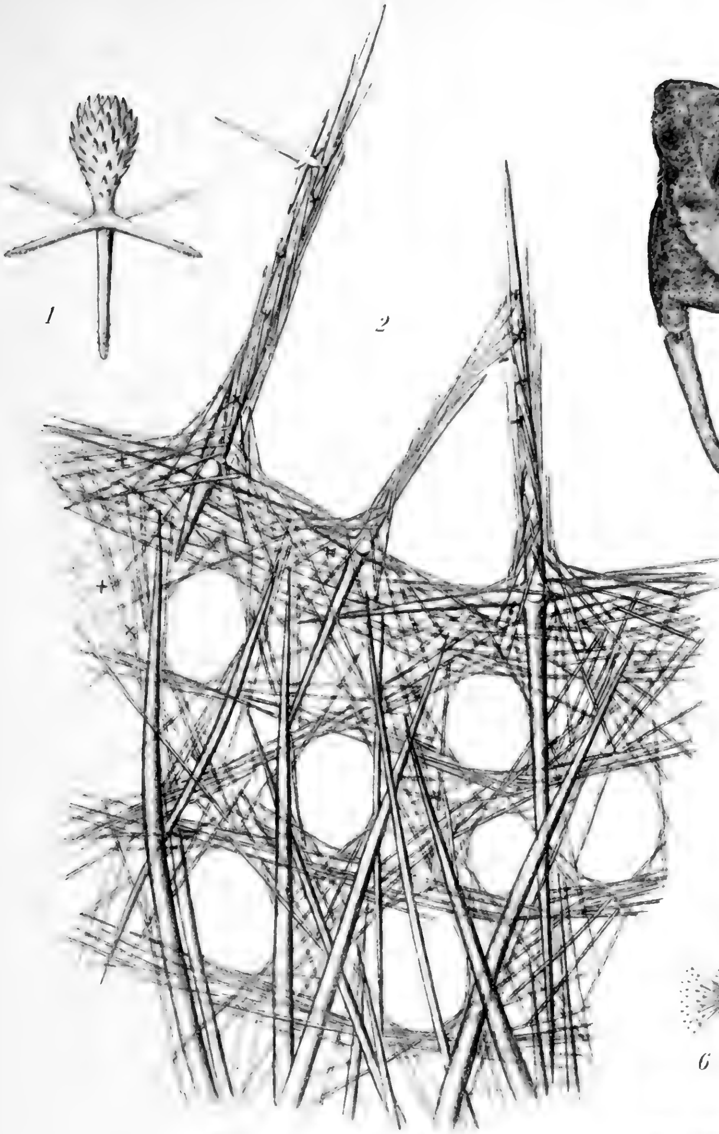
" 7. " " Pinulus from dermal surface; x 150.

" 8. " " Uncommon type of pinulus from gastral surface; x 150.

" 9. " " Pentact; x 70.

" 10. " " Pinulus from gastral surface; x 150.

" 11. *Regadrella delicata.* From a photograph. Dermal and gastral surfaces of lower part of body; dermal surface to the left; gastral surface to the right; $\frac{1}{1}$.



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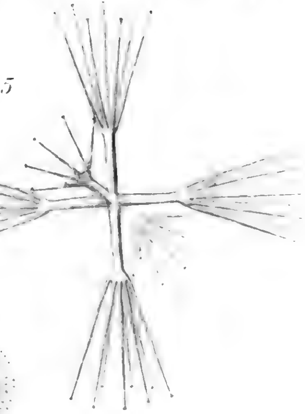

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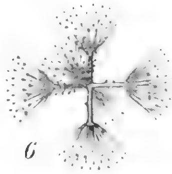

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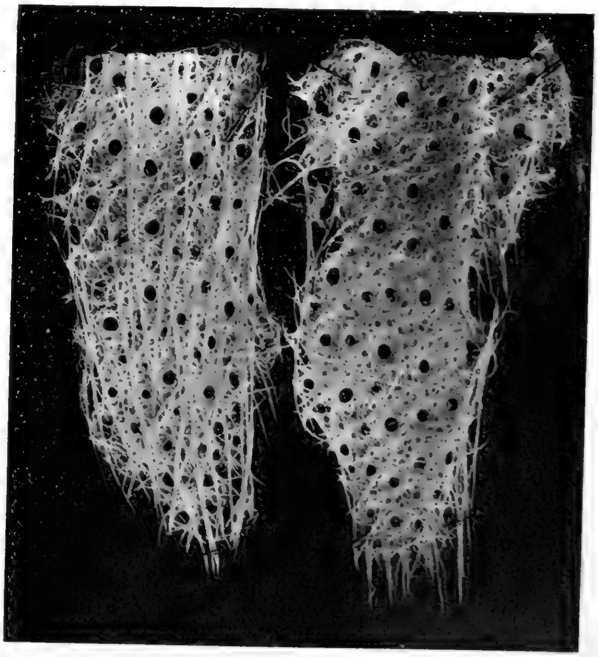

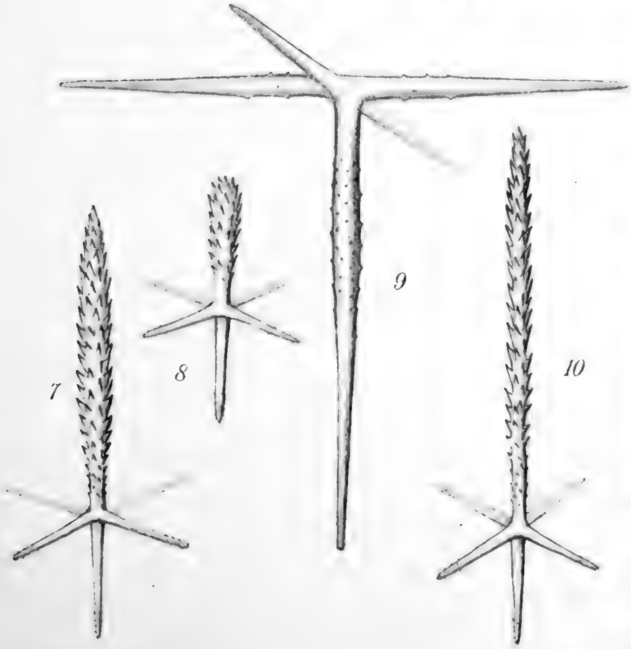

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PLATE 5.

Plate 5.

Fig.	1.	*Caulophacus schulzei.*	Spinose discohexact with some bifid rays (*Discohemihexaster* of Schulze); x 250.
"	2.	" "	Discohexaster; a complete ray showing lateral branches; x 250.
"	3.	" "	Discohexaster; x 250.
"	4.	" "	Spinose discohemihexaster that nearly reaches condition of perfect discohexaster; x 250.
"	5.	" "	Spinose discohemihexaster; centrum and one principal ray with its branches; x 250.
"	6.	" "	Discohexaster; centrum and one complete ray; x 250.
"	7.	*Caulophacus, sp.*	Stalk attached to root spicules of *Hyalonema.* From a photograph; ½.
"	8.	*Caulophacus schulzei.*	Discohexaster; a complete ray, showing asymmetrical base on which the terminals rest; x 250.
"	9.	" "	Spinose discohemihexaster; x 250.
"	10.	" "	Radial section through body showing skeletal arrangement. Thickness of section permits only larger spaces to be seen. Gastral surface uppermost; x 20.
"	11.	*Bathydorus levis spinosus.*	From a photograph; ½.
"	12.	" " "	Oxyhexaster; x 300.
"	13.	" " "	Stauracts; x 300.


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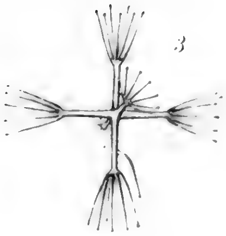
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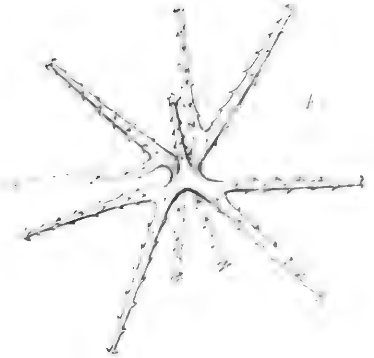
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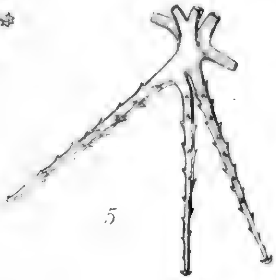
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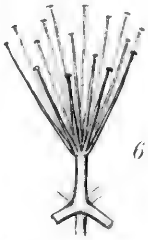
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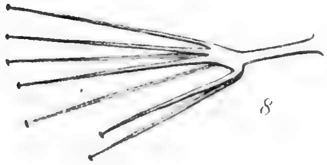
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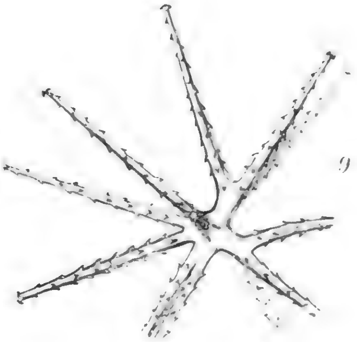
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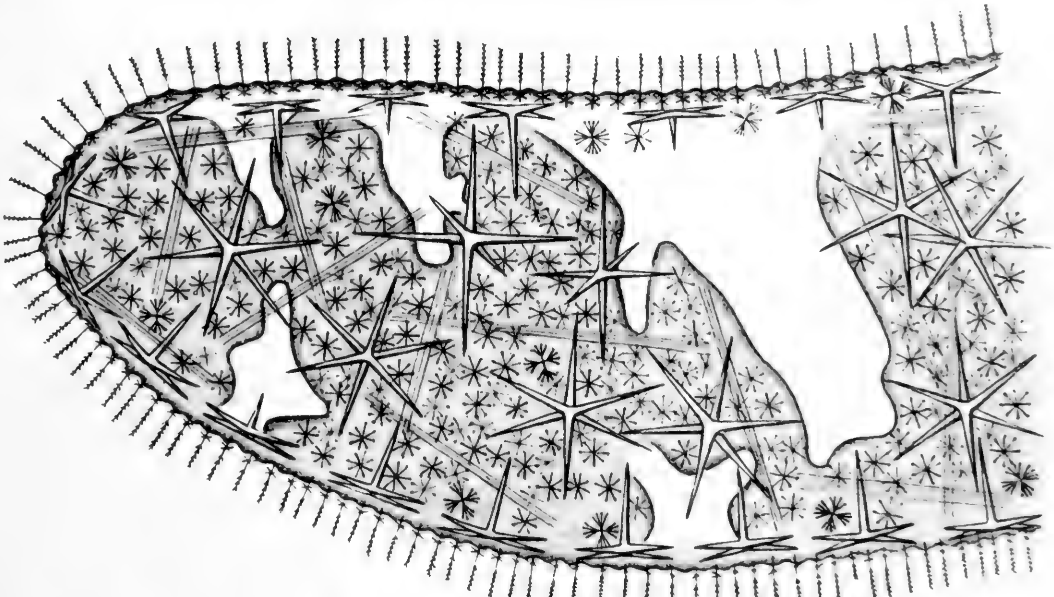
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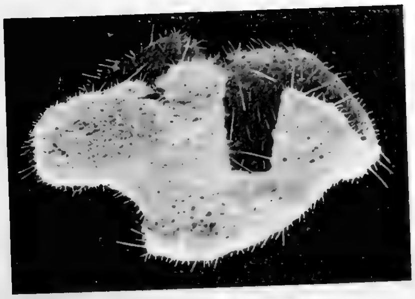
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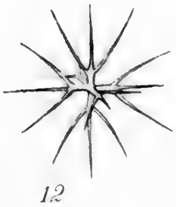
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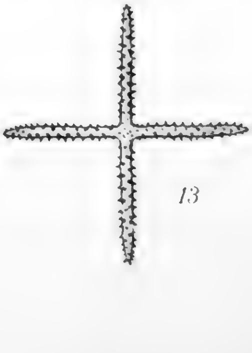
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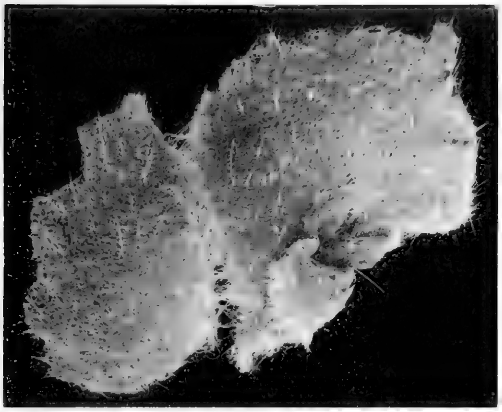
PLATE 6.

PLATE 6.

Fig.	1.	*Bathydorus levis spinosus.*	From a photograph; $\frac{1}{1}$.
"	2.	" " "	Autogastral hexact; x 300.
"	3.	*Farrea occa claviformis.*	From a photograph; $\frac{1}{1}$.
"	4.	*Staurocalyptus, sp.*	Irregular discoctaster; x 300.
"	5.	" "	Paratropal, paratangential rays of prostal pentact; from above; x 100.
"	6.	*Staurocalyptus, sp.*	From a photograph; $\frac{1}{1}$.
"	7.	" "	Part of a paratropal ray of prostal pentact; x 400.
"	8.	" "	Discoctaster with two accessory rays; x 300.
"	9.	" "	Oxyhexaster; x 600.
"	10.	" "	Discoctaster; centrum and three rays; x 450.
"	11.	*Farrea occa claviformis.*	Uncinate; the two ends of same spicule; x 450.
"	12.	" " "	Gastral clavula; from above; x 450.
"	13.	" " "	Gastral clavula; lateral view; x 450.
"	14.	" " "	Gastral clavula; lateral view; x 450.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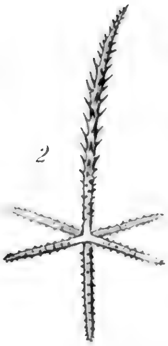
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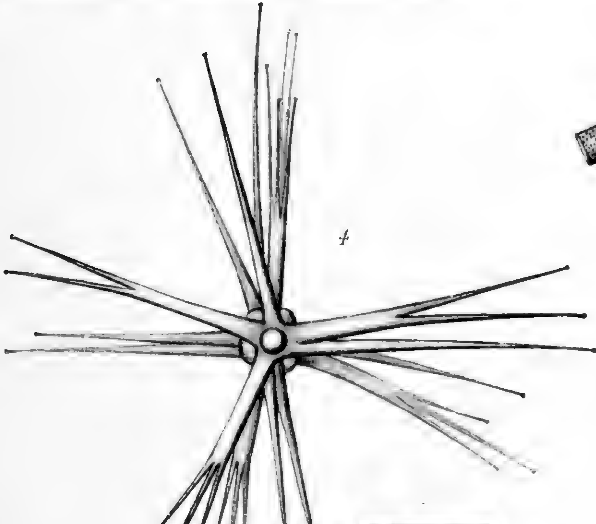
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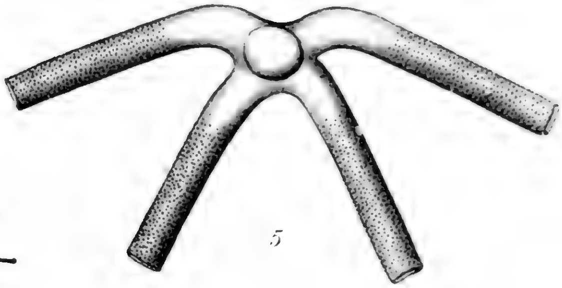
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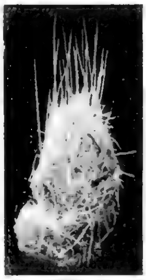
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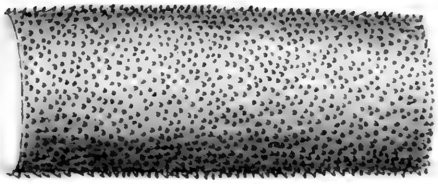
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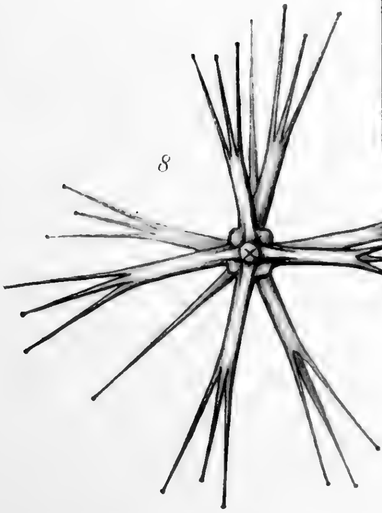
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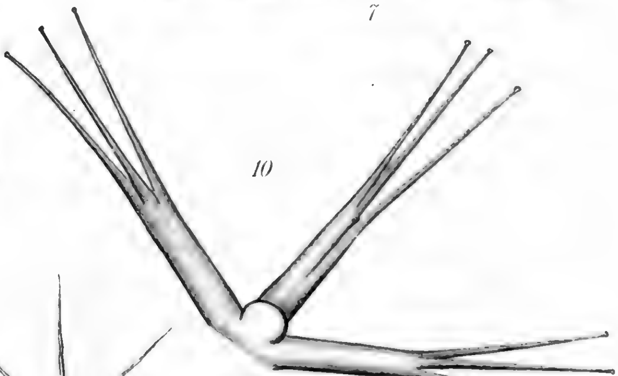
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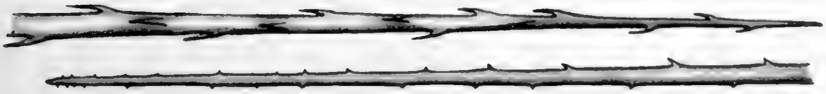
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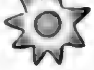
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PLATE 7.

PLATE 7.

Fig. 1, *a*, *b*, *c*. *Farrea occa claviformis.* Gastral clavulae with degenerate teeth; x 450.
" 2. " " " Dermal pentact with clavulae; x 250.
" 3. " " " Gastral clavula; rare form; x 450.
" 4. *Farrea mexicana.* Gastral anchorate clavula; x 450.
" 5. " " " " " x 450.
" 6. *Farrea occa claviformis.* Gastral pentact with clavulae; x 250.
" 7. *Farrea mexicana.* From a photograph; $\frac{1}{1}$.
" 8. " " Pentact with umbellate clavulae; x 250.
" 9. *Eurete erectum tubuliferum.* Part of surface view of sponge taken from the side. Axis of entire sponge about vertical. A completely bifurcated (tubular) lateral branch lies to the right, showing a tubular ridge, which marks the line along which the lips of the earlier, cup-like branch fused. A similar tubular ridge lies at right angles to the just-mentioned line of fusion, extending from the tubular branch on to axis of sponge. From a photograph; $\frac{1}{1}$.
" 10. *Farrea mexicana.* Gastral anchorate clavula; x 450.
" 11. " " " " " ; from above; x 450.
" 12. *Eurete erectum tubuliferum.* From a photograph. Upper end of sponge, from above; $\frac{1}{1}$.

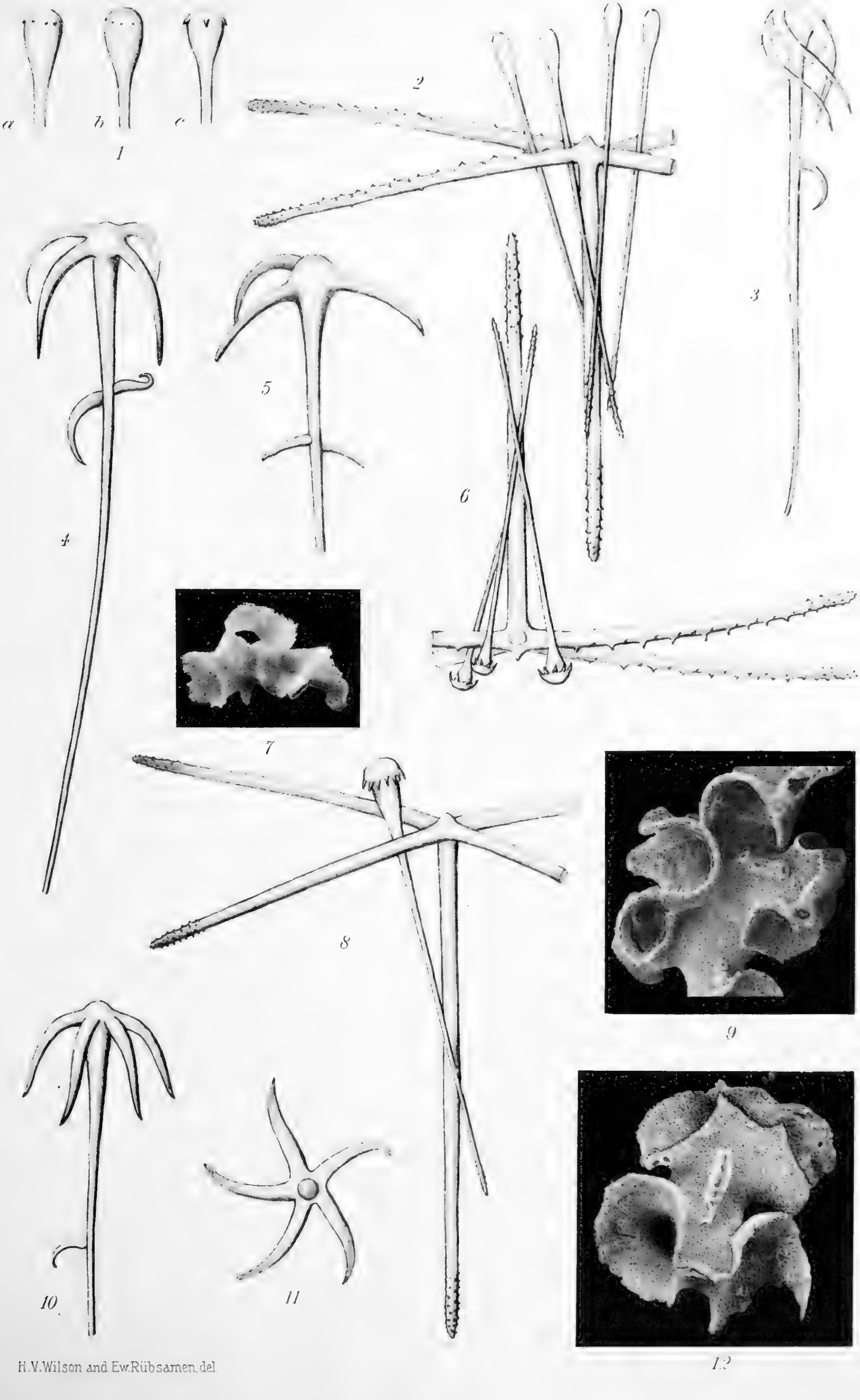

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PLATE 8.

PLATE 8.

Fig. 1. *Eurete erectum tubuliferum.* From a photograph; sponge viewed from side; $\frac{1}{1}$.
“ 2. “ “ “ Gastral hexact with scopula; x 250.
“ 3. “ “ “ Dermal pinulus with scopula; x 250.
“ 4. *Eurete erectum gracile.* Onychaster; x 450.
“ 5. “ “ “ Dermal pinulus; x 250.
“ 6. *Eurete erectum tubuliferum.* Gastral hexact; x 250.
“ 7. *Eurete erectum mucronatum.* Oxyhexaster; x 450.
“ 8. *Eurete erectum gracile.* Gastral hexact; x 250.
“ 9. “ “ “ Characteristic dermal scopula; x 450.

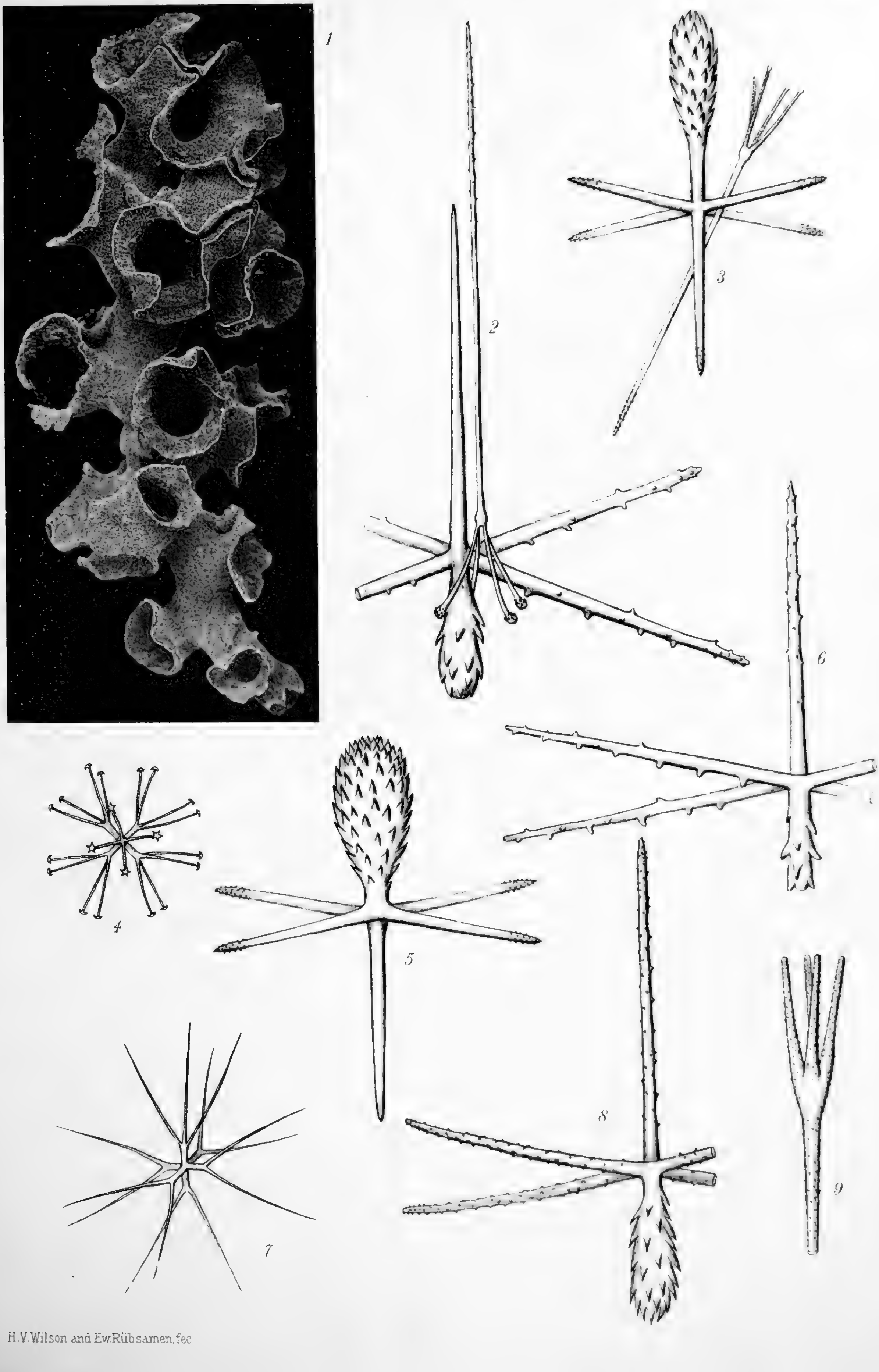

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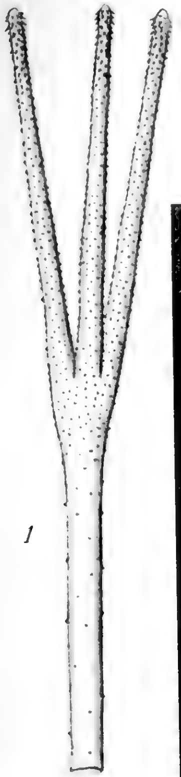
Plate 9.

PLATE 9.

Fig. 1. *Eurete erectum gracile.* Gastral scopula; x 450.
" 2. *Sclerothamnopsis compressa.* From a photograph; $\frac{1}{1}$.
" 3. *Eurete erectum gracile.* Gastral scopula; x 450.
" 4. *Sclerothamnopsis compressa.* From a photograph; two of the smallest branches shown; x 2.
" 5. *Eurete erectum gracile.* From a photograph; $\frac{1}{1}$.
" 6. *Sclerothamnopsis compressa.* Pinulus; x 170.
" 7. " " Oxyhexaster; x 250.
" 8. " " Upper end of scopula; x 250.
" 9. *Regadrella, sp.* Skeletal framework; from a photograph; $\frac{1}{10}$.
" 10. *Sclerothamnopsis compressa.* Spinose hexact; x 170.
" 11. " " Skeletal reticulum; from a transverse section. Upper margin of figure represents surface of sponge; x 70.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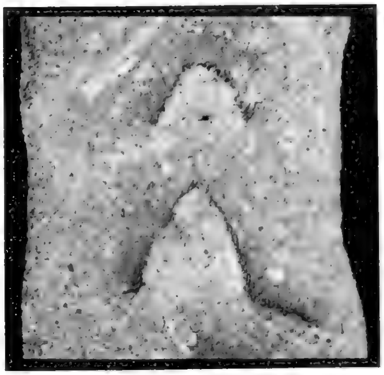
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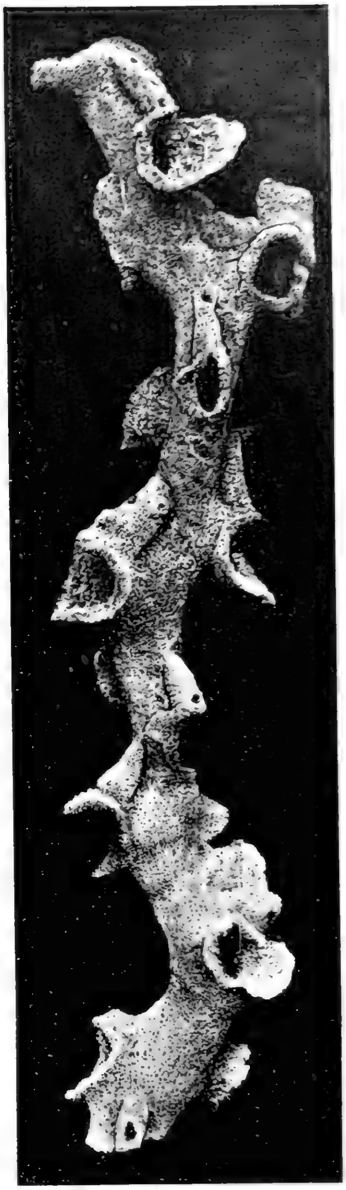
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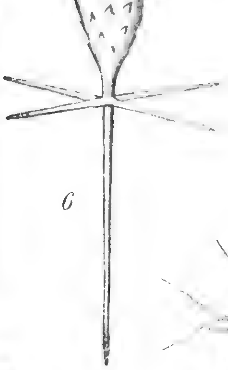
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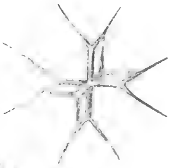
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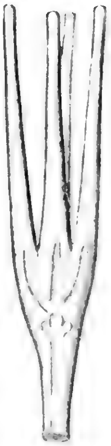
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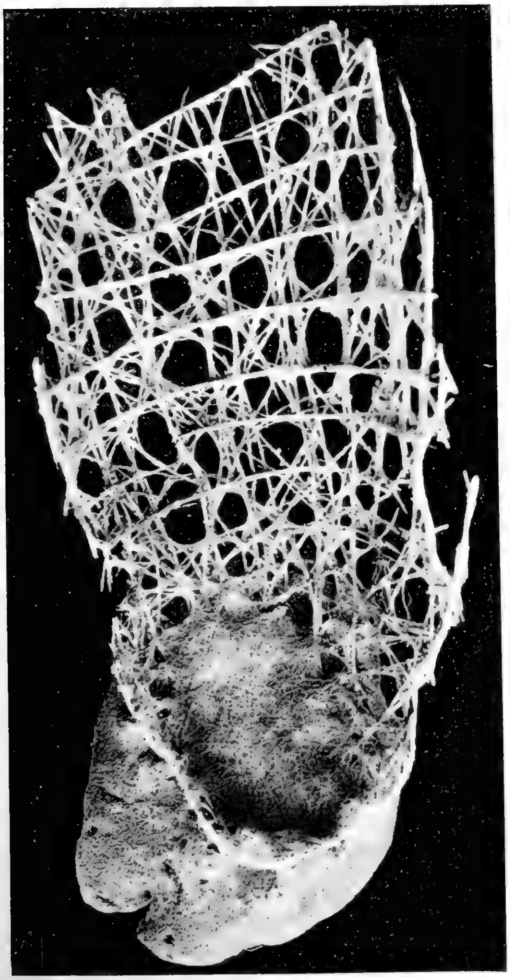
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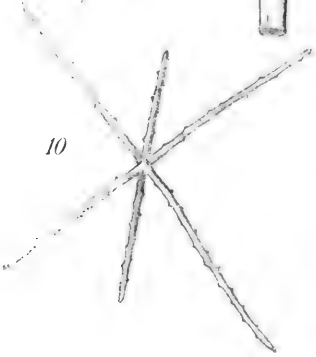
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PLATE 10.

PLATE 10.

Fig. 1. *Sclerothamnopsis compressa.* From a photograph; $\frac{1}{1}$.

" 2. *Bathyxiphus, sp.* From a photograph. A small piece has been taken out, and the two parts fastened together with a pin; $\frac{1}{1}$.

" 3. *Sclerothamnopsis compressa.* From a photograph; $\frac{1}{1}$.

" 4. *Hexactinella labyrinthica.* Scopula; upper and lower ends; x 600.

" 5. *Chonelasma calyx* F. E. Sch. (sp.?). From a photograph. Sponge wall cut away so as to show septum; $\frac{1}{1}$.

" 6. *Hexactinella labyrinthica.* From a photograph; $\frac{1}{1}$.

" 7. " " Group of slender, spinose hexacts and pentacts, partially fused; x 300.

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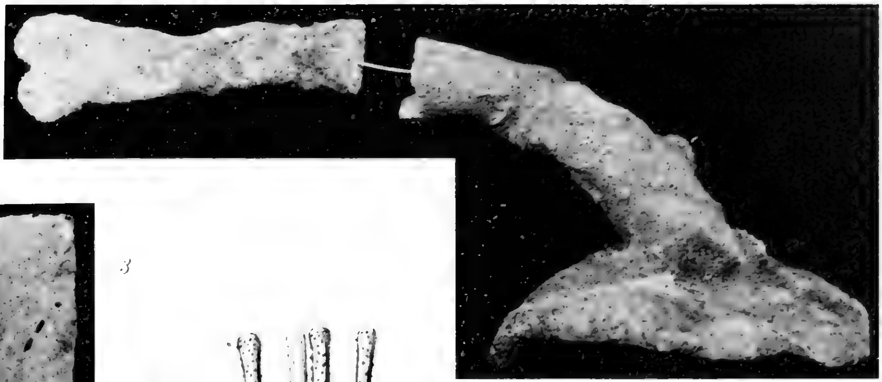

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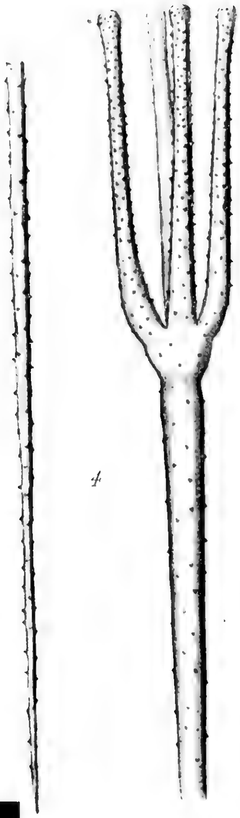

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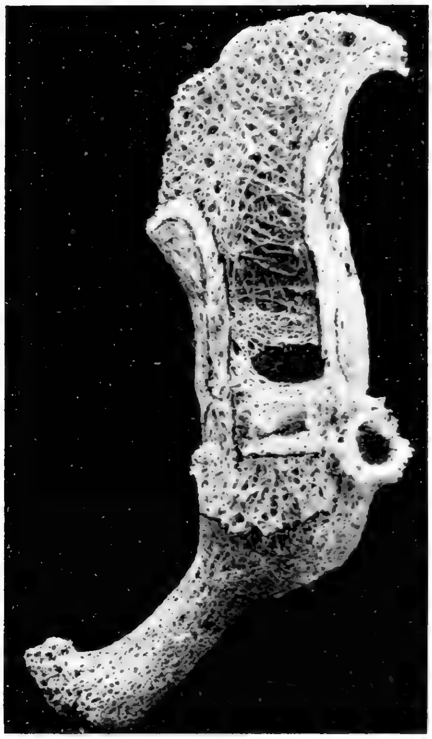

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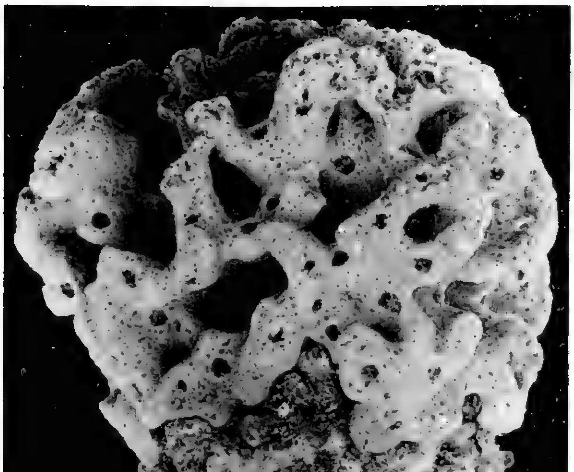

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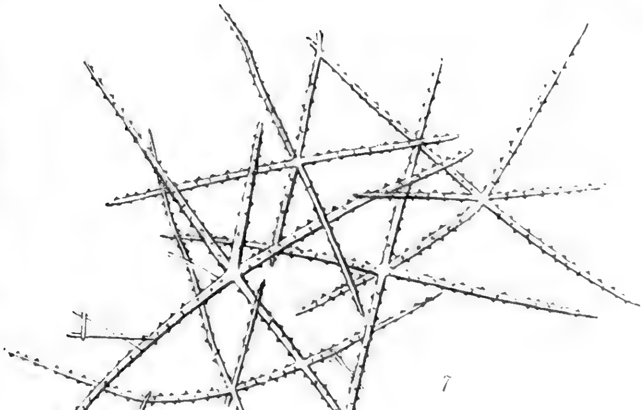

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PLATE 11.

Plate 11.

Fig.	1.	*Hexactinella labyrinthica.*	Lateral surface of skeletal plate. Vertical beams in figure are radial to sponge surface; macerated preparation; x 70.
"	2.	" "	Small scopula; x 600.
"	3.	" "	Discohexaster; x 600.
"	4.	" "	Dermal oxydiact; middle region and the two ends; x 600.
"	5.	" "	Dermal pentact (*a*), and aberrant proximal rays of two other pentacts (*b*, *c*); x 170.
"	6.	" "	Dermal membrane, showing pores and supporting pentact rays; x 100.
"	7.	" "	Section, vertical to surface. Just beneath dermal membrane are a large, and two small, afferent canals. Shaded tissue densely filled with flagellated chambers and small canals; x 70.

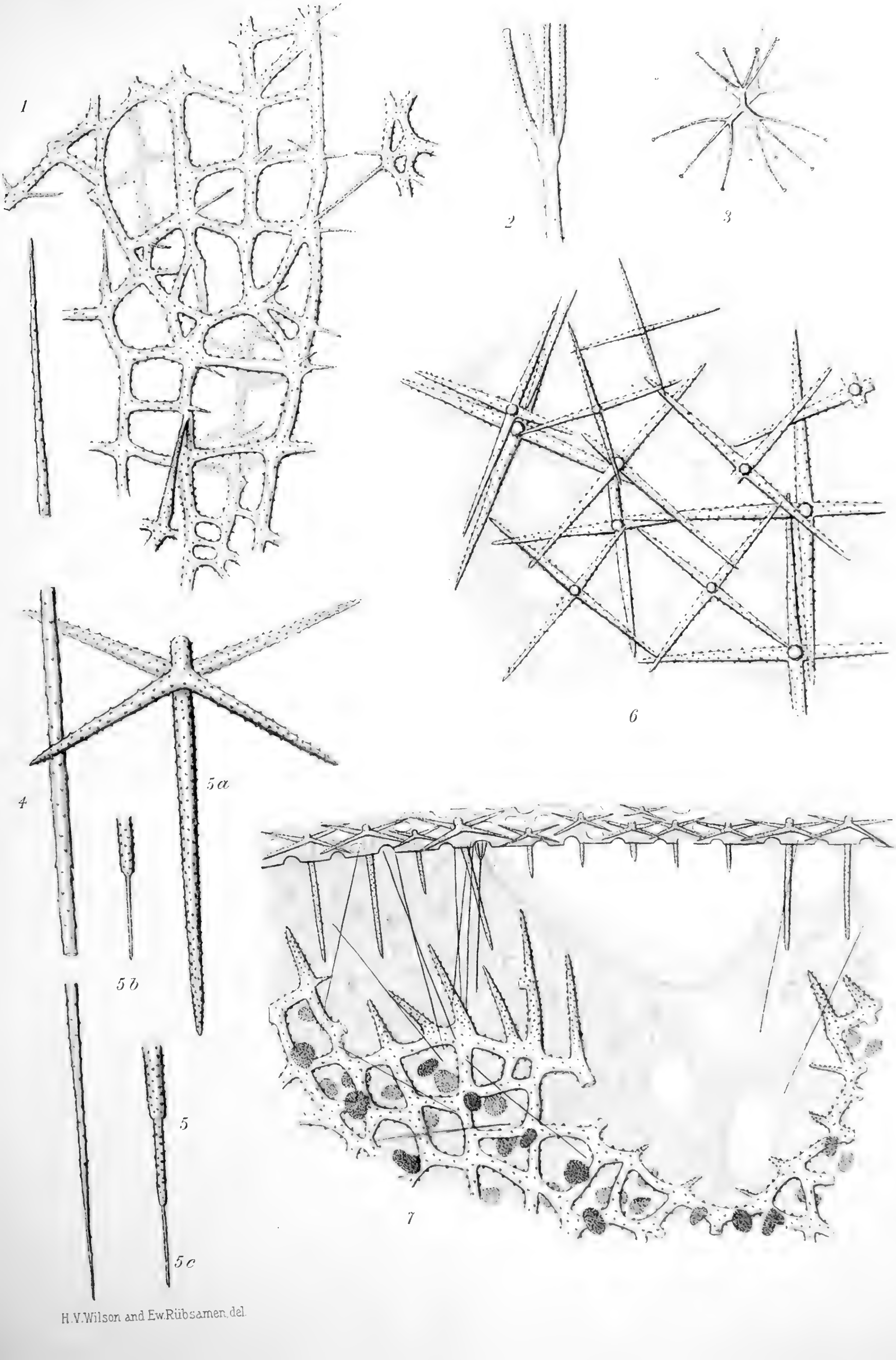

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PLATE 12.

Plate 12.

Fig.	1.	*Thenea echinata.*	Upper surface; from a photograph; $\frac{1}{1}$.
"	2.	" "	From a radial section; upper surface of sponge and adjoining parenchyma; x 20.
"	3.	" "	Spirasters; x 600.
"	4.	" "	Protriaene; x 30.
"	5.	" "	Dichotriaene, modified toward protriaene; x 30.
"	6.	" "	Spicule from root; clavate at one end; x 100.
"	7.	" "	Cladome of dichotriaene; x 30.
"	8.	" "	Somal anatriaene; x 100.
"	9.	" "	From a photograph; from the side; $\frac{1}{1}$.
"	10.	*Thenea lamelliformis.*	Anatriaene, somal; x 150.
"	11.	" "	Anatriaene, radical; x 150.
"	12.	" "	Anatriaene, somal; x 40.
"	13.	" "	Upper surface; from a photograph; $\frac{1}{1}$.

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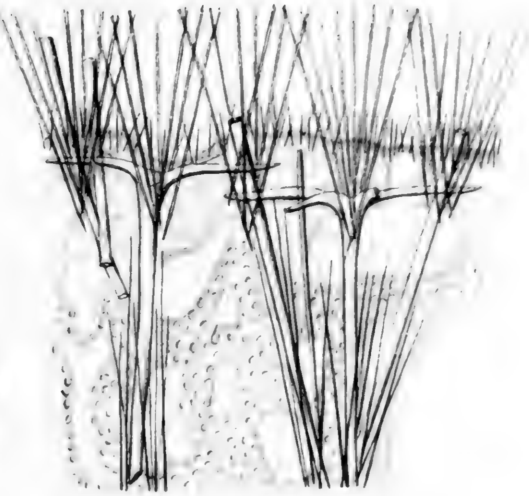

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a b c

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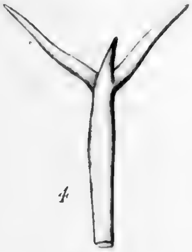

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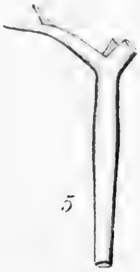

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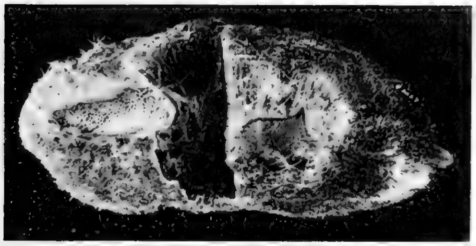

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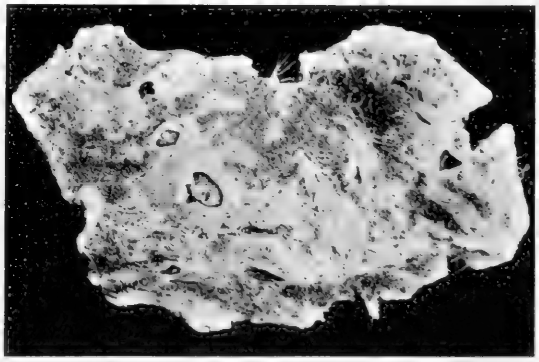

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Plate **13.**

Plate 13.

Fig. 1. *Thenea lamelliformis.* Spirasters; x 600.
" 2. *Thenea fenestrata* O. Schm. From a photograph; from above; $\frac{1}{1}$.
" 3. " " " Spirasters; x 600.
" 4. " " " Protriaene; x 100.
" 5. *Thenea pyriformis.* From a photograph; from the side; $\frac{1}{1}$.
" 6. *Thenea fenestrata* O. Schm. Protriaene; x 100.
" 7. " " " Dichotriaene, modified toward protriaene; x 100.
" 8. *Thenea pyriformis.* From a photograph; from above; $\frac{1}{1}$.
" 9. *Thenea fenestrata* O. Schm. From a photograph; from the side; $\frac{1}{1}$.
" 10. *Thenea pyriformis.* Parenchymal microscleres; x 600.
" 11. " " Microscleres of dermal membrane; x 600.
" 12. *Poecillastra tricornis.* Annulated microxea; x 150.
" 13. " " Triaene with reduced rhabdome; from the side; x 30.
" 14. " " Microxea, nearly smooth; x 400.

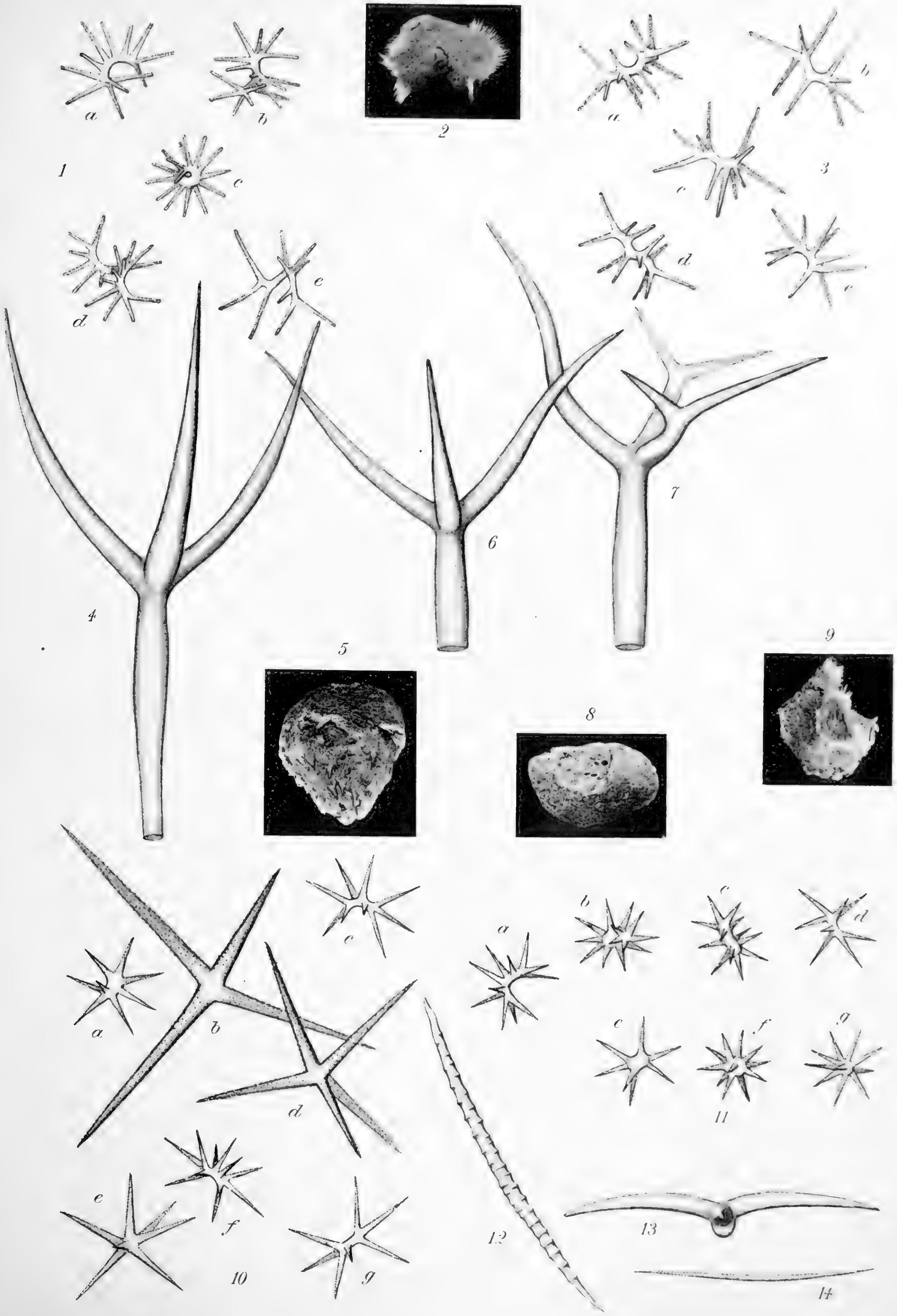

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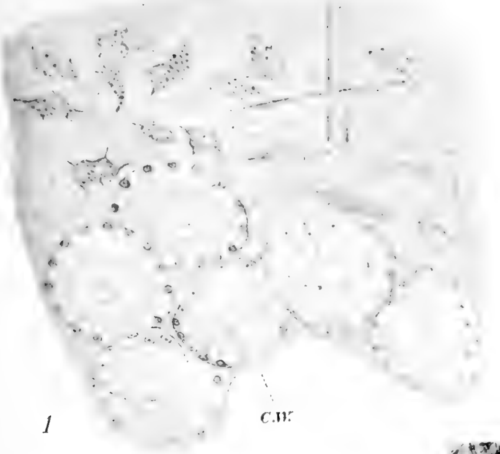
PLATE **14**.

PLATE 14.

Fig.	1.	*Poecillastra tricornis.*	From a section tangential to surface, showing flagellated chambers with Sollas's membrane; *c. w.*, canal wall; x 250.
"	2.	" "	Streptasters; *a*, spiraster from dermal membrane; *c*, parenchymal metaster; *b*, *d*, parenchymal spirasters; x 600.
"	3.	" "	From a radial, vertical section, showing oscular surface, with an oscular depression, through the aperture at the bottom of which a shell of a Foraminifera is partially protruded. Below oscular membrane and aperture an incomplete septum extends across the canal; x 30.
"	4.	" "	From a radial, vertical section, showing pore surface. Pore membrane, forming bottom of a very shallow concavity, is produced into a plug-like process. Axis of this is marked by dense streak of spirasters, representing the closed pore. Side wall of canal, into which pore opens, is shown in perspective and exhibits apertures leading into branch canals. Canal wall bears some incomplete septa. Lowest and thickest septum is perforated by a small aperture, in immediate neighborhood of which is a collection of débris, largely shells of Foraminifera; x 30.
"	5.	" "	Pore surface. One pore area with nearly closed pore shown. Surface preparation; x 30.
"	6.	" "	Oscular surface. Three oscular membranes, one with open aperture, shown. Surface preparation; x 30.
"	7.	" "	From a radial, vertical section, showing oscular surface. A single oscular depression, floor of which constitutes the oscular membrane, is shown. Osculum itself closed. Canal to which osculum belongs exhibits on its lateral wall apertures of branches, and is crossed by perforated septa; x 30.
"	8.	" "	Oscular surface; from a photograph; $\frac{1}{1}$.
"	9.	*Poecillastra cribraria.*	Cladome of triaene, from above; two rays branched; x 70.
"	10.	" "	Characteristic triaene, from the side; x 70.
"	11.	" "	Microxea; x 250.
"	12.	" "	Streptasters: *a*, spiraster from dermal membrane; *b*, plesiaster from parenchyma; *c*, *d*, plesiaster-metasters from parenchyma; x 600.



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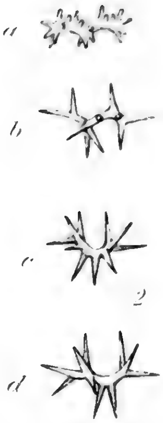

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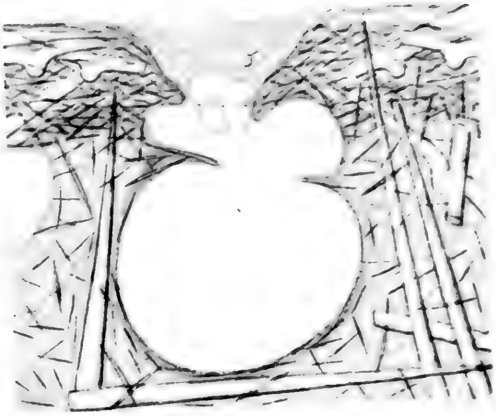

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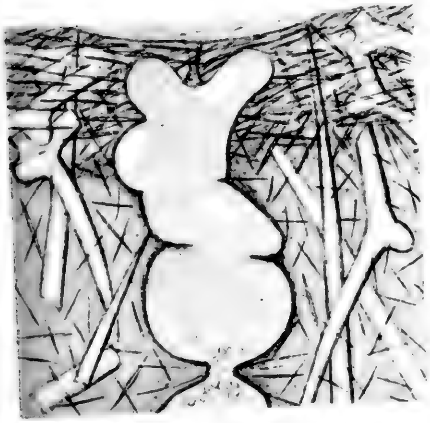

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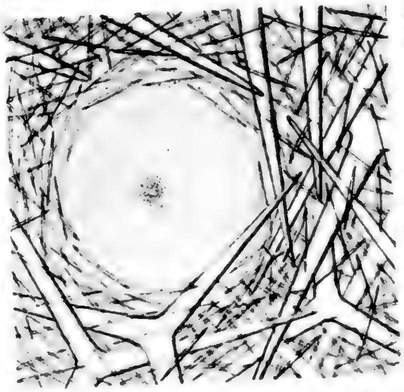

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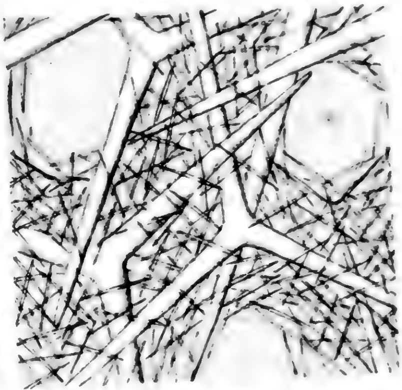

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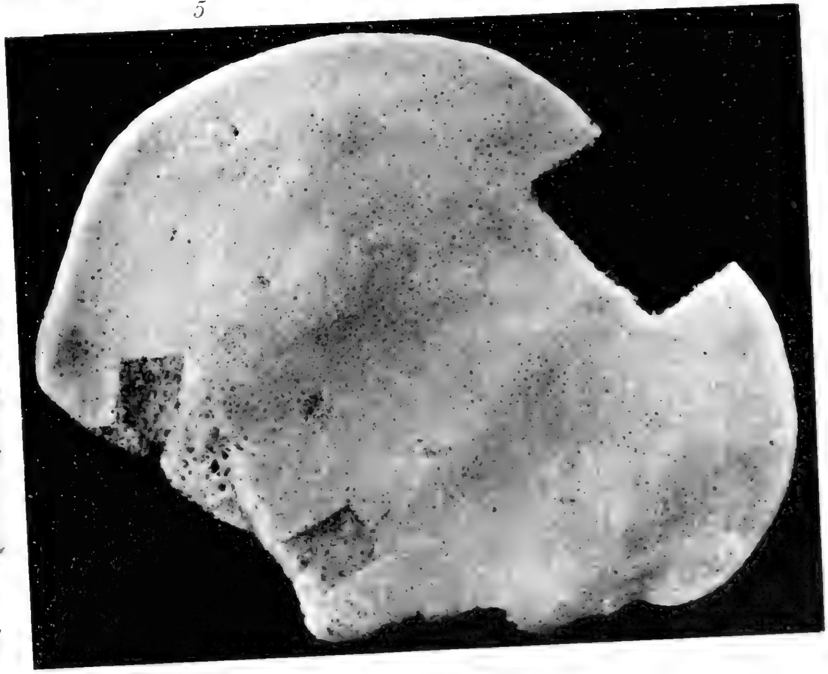

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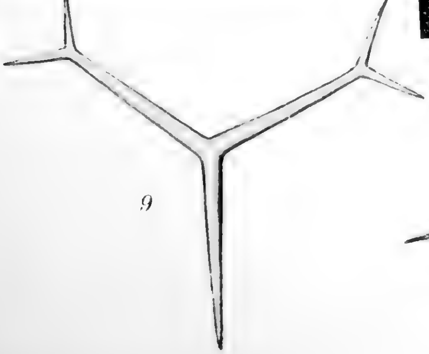

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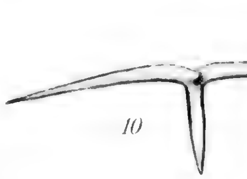

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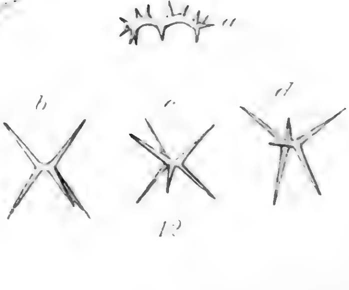

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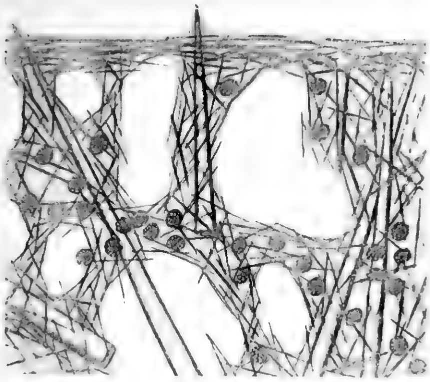
PLATE 15.

Plate 15.

Fig.	1.	*Poecillastra cribraria.*	From a radial vertical section, showing oscular surface. Parenchyma with abundant conspicuous granular cells; x 100.
"	2.	" "	From a section. Posterior wall of flagellated chamber showing several chamber-pores. Boundary membrane of chamber is a thin, finely granular membrane showing no cell-boundaries. On it rest the cell-bodies (wide apart) of the collar cells, appearing as dense angular masses, each enclosing a nucleus; x 1000.
"	3.	" "	Oscular surface; surface preparation; x 30.
"	4.	" "	Pore surface; " " x 30.
"	5.	*Penares foliaformis.*	From a section. A flagellated chamber opens to the right into its efferent canaliculus; afferent canaliculus abutting against boundary membrane of chamber, to left; Sollas's membrane in perspective. Two other flagellated chambers are cut. In right lower corner, a part of an ovum (*ov.*) with part of its nucleus is included; x 1000.
"	6.	" "	From a section vertical to surface of sponge, showing choanosome with a number of small efferent canals cut lengthwise; some canals leading in the section to the flagellated chambers from which they start. The small efferent canals unite to form the two larger canals of the figure. These unite in the next section. Other canals, some cut transversely, appear; some of them, afferent canals; *c.w.*, canal wall; x 70.
"	7.	" "	Surface; from a photograph; $\frac{1}{1}$.
"	8.	" "	Microrhabds; x 250.
"	9.	" "	Vertical section showing ectosome and adjoining choanosome. Two radial pore canals open, each into a subdermal chamber; x 30.
"	10.	" "	Oxyasters; x 600.
"	11.	" "	Surface, showing arrangement of pores and cladomes of the triaenes. Microrhabds with which dermal membrane is densely filled, and which extend over the cladomes as well as throughout the pore areas, are omitted. Surface preparation; x 30.



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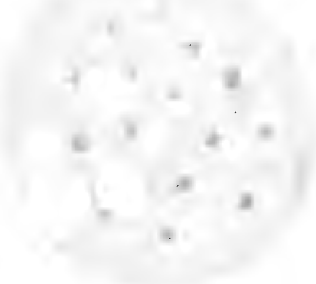

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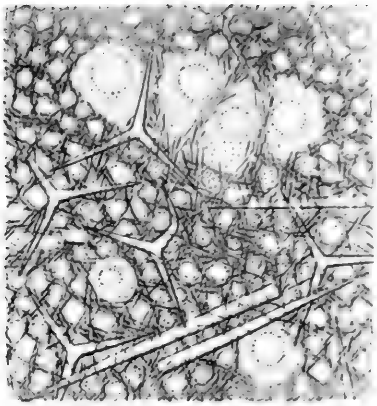

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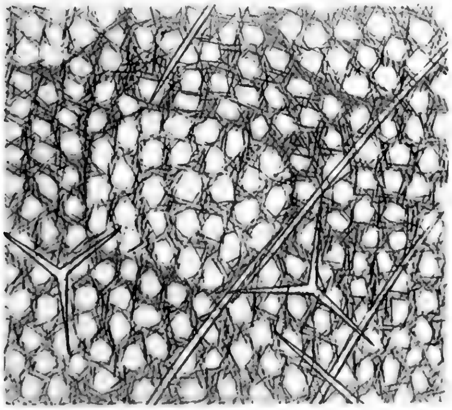

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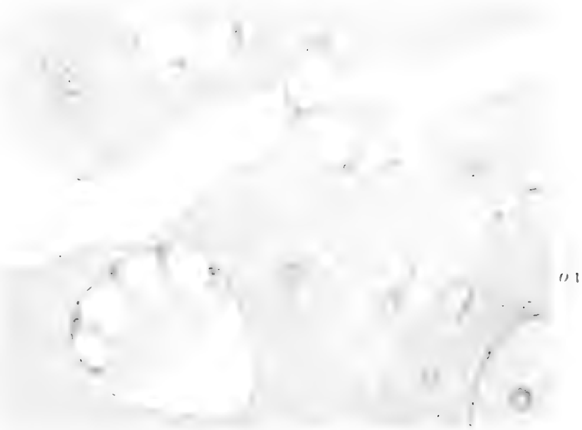

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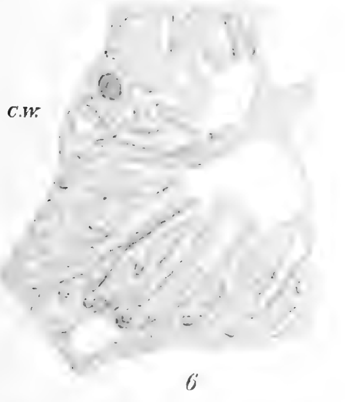

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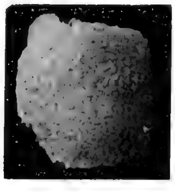

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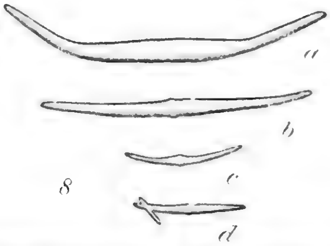

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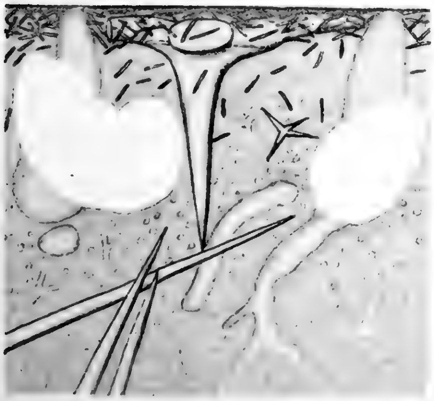

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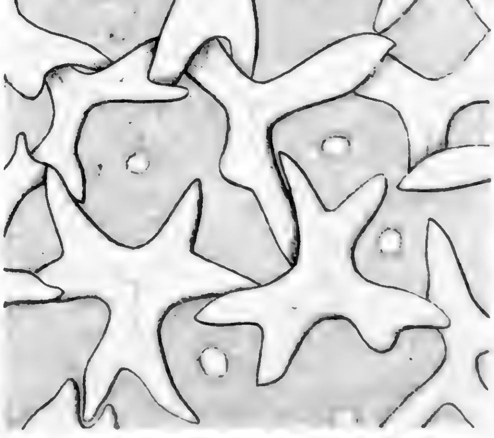

H.V.Wilson and Ew.Rübsamen, del.

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PLATE 16.

PLATE 16.

Fig.	1.	*Poecillastra cribraria.*	From a section; *c. w.*, canal wall. A flagellated chamber occupies a thin trabecula. It opens, to the right, by a wide aperture into efferent canal. Its boundary membrane, to the left, is perforated by a single chamber pore. Collar cells extend between boundary membrane and Sollas's membrane; the latter shown in section and perspective; x 1000.
"	2.	*Polymastia maeandria.*	From a photograph; from the side; $\frac{1}{1}$.
"	3.	*Poecillastra cribraria.*	From a photograph; oscular surface; $\frac{1}{1}$.
"	4.	*Polymastia maeandria.*	Transverse section through wall of oscular papilla; *c. w.*, wall of axial canal. Above are the surface brushes of small tylotes. Two longitudinal spicular bundles are cut; x 70.
"	5.	" "	Spicules; x 70.
"	6.	" "	Section vertical to surface of sponge and through a mammillary protuberance. Beneath superficial layer of small spicules lies layer of more or less tangentially arranged tylostyles. Five radial skeletal bundles appear. Main afferent canal in mammillary protuberance connects with a larger internal canal through a chone-like structure. Small subdermal spaces with pore canals are seen, especially in region of mammillary protuberance; x 10.
"	7.	*Pachychalina acapulcensis.*	Longitudinal section, vertical to surface, of macerated sponge. Surface of sponge to the right. A longitudinal skeletal bundle, *l. b.*, appears; skeletal network in general irregular; *s. v.*, surface villi; x 20.
"	8.	" "	From a photograph; from the side; $\frac{1}{2}$.

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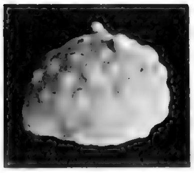

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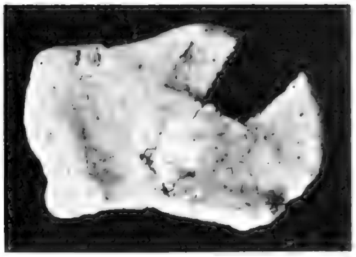

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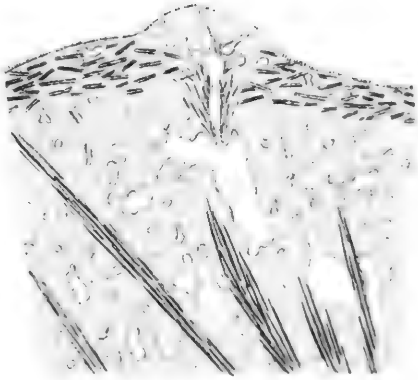

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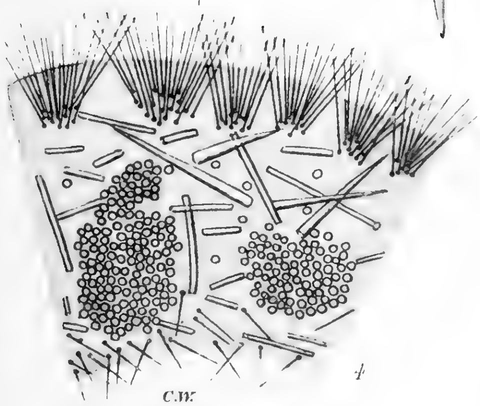

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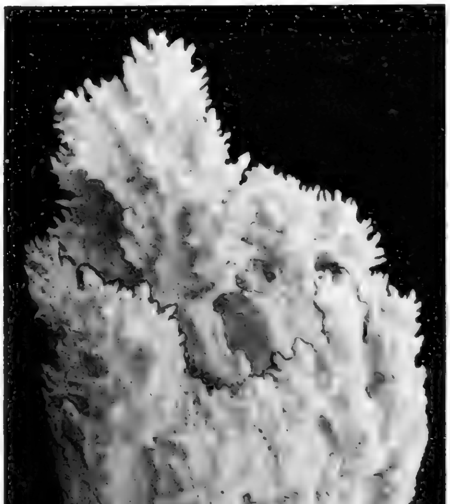

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PLATE **17**.

PLATE **17**.

Fig. 1. *Pachychalina acapulcensis.* Dermal membrane. Pores and dermal reticulum with villi. Surface preparation; x 70.

" 2. " " Horizontal section, vertical to surface, of macerated sponge. Surface of sponge above. A longitudinal skeletal bundle, *l. b.*, is cut transversely. Skeletal network comparatively regular; *s. v.*, surface villi; x 20.

" 3. " " Large radial skeletal fibre; x 300.

" 4. " " Small connective; x 300.

" 5. " " One of the finest fibres, subdividing a skeletal mesh; x 300.

" 6. *Petrosia variabilis crassa.* Oxeas, with spongin; x 100.

" 7. *Petrosia similis densissima.* From a photograph; $\frac{1}{1}$.

" 8. *Oceanapia bacillifera.* Surface of fistula; x 100.

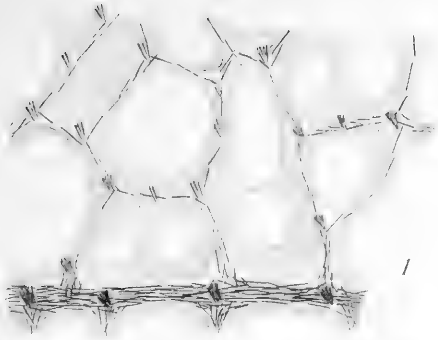
" 9. *Petrosia variabilis crassa.* From a photograph; $\frac{1}{1}$.

" 10. *Petrosia similis densissima.* Oxea and flagellated chambers, one of which opens into efferent canal; x 250.

" 11. *Gellius perforatus.* End of skeletal oxea, with sigmata; x 450.

" 12. *Petrosia variabilis crassa.* From a photograph; $\frac{1}{1}$.

" 13. *Pachychalina acapulcensis.* Longitudinal section through macerated conulus. An axial bundle of spiculo-fibre gives off, and ultimately divides into, radial fibres; *s. v.*, surface villi; x 20.



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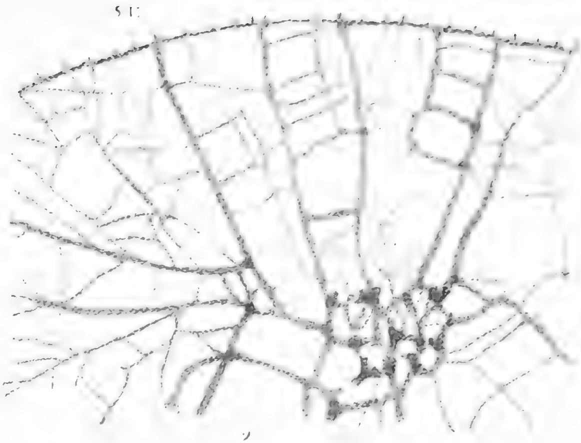

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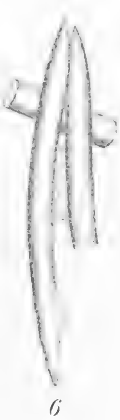

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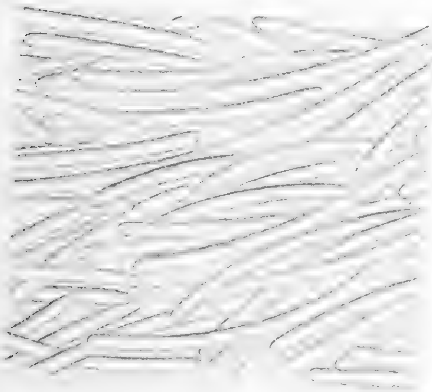

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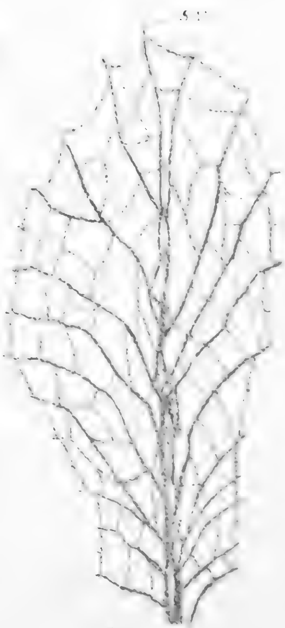

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PLATE **18**.

PLATE 18.

Fig. 1. *Gellius perforatus.* Upper surface; from a photograph; $\frac{1}{1}$.

" 2. *Oceanapia bacillifera.* Fistula; from a photograph; $\frac{1}{1}$.

" 3. *Hymeraphia, sp.* incrusting *Oceanapia bacillifera.* Spicules; x 450.

" 4. *Oceanapia bacillifera.* Tangential section through wall of fistula, showing arrangement of skeletal spicules and spongin. Meshes in the skeletal framework, which in the figure are represented as vacant, are filled with parenchyma; x 70.

" 5. *Tylodesma alba.* Megascleres; x 70.

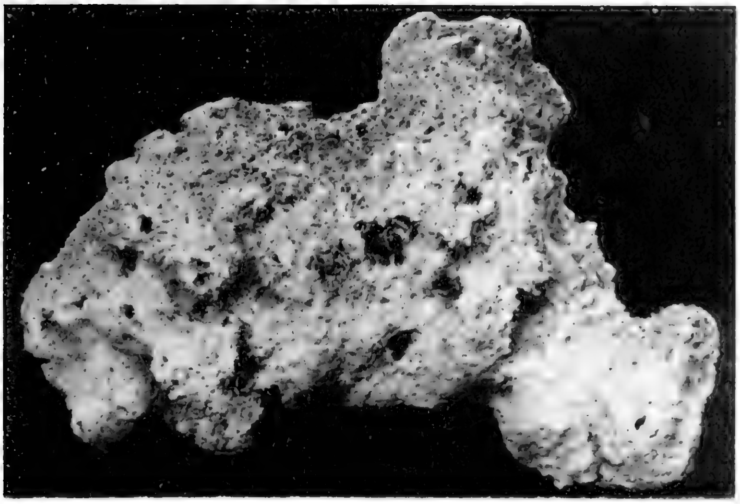
" 6. " " Sigmata; x 450.

" 7. " " From a photograph. Sponge viewed obliquely from the side, so that upper surface is seen; $\frac{1}{1}$.

" 8. *Tylodesma vestibularis.* Megascleres; x 70.

" 9. " " Sigmata; x 450.

" 10. *Phakellia lamelligera.* Outer surface of skeletal framework. Piece has been macerated in potash. From a photograph; x 5.



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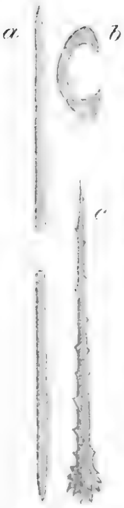

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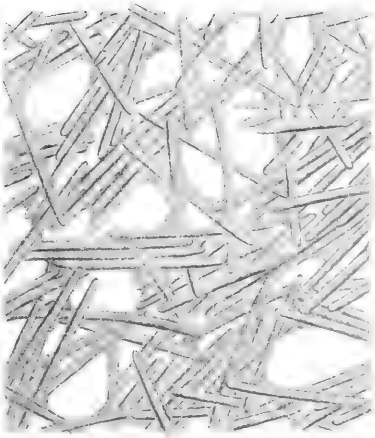

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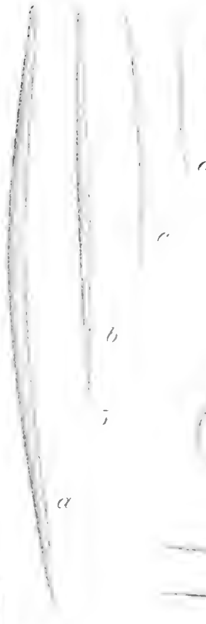

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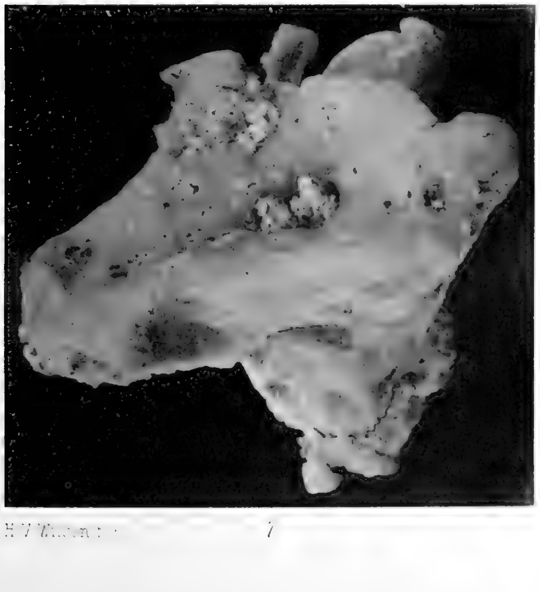

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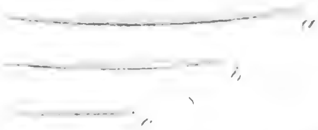

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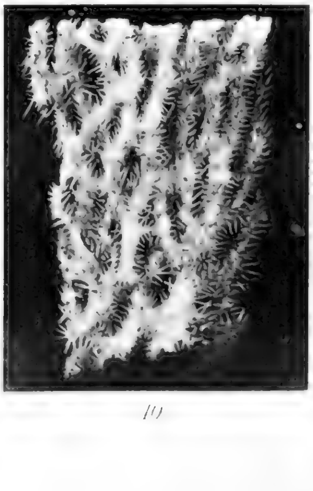

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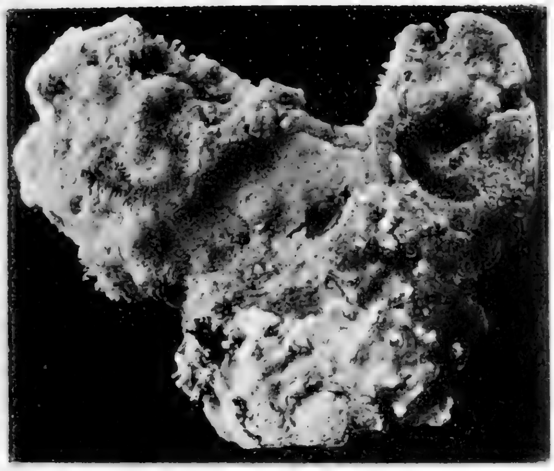
Plate 19.

PLATE 19.

Fig.	1.	*Tylodesma vestibularis.*	From a photograph. Sponge viewed from the side; whitish conglomerate below. Vestibular spaces appear as darker areas. The one best brought out in the figure is well to the left, and has indented margins. The small darker area at extreme left of this space is an osculum ; x $\frac{1}{1}$.
"	2.	*Phakellia lamelligera.*	Spicules; x 70.
"	3.	" "	From a photograph. Sponge seen obliquely from the side; x $\frac{7}{10}$.
"	4.	*Auletta dendrophora.*	Inner face of sponge wall, lining paragastric cavity. Apertures of radiating canals appear; *l. b.*, longitudinal skeletal bundles; x 100.
"	5.	" "	From a transverse section through a "person." Surface of sponge above. A radiating canal opens into a subdermal cavity, *s. c.* Part of the wall of the latter is seen in perspective. Wall of another cavity in lower left corner seen in perspective. On each side of the radiating canal, section strikes a radiating bundle of spicules (styles); x 100.
"	6.	*Iophon indentatus.*	Microscleres; *a*, anisochela in lateral view; *b*, bipocillus from concave side; *c*, bipocillus, apical view of larger end; *d*, bipocillus from convex side; *e*, bipocillus in lateral view; x 1000.
"	7.	*Auletta dendrophora.*	From a photograph; sponge seen somewhat obliquely from the side; x $\frac{1}{1}$.



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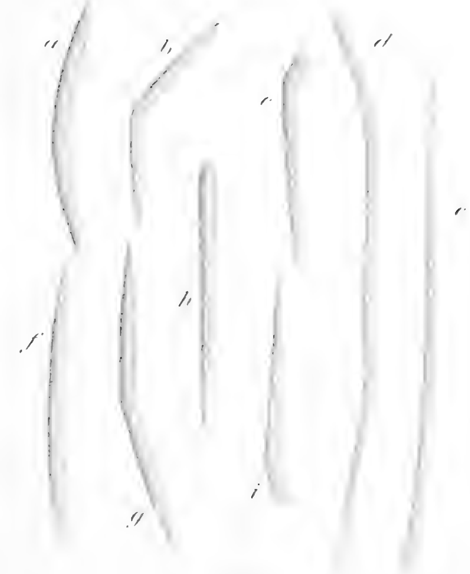

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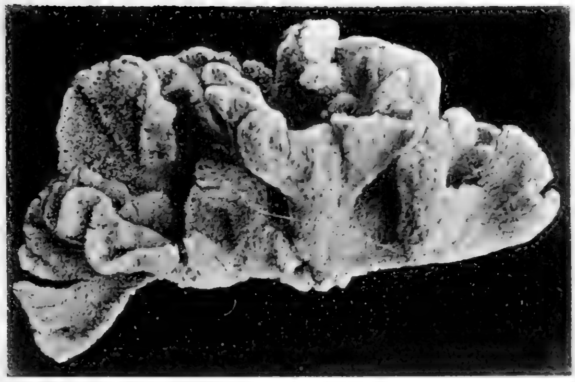

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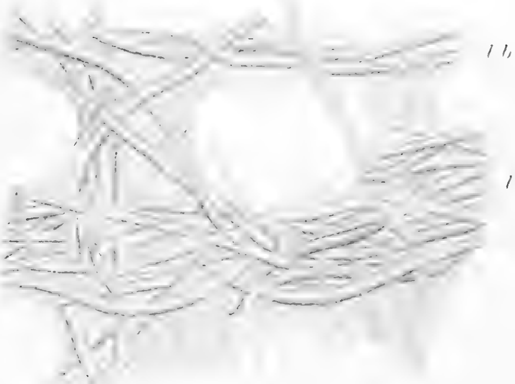

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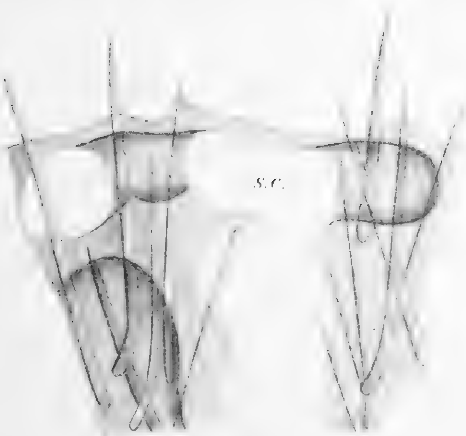

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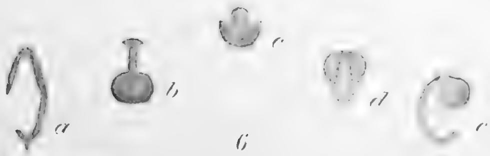

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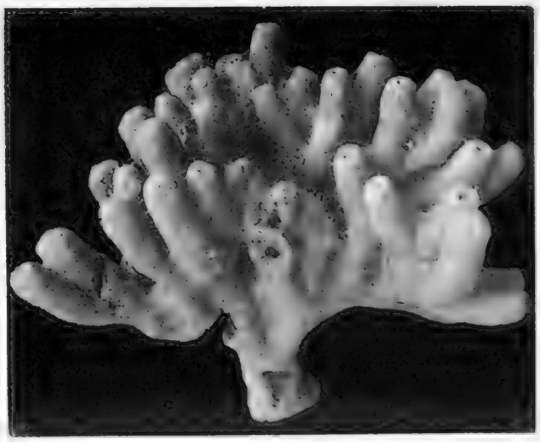

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PLATE 20.

PLATE 20.

Plate 20.

Fig. 1. *Iophon indentatus.* From a photograph; x $\frac{1}{1}$.

" 2. *Iophon chelifer ostia-magna.* Microscleres; *a,* bipocillus from concave side and smaller end; *b,* anisochela in lateral view; *c,* bipocillus in slightly oblique lateral view; *d,* bipocillus from concave side, larger plate in optical section; x 1000.

" 3. *Iophon lamella.* From a photograph. Oscula depressed and surrounded with collenchyma; x $\frac{1}{1}$.

" 4. *Iophon chelifer ostia-magna.* From a photograph. Margin of sponge, with large oscula, to the right; x $\frac{1}{1}$.

" 5. *Iophon indentatus.* Skeletal style; x 250.

" 6. " " Tylote; x 250.

" 7. *Iophon lamella.* Microscleres; *a,* bipocillus from convex side; *b,* anisochela in lateral view; *c,* bipocillus in lateral view; x 1000.

" 8. " " Skeletal style; x 250.

" 9. " " Tylote; x 250.

" 10. *Iophon chelifer ostia-magna.* Skeletal style; x 250.

" 11. " " " Tylote; x 250.

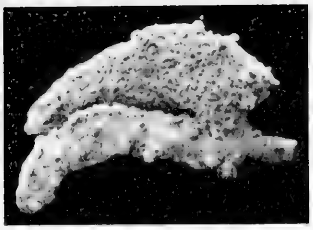
" 12. *Iophon lamella.* From a photograph; upper surface; x $\frac{1}{1}$.

" 13. " " From a photograph. Lower surface of the specimen shown in Fig. 12; x $\frac{1}{1}$.

" 14. *Iophon lamella indivisus.* From a photograph; under surface; x $\frac{1}{1}$.

" 15. " " " Microscleres; *a,* bipocillus from convex side; *b,* anisochela in ventral view; *c,* bipocillus from concave side; *d,* bipocillus in lateral view; *e,* bipocillus, apical view of larger end; *f,* bipocillus, apical view of smaller end; x 1000.

" 16. " " From a photograph. Upper surface of specimen shown in Fig. 14; x $\frac{1}{1}$.



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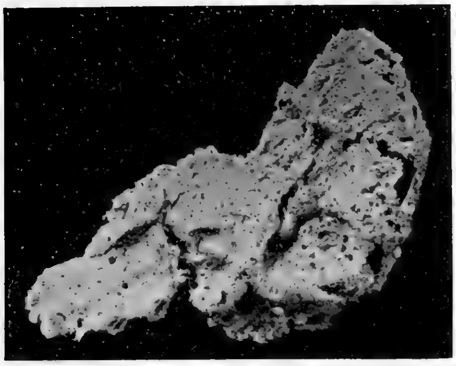

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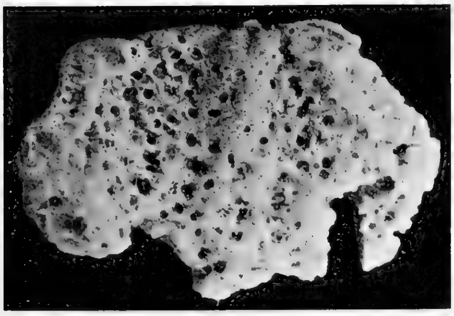

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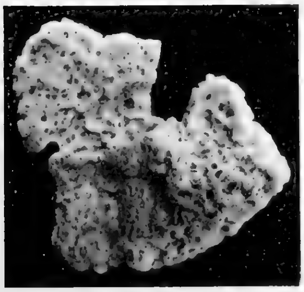

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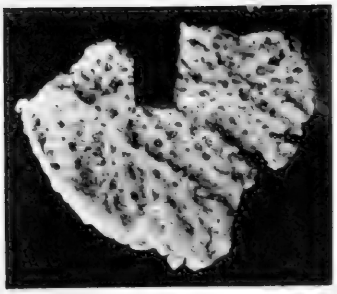

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PLATE **21**.

PLATE **21**.

Microphotographs of thick unstained preparations, showing skeletal arrangement.

Fig. 1. *Polymastia maeandria.* Dermal surface; x 50.
" 2. *Petrosia variabilis crassa.* " " x 20.
" 3. " " " Section vertical to surface, which is represented by upper margin of figure; x 15.
" 4. *Petrosia similis densissima.* Section vertical to surface, which is represented by upper margin of figure; x 15.
" 5. " " " Dermal surface; x 20.
" 6. *Gellius perforatus.* Dermal surface; x 25.

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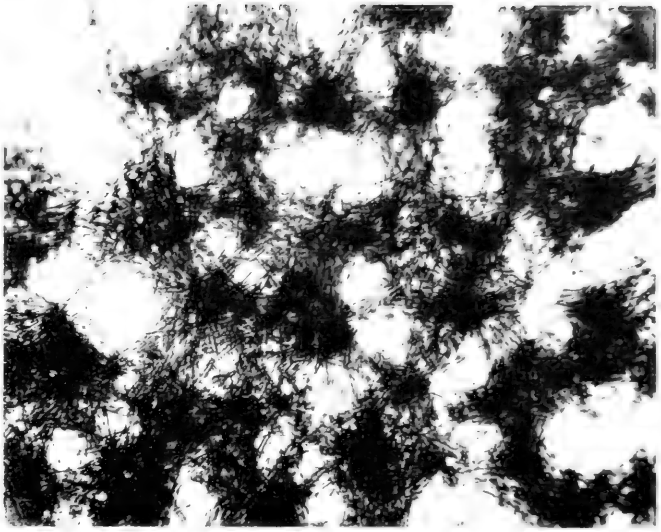

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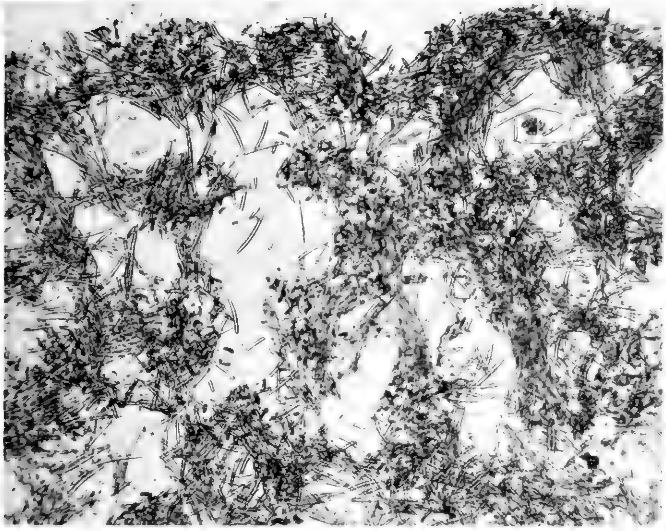

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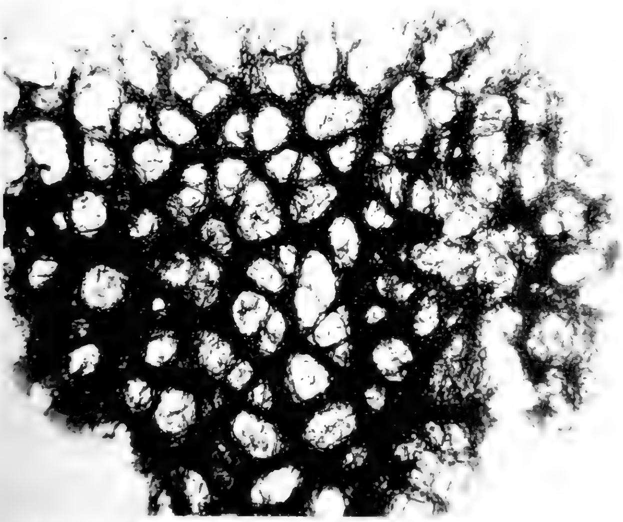

H V Wilson and J Zeleny, photo 5

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PLATE 22.

PLATE 22.

Microphotographs of thick unstained preparations showing skeletal arrangement.

Fig. 1. *Gellius perforatus.* Section vertical to surface, which is represented by right margin of figure; x 15.

" 2. *Tylodesma alba.* Section vertical to surface, which is represented by right margin of figure. Dermal surface in upper part of figure is roughened with projecting spicular tufts, elsewhere smooth; x 15.

" 3. " " Section vertical to surface, which is represented by right margin of figure. Surface is smooth, although it scarcely appears so, owing to the fact that it is partially seen in perspective; x 15.

" 4. *Tylodesma vestibularis.* Section vertical to surface, which is represented by right margin of figure. A vestibular space is cut across. The hexactinellid skeleton is conspicuous in the deeper part of the section; x 15.

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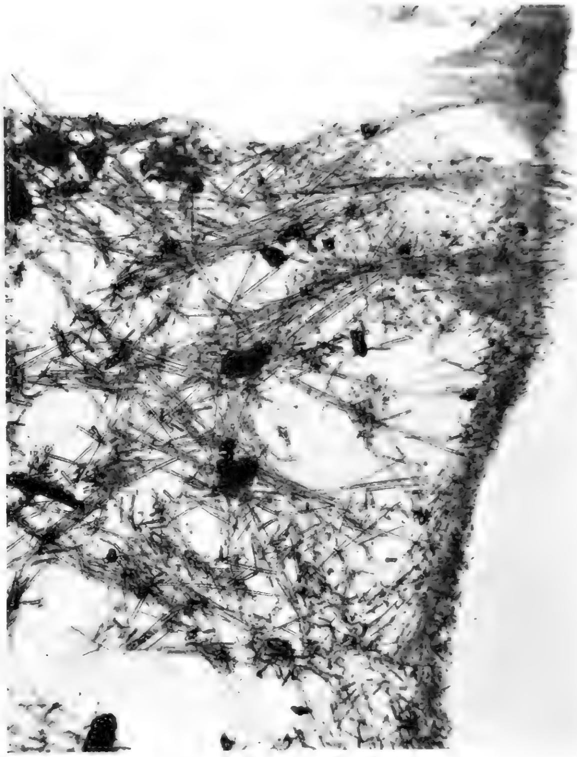

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H.V.Wilson and Zehle, photogr 3

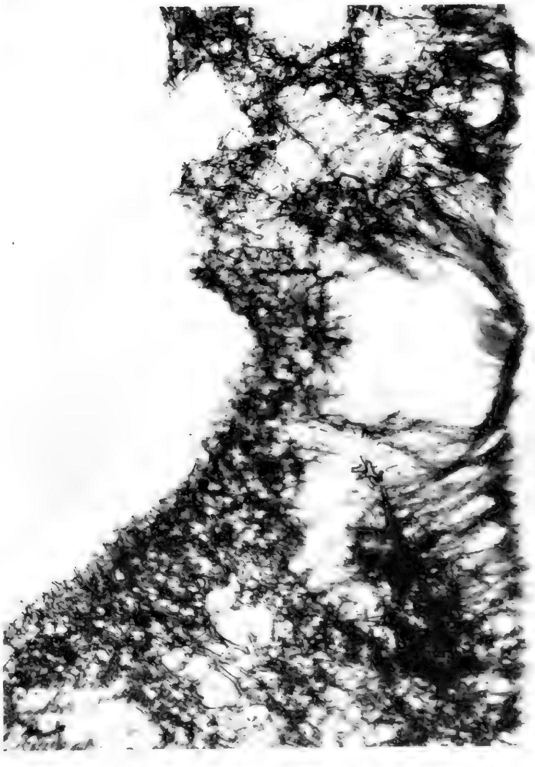

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PLATE 23.

PLATE **23**.

Microphotographs of thick unstained preparations showing skeletal arrangement.

Fig. 1. *Tylodesma vestibularis.* Section vertical to surface of sponge, which is represented by right margin of figure. Hexactinellid skeleton appearing in deeper part of section; x 25.

" 2. " " Dermal membrane covering in a large vestibular cavity. Upper right margin represents edge of osculum; x 15.

" 3. " " Dermal membrane covering in, and adjoining, a medium-sized vestibular cavity; x 15.

" 4. *Iophon indentatus.* Section vertical to surface, which is represented by right margin of figure. Section includes large part of the *Gorgonia* axis (to the left); x 25.

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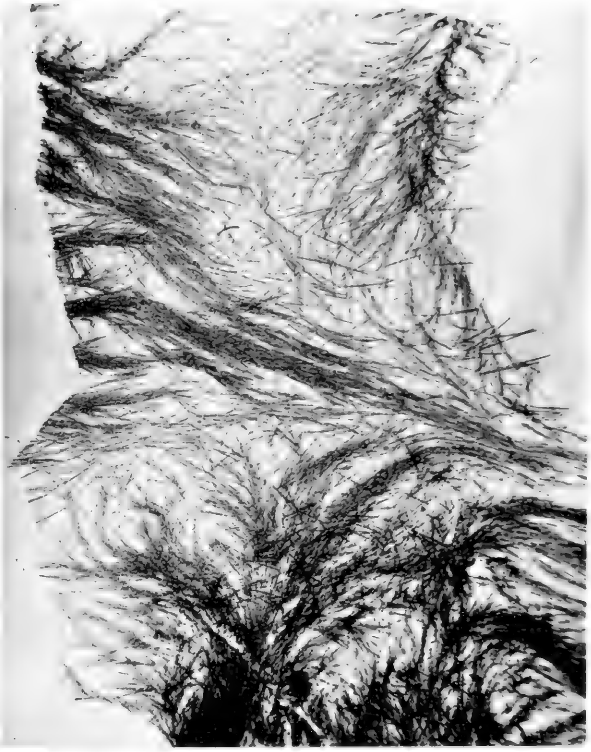

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H.V. Wilson and Zehle, photogr. 3

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PLATE 24.

PLATE **24.**

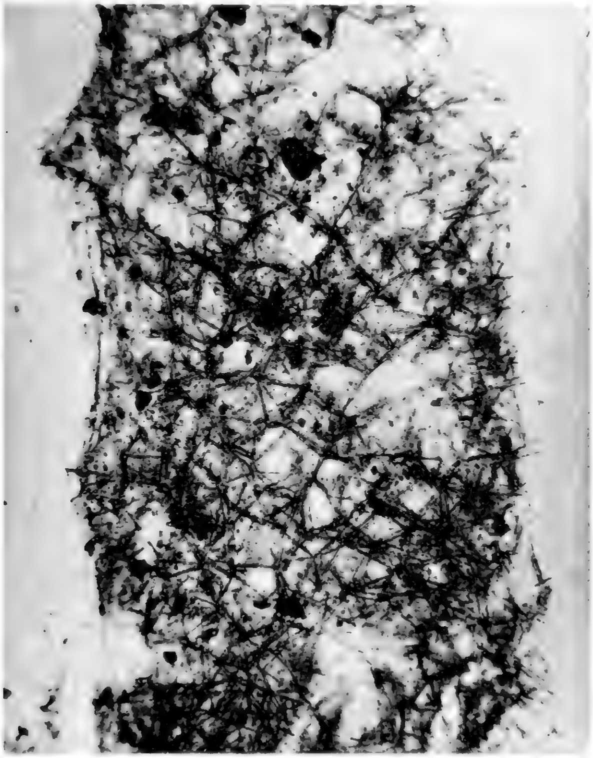
Microphotographs of thick unstained preparations showing skeletal arrangement.

Fig. 1. *Iophon chelifer ostia-magna.* From a section vertical to surface and radial to margin of sponge, and passing through a large marginal osculum and efferent canal (*cf.* Fig. 4, Pl. 20). Figure includes thickness of sponge lying between surface and canal. Right margin of figure represents surface of sponge; left margin, canal wall; x 15.

" 2. *Iophon lamella.* Surface; reticulate condition; x 15.

" 3. " " Section vertical to surface, and through entire thickness of lamellate body. Right and left margins of figure represent surfaces of body; x 15.

" 4. " " Idem; x 15.



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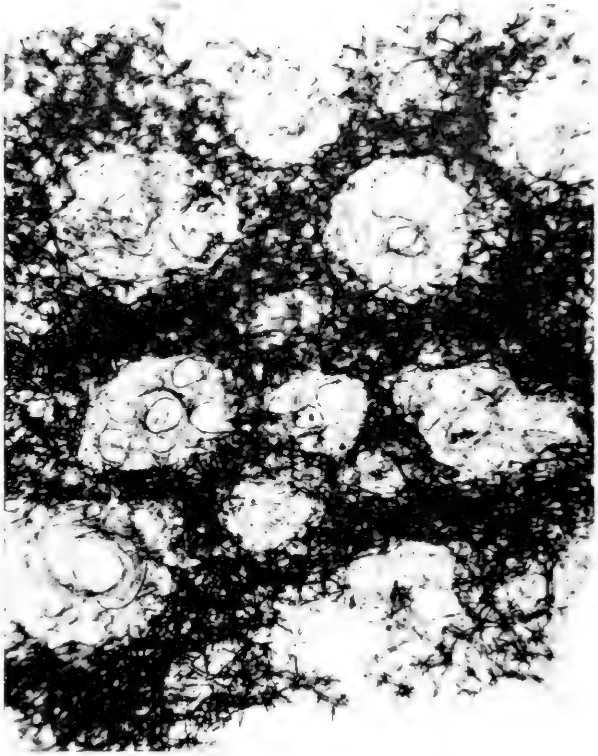

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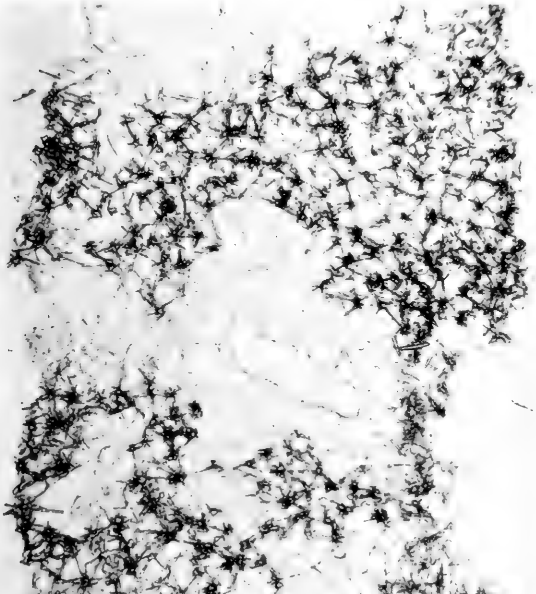

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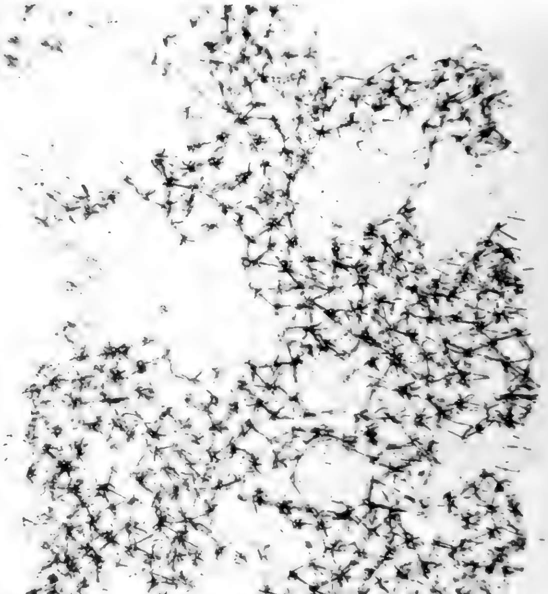


4

H.V. Wilson and Zehle, photogr.

Plate 25.

PLATE 25.

Microphotographs of thick unstained preparations showing skeletal arrangement.

Fig. 1. *Phakellia lamelligera.* Section vertical to surface, and passing completely through lamellate wall; in horizontal plane of sponge; x 15.

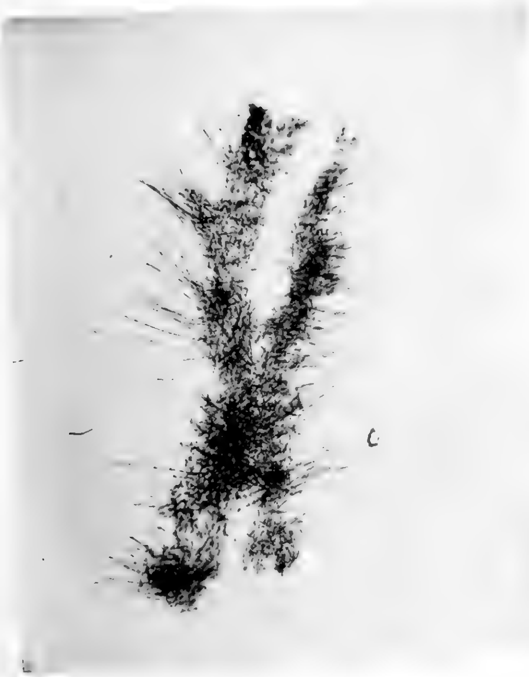
" 2. *Auletta dendrophora.* From a median longitudinal section through a "person." Left margin of figure represents surface of sponge; right margin, surface of paragastric cavity. Along latter margin appears a longitudinal skeletal fibre, from which short echinating spicules project; x 30.

" 3. *Phakellia lamelligera.* Skeletal lamella, seen from its flattened face. Long projecting spicules along right and left margins of figure are the spicules projecting from surfaces of sponge. Lamella was dissected out and cleaned with potash; x 10.

" 4. " " Idem. Figure was not well reproduced, and the projecting (prostal) spicules are indistinct; x 10.

1

2



H. V. Wilson and Zehle, photogr.

3

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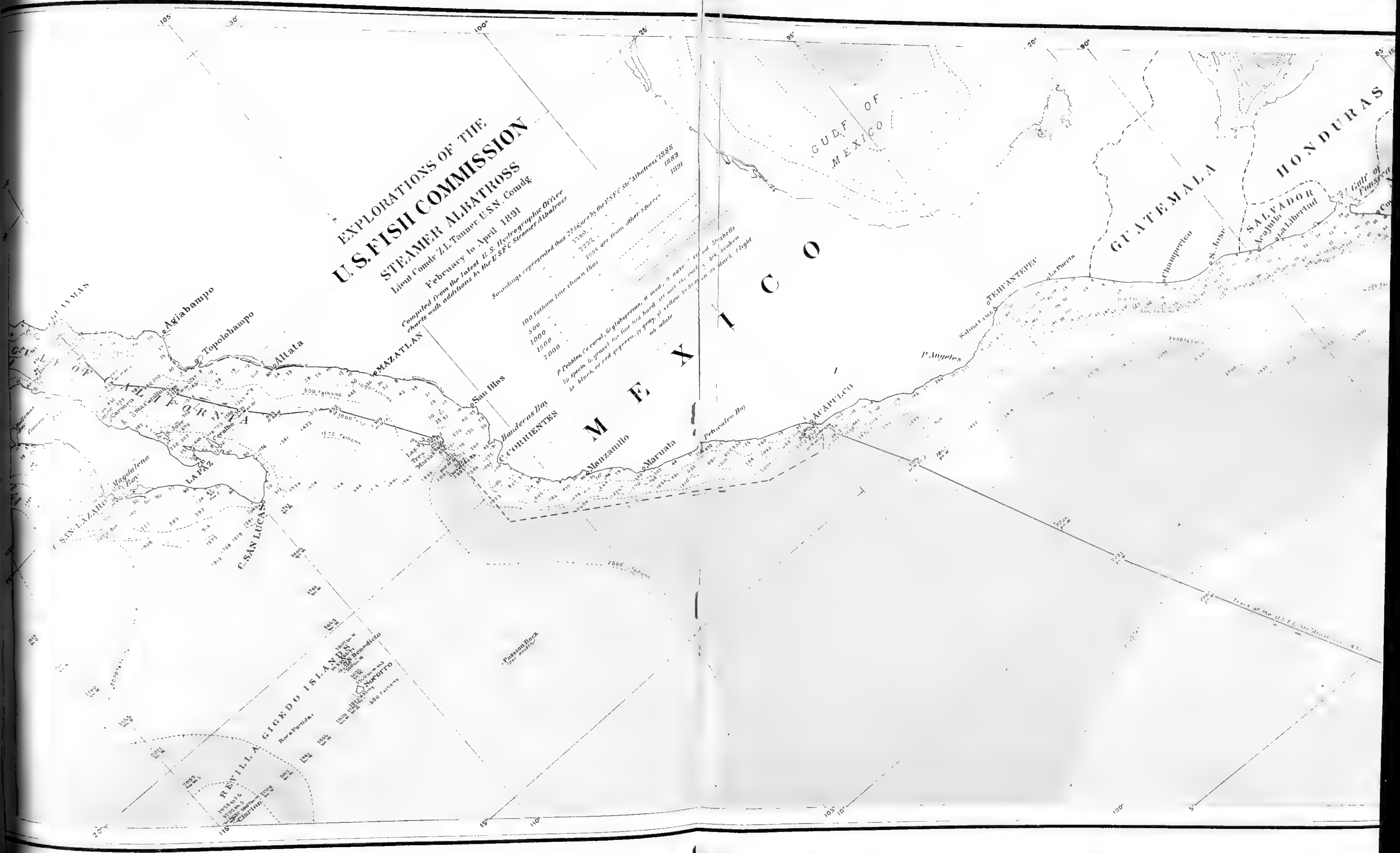
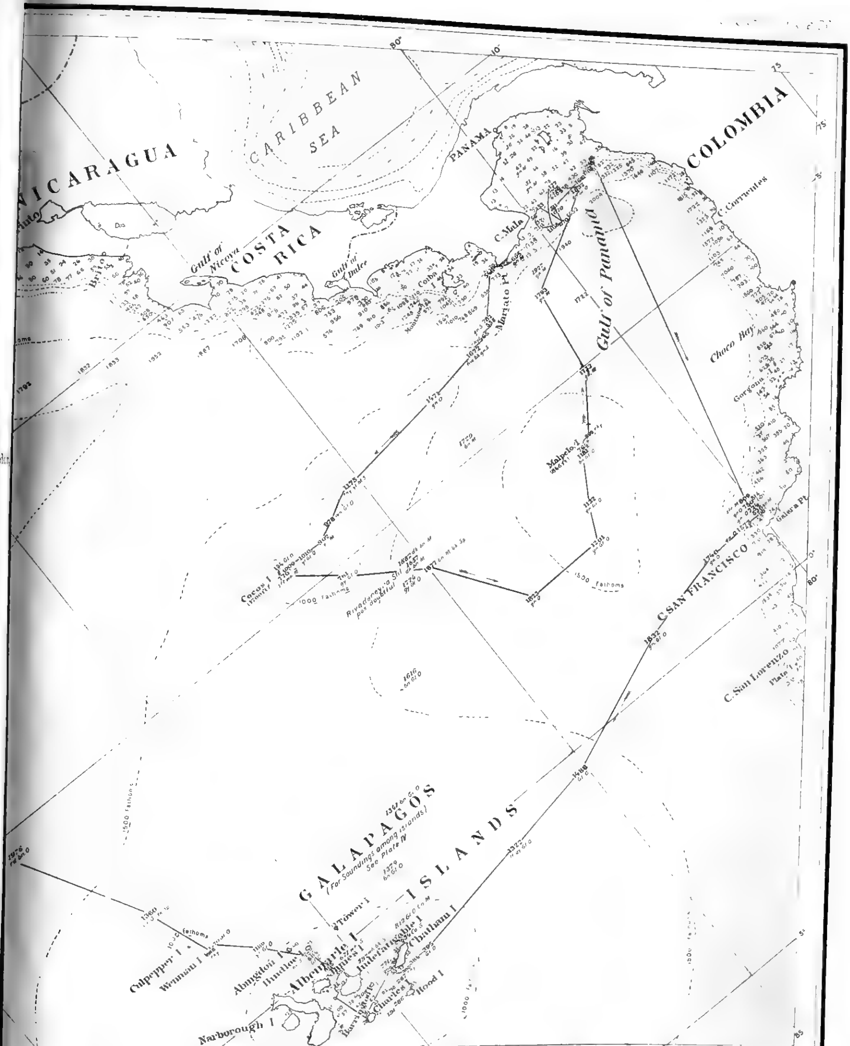
PLATE 26.

Plate 26.

Hydrographic Sketch of the Pacific, from the Gulf of California to Northern Ecuador, with the Track of the "Albatross," February 22 to April 23, 1891.


EXPLORATIONS OF THE
U.S. FISH COMMISSION
STEAMER ALBATROSS
Lieut Comdr Z. L. Tanner, U.S.N. Comdg
February to April 1891
Compiled from the latest U. S. Hydrographic Office charts with additions by the U.S.F.C. Steamer Albatross
Soundings represented thus 2256 are by the U.S.F.C. Str "Albatross" 1888
2280 1889
2232 1891
2004 are from other sources
100 fathom line shown thus
500
1000
1500
2000
P Pebbles, Co coral, Gl globigerina, M mud, O ooze, S sand, Sh shells
Sp specks, G gravel, fne fine, hrd hard, stf stiff, sft soft, rky rocky, brk broken
bk black, rd red, gn green, gy gray, yl yellow, bn brown, dk dark, lt light
wh white
MEXICO
GULF OF MEXICO
GUATEMALA
HONDURAS
SALVADOR
GULF OF CALIFORNIA
Agiabampo
Topolobampo
Altata
MAZATLAN
San Blas
Banderas Bay
C. CORRIENTES
Manzanillo
Maruata
Petacalco Bay
ACAPULCO
P. Angeles
Salina Cruz
TEHUANTEPEC
La Puerta
Champerico
S. Jose
Acajutla
La Libertad
Gulf of Fonseca
Carmen
Sta Catalina
S. Jose
Cerralbo
LA PAZ
Magdalena Bay
C. SAN LAZARO
C. SAN LUCAS
Tres Marias
REVILLA GIGEDO ISLANDS
S. Benedicto
Socorro
Roca Partida
Clarion
Passion Rock
500 fathoms
1000 fathoms
2000 fathoms
Track of the U.S.F.C. Str Albatross 1891
105°
100°
95°
90°
85°
115°
110°
30'
25°
20°
15°
10°
5°


NICARAGUA
CARIBBEAN SEA
COSTA RICA
PANAMA
COLOMBIA
Gulf of Nicoya
Gulf of Dulce
C. Mala
Mariato Pt
Gulf of Panama
C. Corrientes
Choco Bay
Gorgona I
Malpelo I
Cocos I
Rivadeneyra Shl pos doubtful
Galera Pt
C. SAN FRANCISCO
C. San Lorenzo
Plata I
GALAPAGOS ISLANDS
(For Soundings among Islands See Plate IV
Tower I
Culpepper I
Wenman I
Abingdon I
Bindloe I
Albemarle I
James I
Indefatigable I
Chatham I
Barrington I
Charles I
Hood I
Narborough I
1000 Fathoms
1500 Fathoms
80°
75°
10°
5°
0°
95°
90°
85°

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. XXX. NO. 2.

REPORTS ON AN EXPLORATION OFF THE WEST COASTS OF MEXICO, CENTRAL AND SOUTH AMERICA, AND OFF THE GALAPAGOS ISLANDS, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," DURING 1891, LIEUT. COMMANDER Z. L. TANNER, U. S. N., COMMANDING.

XXXI.

THE RADIATING ORGANS OF THE DEEP SEA FISHES.

BY ROBERT VON LENDENFELD.

WITH AN APPENDIX ON THE STRUCTURE OF THE BUD-LIKE ORGANS OF MALTHOPSIS SPINULOSA GARMAN.

BY EMANUEL TROJAN.

WITH ELEVEN PLATES,
AND A CHART OF THE ROUTE.

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AUGUST, 1905.

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APPENDIX.

THE RADIATING ORGANS OF THE DEEP SEA FISHES.

1. INTRODUCTION.

The fishes collected by the "Albatross" in 1891 have been carefully described by Mr. Samuel Garman ('99). A considerable number of them possess radiating, or, as they were formerly termed, phosphorescent organs. Mr. Alexander Agassiz was so kind as to place many of these at my disposal and to permit me to study the minute structure of their radiating parts. For this valuable material and his subsequent furtherance of the work, I express my sincerest thanks. The results of the examination of these organs are detailed in this paper.

The fishes sent to me belong to the following species: —

Argyropelecus lychnus Garman.
Bassozetus nasus Garman.
Chauliodus barbatus Garman.
Cyclothone acclinidens Garman.
Halosaurus radiatus Garman.
Idiacanthus antrostomus Gilbert.
Ipnops agassizii Garman.
Leuciocorus lusciosus Garman.
Lychnopoles argenteolus Garman.
Macrurus canus Garman.
Malthopsis spinulosa Garman.
Mixonus caudalis Garman.
Myctophum aurolaternatum Garman.
Sternoptyx obscura Garman.
Stomias hexagonatus Garman.

All, with the exception of *Mixonus caudalis*, were sufficiently preserved in alcohol to allow of the examination of their radiating organs.

Since Garman did not pay particular attention to these organs, his statements concerning their arrangement and number are not always sufficient. This applies to the figures even more than to the descriptions. For this reason the entire fishes are here figured again.

The minute structure of the organs was studied by means of paraffin and celloidin sections. Various stains were employed. Van Gieson's haematoxylin-picric acid-fuchsin gave the best results. Most of the sections photographs, and drawings were made by Mr. E. Trojan while working in my laboratory. I must express my thanks for the great pains Mr. Trojan has taken with this work; and for his paper on the structure of the bud-like organs of *Malthopsis spinulosa* which I add as an appendix to this memoir.

Three types of radiating organs are represented by the fishes examined: — ocellar radiating organs, radiating discs, and tubular radiating organs.

2. DESCRIPTION OF THE RADIATING ORGANS.

(1) THE FISHES WITH OCELLAR RADIATING ORGANS.

Argyropelecus lychnus Garman.

Plate 6, Figs. 24, 25.

This species has been described by Garman ('99, p. 234, Plate J, Fig. 1, 1b). The radiating organs are of considerable size, possess exceedingly brilliant reflectors and are surrounded by a layer of dark pigment, so that they are very conspicuous. There are on each side 1 anteorbital (Plate 6, Fig. 25, ao), 1 postorbital (po), 2 opercular (op), 6 branchiostegal (br), 6 pectoral (pc), 12 ventrothoracic (vt), 2 anterior lateral (al), 6 medial lateral (ml), 4 ventromedial (ve), 6 anal (a), and 4 ventrocaudal (vc), radiating organs. Besides these there also exists, according to Garman ('99, p. 234), a frontal.

The axis of all the organs lies very obliquely and nearly parallel to the surface in such a way that it is directed vertically downwards. The anteorbitals, the postorbitals, and the opercular are simple. The others are joined in longitudinal rows in which they lie side by side. The right and left ventrothoracic organs form a double row which appears as a medial crest, protruding ventrally. All the organs with the exception of the anteorbitals, in which the sheaths are absent, are similar in structure, and size, and the differences in their appearance are due chiefly to the different degrees of coalescence. This is *nil* in the three cephalic organs mentioned, and greatest in the ventrothoracics.

The organs are 2 to 3 mm. long and 1 mm. or a little more broad. Each radiating organ (Fig. 24) is composed of a slender elongated ellipsoidal proximal (A), and a narrow funnel-shaped distal part (D). These parts are separated by a clearly marked constriction (C). The proximal oval part has in the single organs a circular transverse section throughout; in the joined organs it is not so regular. The distal funnel shaped part is in life probably a rotation paraboloid, but on account of shrinkage appears somewhat irregular in the sections (Fig. 24). In accordance with the smallness of the angle enclosed between the axis of the organ and the surface of the fish, the funnel abuts very obliquely on the latter; it is long on the inner, and very short on the outer face, a very oblique truncated cone with bulging parabolic sides.

The whole organ with the exception of the funnel mouth, which is closed by a transparent membrane, is surrounded by a thin layer of cells containing a dark brown pigment. These form an outer pigment sheath (p). Inside this lies another sheath composed of colorless, highly refractive fibres. This (r) is exceedingly thick at the proximal end of the inner, oval part of the organ and gradually thins out from here to the margin of the funnel. It is most highly developed in the joined ventrothoracic organs, where it forms a continuous mass. The fibres composing this layer are parallel, pretty stout, lie close together, and extend longitudinally from the proximal apex of the elliptical part to the distal margin of the funnel. In life these fibres probably follow the curvature of the layer which they form, but are not otherwise bent. In sections (Fig. 24) they often form zigzag lines in the distal thin part of the reflecting layer (B). This also is probably attributable to shrinkage.

In the tissue occupying the proximal and central part of the interior space surrounded by the fibrous layer three regions can be distinguished: an inner (g), a middle (l), and an outer (s). The limits between these regions are well defined. The inner region extends to the constriction between the oval and conic part of the organ and there ends with a slightly convex surface vertical to the axis. In the joined organs, particularly in the ventrothoracics, the inner regions of adjacent organs coalesce to form extensive cellular masses surrounded by common fibre and pigment sheaths.

The tissue occupying the inner region (g) has in all sections, whatever their direction may be, an alveolar or reticulate appearance; in the alveoles or meshes residual masses of protoplasm and small spherical nuclei, both readily staining with haematoxylin, are clearly visible. Very rarely a slight indication of an arrangement of the meshes of this network in rows is met with. The meshes or alveoles are about 20 μ wide. Occasionally one sees a capillary vessel traversing this tissue but these appear to be rare. The residual protoplasmatic masses and the nuclei appear attached to the strands of the network, or the walls of the alveoles. The structure of this tissue is pretty much the same throughout the whole region it occupies.

The middle region (l) occupies the lower portion of the conic part of the organ. Its limit towards the inner region is, as we have seen, concave and smooth. The outer limit is not well defined, the middle region gradually passing into the outer, which is composed of small digitate papillae lying close together. The middle region is composed of cells, which, in longitudinal, axial sections (Plate 6, Fig. 24) appear transversely arranged and mostly long, slender, and spindle-shaped. On the whole this tissue takes stains, particularly haematoxylin, somewhat less readily than the parts below and above it. It is traversed by numerous capillary vessels. Whether the cells here in the proximal part of the middle region are really spindle-shaped or lamellar, overlying each other like the cells in the epithelium of the human skin, could not be decided. Distally, towards the papillae, the arrangement of these cells becomes less regular and the cells themselves become smaller, the nuclei lying much closer together. The papillae forming the outer region are composed of similar cells; these are often much curved, but also on the whole arranged paratangentially. This outer region is poorer in blood vessels than the inner.

The distal part of the cone beyond the outer region contains only a few doubtful traces of cells and chiefly consists of a gelatinous substance, which takes haematoxylin and some other stains pretty readily and which in some sections exhibits a very strongly marked stratification, the layers being slightly oblique to the outer surface.

The structure of the radiating organs in the genus Argyropelecus was first examined in *A. hemigymnus* by Ussow ('79, pp. 103–104, Plate 1, Fig. 5). According to his description these organs of *A. hemigymnus* are similar in appearance and arrangement to those of *A. lychnus* described above. Ussow states that the internal tissue of the inner region is composed of glandular cells supported by a scaffolding (Gerüst) of connective tissue.

Leydig ('81, pp. 26–39, Plate 1, Fig. 5; Plate 1, Figs. 13, 14; Plate 3, Figs. 19, 20, Plate 4, Figs. 22–27; Plate 5, Figs. 28–31; Plate 6, Fig. 35) has described these organs in the same species. So far as their arrangement and appearance are concerned, this description accords with that of Ussow. The anteorbital organ is innervated by branches of the nervus trigeminus, which enter it at various points. The stoutest nerve branch enters the organ at the constriction between the oval and conic parts. The cells composing the inner region are described as arranged in columns. Leydig suggests (l. c., p. 38) that the fish may swim on its side like a pleuronectid, and not vertically. He supports this view by stating that the pigment is not equally developed on the right and left side and by quoting a statement of Valenciennes to the effect that the similar *Sternoptyx hermanni* "flotait renversé sur le côte." Garman (l. c.) does not mention the occurrence of any difference in the coloration of the two sides in *A. lychnus*, nor have I noticed it. However the case may be with *A. hemigymnus* I do not think it likely that *A. lychnus* swims on its side. In a previous paper ('87, pp. 303–307) I have described the radiating organs of *A. hemigymnus* and other fishes, in which they have a similar structure. The fibrous layer in the organs of *A. hemigymnus* was found to contain parallel and longitudinally arranged fibres of considerable length; so there is no difference between these species and *A. lychnus* in this respect. The statement there made that the inner region is composed of tubes *lined* with glandular cells does not apply to *A. lychnus*, where such tubes could not be made out; there is hardly even a trace of the columnar arrangement described by Leydig.

Brandes ('99, p. 470), who also described *A. hemigymnus*, says that the anteorbital organs are connected with muscles and can be moved about at will so as to throw their radiation in any direction the fish may choose. This statement has been contradicted by Handrick ('01, p. 54). The fibre sheath consists of long and slender tissue cells containing guanin and lime. The tissue of the inner region is, according to Brandes ('99, p. 484), composed of roundish gland cells and is without efferent ducts. These cells produce a secretion which, according to Brandes, disintegrates chemically and thereby emits light. The light passes the middle region, considered by him as a biconcave lens, and illuminates the gelatinous mass which occupies the outer region, and which is backed by the inner face of the distal part of the reflecting fibre layer. Thus the luminosity would be visible chiefly from points at the side of the fish.

Chiarini ('00, pp. 7–10, Figs. 1, 4, 5) has likewise studied the organs in *A. hemigymnus*. He reproduces a figure (1) of an axial longitudinal section of one of them, which — apart from its being upside-down — closely corresponds to the figure of a similar section of the anterior lateral organ in *A. lychnus* here given (Plate 6, Fig. 24). According to Chiarini the pigment layer of the organs of *A. hemigymnus* is not quite continuous, but interrupted by longitudinal lines free from pigment. The fibre layer is exceedingly thick. The internal tissue has no special covering membrane and is in immediate contact with the fibre layer. The inner region of the internal tissue is composed of polygonal cells. Each contains granules and one or two nuclei. These cells are not regularly arranged; there is, however, an indication of a concentric stratification near the outer limit (towards the middle region). The cells of this inner region are supported by reticulate connective tissue. The middle region is composed of cells with a polygonal contour, arranged transversely. In the outer region the cells are arranged more or less longitudinally. Also in this middle region a supporting reticulation of connective tissue is met with. The distal portion of the cone is occupied by gelatinous tissue.

Handrick ('01) has published a detailed account of the nervous system and the radiating organs of the same species. He appears to have been unacquainted with Chiarini's paper cited above. Handrick ('01, p 58, 59) carefully worked out the innervation for most of the radiating organs ('01, pp. 58, 59). The anteorbital is — as Leydig had previously stated (see p. 173) — innervated by the trigemius, the postorbital, opercular, and branchiostegal by the facialis, the others by spinal nerves. The radiating organs are not movable relative to the body (*versus* Brandes, see p. 173) but the concavity of the sheath can be changed by muscular action ('01, p. 54). A few very elongated nuclei belonging to the fibre cells were observed in the inner sheath. The tissue of the inner region, the "Leuchtkörper," is very minutely described ('01, p. 55). It is not in direct contact with the fibre sheath (as stated by Chiarini), but separated from it by a special membranous layer of connective tissue. From this, strands of connective tissue extend inward. These are much branched and anastomizing form a network along which nerves and blood vessels extend, and in the meshes of which large round or polyedric cells lie. The columnar arrangement described by Leydig ('81, p. 31, see p. 173) cannot be made out. Handrick ('01, p. 56) gives a detailed description of the internal structure of these cells and distinguishes two varieties of them. According to him they always have only one nucleus, not sometimes two as stated by Chiarini (see above). The tissue of the middle region is, according to Handrick ('01, p. 57), also supported by a reticulation of connective tissue. He considers the cells forming its proximal portion as spindle shaped, those forming the distal portion as "polygonal," meaning perhaps polyedric. The latter are, as it has been described above of *A. lychnus*, also in *A. hemigymnus*, smaller than the former. Handrick found blood vessels but no nerves in the middle region. The extent of the gelatinous tissue occupying the distal part of the cone is different in the different organs; it is absent altogether in the anteorbitals. In this region a loose network of connective tissue with large nuclei extends, the interstices being occupied by a gelatinous substance ('01, p. 58).

According to this, the latest paper on *A. hemigymnus*, the radiating organs of this fish seem to have very much the same structure as those of *A. lychnus*.

Sternoptyx obscura Garman.

Plate 6, Figs. 26, 27.

This species was described by Garman ('99, p. 232, Plate 53, Fig. 1). The radiating organs are, as in *Argyropelecus lychnus*, very conspicuous. There are on each side 2 opercular (Plate 6, Fig. 26 op), 5 branchiostegal (br), 10 ventrothoraic (vt), 3 ventral (ve), 3 anterior lateral (al), 3 posterior lateral (pl), 3 anal (a) and 4 ventrocaudal organs (vc). As in *Argyropelecus lychnus* all these groups form rows in which they lie close together. The 20 ventrothoracic organs of the two sides are joined to form a medial crest protruding from the ventral side of the fish. The inner regions of the internal parts of these organs are joined and form a continuous mass. The axes of all the organs enclose very small angles with the outer surface and thus lie nearly paratangentially. The 2 opercular of each side are oblique, directed downwards and backwards, all the others more or less vertically downwards.

Besides these organs observed by me, Garman ('99, p. 233) mentions a silvery area below the eye which he thinks may be a rudimentary suborbital radiating organ.

The structure of the organs is apparently the same as in *Argyropelecus lychnus*. In some of them, however, chiefly in the ventrothoracic organs (Plate 6, Fig. 27), the proximal part of the pigment sheath (p) is thicker and the middle and outer region together are much less extensive than in that fish. These appear here (l and s) as a rather thin, oblique, lenticular body separating the extensive gelatinous outer mass (gl) from the cellular inner region (g). Traces of stratification could also be detected in the outer region.

I have described ('87, p. 303, Plate 70, Figs. 15–24) the radiating organs of *Sternoptyx diaphana.* In that species extensive radiating organs are met with on the lips, and I think that such may also be present in *S. obscura;* but as that portion of the specimen at my disposal is somewhat injured I cannot express myself with certainty on this point. The glandular tubes as figured ('87, Plate 70, Fig. 20) in the inner coalesced regions of the ventrothoracic organs cannot be made out in *S. obscura;* in this fish they appear to consist, as in Argyropelecus, of an alveolar network containing large, roundish cells.

Lychnopoles argenteolus Garman.

Plate 7, Figs. 31–37.

This species has been described by Garman ('99, p. 244, Plate 53, Figs. 4, 4a). The radiating organs appear as spots, 700 μ in diameter, with a silvery lustre, and are pretty conspicuous. There are on each side 1 anteorbital (Plate **7**, Figs. 31, 32 ao), 1 mandibular (Figs. 32, 33 ma), 11 branchiostegal (Fig. 33 br) 9 guttural (Figs. 33 g), 2 opercular (Figs. 31, 32 op), 14 ventrothoracic (Figs. 31, 32 vt) — Garman ('99, p. 245) counts 15 of these — 19 ventromedial (Figs. 31, 32 ve), 22 anal (Figs. 31, 32 a), 11 anterior lateral (Figs. 31, 32 al), 10 mediolateral (Figs. 31, 32 ml), and 22 posterior lateral (Figs. 31, 32 pl) radiating organs. Garman ('99, p. 245) states that there are besides these two parallel rows of radiating organs on the sides of the body. In the partly injured specimen at my disposal these could not be made out.

With the exception of the anteorbital organ which is somewhat peculiar and which will be described below, all the radiating organs mentioned have the same external and internal structure. They consist, as in Argyropelecus and Sternoptyx, of two parts, a proximal and a distal. The proximal part (Plate **7**, Fig. 37 A) is approximately spherical and forms about three quarters of a sphere. The constriction (C) between the proximal and distal part is well defined but shallow, so that the "neck" of the organ has a considerable breadth. The distal part (D) appears as a broad and somewhat short rotation paraboloid, obliquely cut off where it abuts on the surface of the body. The blood vessels in the subcutaneous connective tissue surrounding the organ (b) are more numerous close to the pigment sheath than elsewhere. The pigment sheath (Plate **7**, Figs. 35, 37 p.) is stout, dense, and of uniform thickness in the inner spherical part and the proximal portion of the outer parabolic part. Towards the surface it thins out. The reflecting layer (Figs. 35, 37 r) is about as thick as the pigment layer and composed of longitudinally arranged fibrous cells. It does not extend to the surface and terminates some distance within the margin of the pigment layer. On the inner side of the reflecting layer a conspicuous connective-tissue membrane (Figs. 35, 37 c) about as thick as the two other layers, is met with. Distally this membrane passes into the gelatinous portion of the outer region of the organ.

Three regions (Plate **7**, Fig. 37 g, l, s), can be distinguished in the tissue forming the internal part of this organ in Lychnopoles as in Argyropelecus and Sternoptyx; in Lychnopoles, however, these are built on a somewhat different plan.

From the connective-tissue membrane (Plate **7**, Figs. 35, 37 c) mentioned above membranous diverticula extend inward which join to form facets arranged radially. In the proximal spherical part of the organ these membranes are straight and each facet encloses a regular pyramidal space. Its apex lies near the centre of the sphere, and its base abuts on the connective-tissue membrane overlying the reflecting layer (Plate **7**, Fig. 37). The radial membranes (facets) do not extend quite to the axis. A somewhat irregular tubular cavity (Plate **7**, Fig. 37 cc) occupies that portion of the axial part of the organ which lies between the centre of the proximal sphere and the focus of the distal paraboloid. The margin of this tube is so well defined that it looks as if a special limiting membrane were present. Its cavity appears empty, neither blood corpuscles nor other bodies were found in it. In the pyramidal spaces enclosed by the facets, nuclei and residual protoplasmatic masses highly stainable with acid-fuchsin are met with. These adhere chiefly to the connective-tissue membrane at the base of the pyramid and to the adjoining parts of the radial membranes: the central parts of the facets (Plate **7**, Fig. 37 ci) are pretty free from them.

The facets in the distal paraboloid are not so regular as those in the proximal sphere. The inner (proximal) part of the paraboloid is occupied by pretty narrow, more or less curved facets (Plate **7**, Fig. 37, cm) extending from the sides towards the distal end of the tubular cavity above described. These facets are pyramidal, distally broad and proximally contracted. The outer (distal) part of the paraboloid is occupied by regular straight, prismatic facets (Plate **7**, Fig. 37 co) which are parallel to the axis of the organ; they are rounded off distally and drawn out proximally to points converging towards the distal end of the tubular cavity. The distal ends of these facets lie in a surface convex outwardly and *in toto* vertical to the axis of the whole organ. The triangular space outside these facets, between them and the surface, is occupied by gelatinous tissue (gl).

The small curved facets and the proximal portions of the large straight ones which together occupy the inner part of the paraboloid and form the middle region of the organ (Plate **7**, Fig. 37) are clothed with a single layer of cylindrical cells which form a kind of simple epithelium (Plate **7**, Fig. 36). These cells take up the greater part of the space within the facet and only leave an exceedingly narrow central canal (Plate **7**, Fig. 36 cn) free. This canal extends longitudinally in the axis of the facet towards the tubular space in the interior of the organ. Probably it opens into it, as I have seen many indications of such a connection, but I am not certain about it. The cylindrical cells forming the epithelial clothing of these facets and surrounding the central canal are composed of two kinds of protoplasm. The proximal three quarters of each cell (lying next the canal) (Plate **7**, Fig. 36 ph) are transparent and only slightly stainable; the distal quarter (lying next the facet wall) (Plate **7**, Fig. 36 pt) is granular and takes stains very readily, so that it appears dark and not transparent in the stained sections. In this highly stainable, basal portion of the cell the nucleus (nu) is situated.

It is probable that the facets of the proximal spherical part of the organ described above contain the same kind of tissue, but the condition of the material does not allow of this being definitely determined.

The tissue occupying the distal parts of the large straight cylindrical facets and forming the outer region of the organ (Plate **7**, Fig. 37 s) is of an entirely different character. Here we find elongated, slender cells, which are rather indifferent to most stains, but become intensely yellow after treatment with picric acid. In the distal basal part of each of these facets these cells are very slender, spindle-shaped, and arranged longitudinally, parallel to the axis of the facet (Plate **7**, Fig. 34 sp). Towards the proximal part they become stouter and shorter and here they often appear club-shaped. The cells appear to rise from the walls of the facet. Those joined to the terminal face of the facet arise more or less vertically; those joined to the sides arise very obliquely and extend nearly parallel to the facet wall to which they are attached. The cells in the distal part of the facets are nearly straight throughout the whole of their length. As we approach the proximal part of the facet we find these cells curving away more and more from the walls of the facet so that their free ends come to lie more or less obliquely (Plate **7**, Fig. 34 sc). Finally they are situated nearly transversely, the cells arising from the different sides interlacing axially.

In the sections one often finds a circular structure of considerable size (Plate **7**, Figs. 34, 35 o) in the centre of the facet. Sometimes it appears as an empty space, and is perfectly colorless and structureless; sometimes it has — in sections stained with acid-fuchsin — a bright red color and then one occasionally notices traces of a granular structure within it. The tissue surrounding the circle often shows a fine radial structure (Plate **7**, Figs. 34, 35). I have not been able to ascertain the real nature of these circles and their coronas with any degree of certainty. The circles seem to be the expression of spherical spaces lying between the cells, and the radial structure surrounding them might be due to the fact that the slender inner terminations of the spindle cells abut vertically on this sphere.

The organ is rich in blood vessels. These follow the facet walls and can often be traced for a considerable distance.

The gelatinous tissue (Plate **7**, Figs. 34, 37 gl) mentioned above is composed of a gelatinous ground substance traversed in all directions by exceedingly slender spindle cells. It passes into the connective-tissue membrane overlying the reflecting layer. A thick granular lamella or cushion (Plate **7**, Fig. 37 gr) underlies this gelatinous tissue and separates it proximally from the reflecting, and distally, where this is absent, from the pigment layer.

As mentioned above, the anteorbital radiating organ differs in some respects from the others. It appears to be much larger and measures 1.5 mm. in diameter. Closer examination shows that it is a duplex organ composed of two, each similar to the other radiating organs of the fish. These two organs point different ways and are enclosed in a common pigment sheath which has the shape of a curved tube open at both ends. The two orifices of this tube lie in the surface; one is oblique, directed upwards and forwards towards the eye, the other vertical, directed straight downwards. The spherical parts (inner regions) of the two organs occupy its central, the paraboloidal parts (middle and outer regions) and the gelatinous and granular tissue the terminal portions of the tube. These two joined organs throw their radiation in different directions, one into the field of vision and the other downward, neither inward nor backward, as Garman ('99, p. 245), who also noticed that this organ differs in structure from the others, seems to think.

Cyclothone acclinidens Garman.

Plate 6, Figs. 28-30.

This species has been described by Garman ('99, p. 247, Plate J, Fig. 4), whose statements concerning the radiating organs are, on the whole, in accordance with my observations; in his figure (4), however, 2 opercular and 5 posterior lateral organs are drawn which do not exist and which Garman himself does not mention in his description. The other organs are represented in the figure as lateral whilst they are in reality situated on the ventral side of the body.

The radiating organs are very small, only 700 μ in diameter, and are destitute of reflectors. On account of their insignificant size and want of lustre, they are far from conspicuous and not easy to make out. There are on each side 10 branchiostegal (Plate 6, Fig. 29 br), — Garman ('99, p. 247) gives their number as 13 — 13 ventrothoracic (Figs. 28, 29 vt), 3 ventromedial (Figs. 28, 29 ve), and 16 ventroanal (Figs. 28, 29 a) radiating organs.

All the organs seem to have the same structure. They are approximately spherical and enclosed in a pigment sheath which forms over three quarters of a sphere and encloses them on all sides except where they abut on the surface of the fish. A straight line drawn through the centre of the sphere and the centre of the more or less circular superficial orifice of the pigment sheath is vertical to the surface of the body.

The pigment sheath (Plate 6, Fig. 30 p) is composed of cells containing dark brown pigment granules. It is very stout. Its inner surface is pretty smooth, the outer covered with irregular protuberances. Within the pigment sheath a connective-tissue membrane (Plate 6, Fig. 30 c) is met with. Near the surface this splits up into two membranes, one covering the mass of radiating cells proper on the outer side (Plate 6, Fig. 30 cr) the other forming a thick superficial cell layer (Plate 6, Fig. 30, l and cd).

Three zones can be distinguished in the organ: an inner, occupying about three quarters of the whole sphere, an intermediate, and an outer.

The inner zone is composed of a mass of large polyedrical cells and enclosed in a connective-tissue capsule. The part of this capsule which covers the radiating cell mass inwardly and laterally and separates it from the pigment sheath (Plate 6, Fig. 30 c) is the connective-tissue membrane mentioned above. The part of the capsule covering the cell mass outwardly and separating it from the intermediate zone (Plate 6, Fig. 30 cr) is the innermost of the two layers into which the connective-tissue membrane splits up near the surface. From this outward part of the covering membrane lying near the surface diverticles extend inwards dividing the outer two thirds of the cell mass into somewhat irregularly pyramidal facets, the (distal) bases of which are closed by the outer capsule membrane whilst the (proximal) apices are wide and open. The innermost part of the cell mass is not thus divided into facets. The facets are occupied by large polyedrical cells (Plate 6, Fig. 30 r) arranged in radial rows. Each cell contains a large and conspicuous spherical nucleus; its protoplasm is readily stainable with acid-fuchsin. The same cells are met with on the inward side of the organ, but here they form layers parallel to the surface of the organ and are not arranged in radial rows. In the interior, a little below the centre, a mass of much smaller cells (Plate 6, Fig. 30 m) is observed. These look like closely packed blood corpuscles. Possibly there exists here a blood sinus; I have not been able, however, to make out clearly a wall separating these smaller internal cells from the larger ones around them.

The intermediate zone (Plate 6, Fig. 30 t) has in sections the appearance of a nearly empty space. It is in life perhaps occupied by a gelatinous substance with few slender cells. It may, however, be a mere artifact produced by shrinkage.

The outer zone is composed of two layers, an inner layer of cylindrical cells arranged vertically to the surface (Plate 6, Fig. 30 l) and an outer layer of ordinary connective tissue composed of slender cells arranged paratangentially (cd) which forms the superficial covering of the organ in the orifice of the pigment sheath. The protoplasm of the cylinder cells of the inner layer is concentrated at their proximal ends which abut on the intermediate zone. Here also the nucleus is situated. The rest of the cell body is very transparent and the cell walls are difficult to make out. These cells do not take stains readily and thus essentially differ from the polyedric cells of the inner zone. In their microchemical behavior and their general appearance they resemble the cells of the middle region of the radiating organs of Argyropelecus and Sternoptyx.

A blood vessel, artery, (Plate 6, Fig. 30 b) of considerable size entering the organ at the innermost point was observed in several sections.

Myctophum aurolaternatum Garman.

Plate 5, Figs. 21–23.

This species has been described by Garman ('99, p. 254, Plate 55, Fig. 3). His statements concerning the distribution of the radiating organs agree with my observations, but his figure ('99, Plate 55, Fig. 3) differs in several respects from what I find in the specimen examined.

The radiating organs are for the most part nearly equal in size about 600 μ in diameter. They are provided with reflectors, lustrous, and therefore, although so small in size, quite conspicuous.

There are on each side 3 mandibular (Plate 5, Figs. 21, 22 ma), — these are mentioned by Garman ('99, p. 265), but not represented in his figure ('99, Plate 55, Fig. 3),— 4 branchiostegal, 2 opercular (op),— the lower one, which is smaller than the upper one, is not represented in Garman's figure ('99, Plate 55, Fig. 3),— 3 pectoral (pe) forming an arc just behind the gill slit, 5 ventrothoracic (vt), over the last of these 1 anterior lateral (al), 4 ventromedials (ve), 3 mediolaterals (ml) forming an oblique row, 10 anterior ventroanal (va), 1 posterior lateral (pl), over the last one of the former 6 posterior ventroanal (vp) — according to Garman's figure ('99, Plate 55, Fig. 3) 7, — and 2 ventrocaudal radiating organs (vc) at the base of the tail.

All the organs examined appear to have the same structure. Viewed from the surface each appears as a lustrous spot enclosed above and at the sides by a dark strip, which has the shape of a horseshoe open below. Each radiating organ of the body lies between two scales. The outer one which covers it (Plate 5, Fig. 23 ss) is convex and possesses near the centre an H-shaped thickening (t) produced by a local accumulation of calcareous laminae, which make the scale very brittle. On treatment with acid the thickening disappears. The horseshoe-shaped pigment stripe mentioned above is attached to the inner side of this scale. An axial section of the organ vertical to the medial plane of the fish passes through the apex of the horseshoe (p). The lower scale (si) is concave; on its inner side a continuous layer of pigment (pp) is observed. The lenticular space between the convex outer and the concave inner scale is for the most part occupied by connective tissue (c). This is composed of a ground substance traversed by slender, elongated cells which are somewhat irregularly curved.

This tissue is rich in blood vessels. The radiating organ proper, that is, the mass of cells (pc) which probably emit the radiation, lies in the middle of this connective tissue. It is pear-shaped, the thinner end extending outward and downward. The cells composing it are flattened and extend parallel to the surface of the body. The protoplasm is quite transparent and each cell contains a large granular nucleus. The blood vessels form a fine-meshed capillary network (b) on the surface of this cell mass, but do not penetrate into its interior.

Radiating organs of this kind seem to be rare in fishes. Somewhat similar ones have been described by Emery ('84, p. 473) from the ventral series of *Scopelus elongatus*.

Chauliodus barbatus Garman.

Plate 8, Figs. 38–40; Plate 9, Figs. 43–46.

This species has been described by Garman ('99, p. 271, Plate K, Figs. 2, 2 a). The radiating organs are very numerous. Three different kinds of them can be distinguished. The differences between these are considerable and clearly discernible with the naked eye. Some of the organs are simple, some composed, as in the fishes described above, of an inner spherical and an outer paraboloidal part. The simple ones again are either uncovered or provided with a pigment sheath. I have designated these three kinds of organs accordingly as simple organs without pigment sheath, simple organs with pigment sheath, and compound organs with pigment sheath.

The simple radiating organs without pigment sheath appear as very small whitish dots. They are arranged in groups of from 4 to 16. These groups are scattered over the medial part of the ventral surface (Plate **8**, Fig. 39 u) and also occur in great numbers on other parts of the surface, chiefly on the back of the fish.

The simple organs with pigment sheath appear as dark spots 300 μ in diameter. They are scattered in great numbers over the whole of the surface and seem to be most numerous on the sides of the head just behind the eyes (Plate **8**, Fig. 38 x). In the barbel there are 8 of these organs (Plate **8**, Figs. 38–40 Ba).

The compound organs with pigment sheath are lustrous, elongated, about 1mm. long and 600 μ broad. Of these organs there are on each side 1 anteorbital (Plate **8**, Fig. 38 ao), 1 suborbital (Fig. 38 so), 18 branchiostegal, 8 guttural (Plate 8, Fig. 39 g), 19 ventrothoracic (Figs. 38, 39 vt), 22 ventromedial (Figs. 38, 39 ve), 11 ventroanal (Figs. 38, 39 a), 17 anterior lateral (Figs. 38, 39 al), and 22 medial lateral (Figs. 38, 39 ml).

The simple radiating organs without pigment sheath are not in a particularly good state of preservation. So far as they could be made out, their structure corresponds with the same organs of *Chauliodus sloani* described by Chiarini ('99, pp. 16, 17). They are spherical or oval, enclosed in a capsule of connective tissue and composed of a layer of superficial, radial, cylindrical elements surrounding a group of central polyedrical cells.

The simple radiating organs with pigment sheath (Plate 9, Figs. 43, 44) have an oval (Fig. 43) or irregular (Fig. 44) shape. They seem, however, always to be elongated in the direction of their axis. The angle between the axis and the part of the surface of the fish where they are situated is very variable. It may be 90°, the organ then being vertical to the surface (Fig. 43), or it may be smaller, sometimes so small that the axis of the organ is nearly parallel to the surface of the fish (Fig. 44). It appears that this angle is correlated to the shape of the organs, the regularly oval ones being usually vertical to the surface, the irregular ones inclined to it; and it seems that the organs are the more irregular the more obliquely they are situated. These organs are not, as is generally the case, imbedded entirely in the body of the fish, but protrude considerably over the surface, forming rather conspicuous rounded protuberances (Plate 9, Figs. 43, 44). They are covered distally by a layer of considerable thickness (Plate 9, Figs. 43, 44 h) which appears structureless and transparent in the sections. Laterally and proximally they are enclosed in a pigment sheath (p). In the regularly oval organs of this kind the axis of which is vertical to the surface (Fig. 43) the pigment sheath extends only over the part of the organ imbedded in the body of the fish. In the irregular ones (Fig. 44) with oblique axis it covers also the proximal portion of the protruding part. The pigment sheath is thickest at the proximal apex of the organ and gradually thins out towards the margin. Its distal orifice is of considerable extent, and occupies about a third of the whole surface. In this a fine connective-tissue membrane (Plate 9, Figs. 43, 44 c) is extended which here replaces the pigment sheath. In this thin layer which separates the radiating cell mass proper from the structureless outer covering mentioned above, nuclei, appearing paratangentially elongated in axial sections of the organ, are observed. The interior of the organ is occupied by a mass of polyedrical cells in the centre, and cylindrical elements on the surface. The latter (Plate 9, Figs. 43, 44 pc) resemble a cylinder epithelium clothing the pigment sheath and distal connective-tissue membrane internally. They are not vertical to this surface however, but so arranged as to converge to a point within the organ very near its proximal apex. In the distal part of the organ these cells are short, hardly longer than broad. Inwardly they increase very rapidly in length and those situated at the sides are nearly half as long as the organ itself. The nucleus is conspicuous, spherical, or radially extended, oval, and always situated at the distal end of the cell. The protoplasm is granular. The limits between these cells are distinct enough distally, but become very indistinct centrally and finally vanish altogether; in the proximal part of the organ to which these cells converge, no trace of cellular division is discernible. This part of the organ is occupied by a granular protoplasmatic mass (Plate 9, Figs. 43, 44 m) in which neither cell walls nor nuclei are met with. The proximal apex itself is in the regular oval organs free from these cells, or cells of any kind, the granular mass (m) extending here right up to the pigment sheath (Plate 9, Fig. 43). In the axial sections of irregular organs, however, a network of cell limits with nuclei in the meshes is usually observed in the part appearing as the proximal apex (Plate 9, Fig. 44). It seems to me, however, that this point does not exactly correspond to the proximal apex of the regular organs and that the "cells" seen there are transverse sections of the same kind of superficial cylinder cells as appear cut longitudinally elsewhere. These organs being so very irregular in shape, an irregularity in the arrangement of the superficial cylinder cells, giving rise to such an appearance of axial sections, would be not at all surprising.

The inner mass of polyedrical cells (Plate 9, Figs. 43, 44 l) has the shape of a bee-hive or truncate cone resting with its broad base on the distal cylinder cells and extending inward a good way beyond the centre of the organ. The distal cells of this mass are smaller and arranged irregularly, the proximal ones larger and situated in more or less clearly pronounced longitudinal rows. In their appearance these cells differ essentially from the cylindrical elements surrounding them. Their nuclei are pretty large, spherical, or flattened radially, and their protoplasm is transparent and free from granules. Picric acid stains them a bright yellow. The superficial cylindrical cells are comparable to the cells forming the inner region of such radiating organs as those described above of Argyropelecus and Sternoptyx; the inner polyedrical cells on the other hand resemble the cells of the middle region of the organs of these fishes.

Three of the simple radiating organs with pigment sheath in the barbel are joined to form a composite mass. Two of these are irregular and lie symmetrically right and left opposite each other. The third is a regular one and lies between the other two. The axes of the two former lie in a plane vertical to the axis of the barbel; the axis of the latter is orientated longitudinally, parallel to the axis of the barbel. A close inspection of a continuous series of sections through this organ reveals the remarkable fact that the central one of these three organs is *completely* enclosed by the pigment layer on all sides, a thing I have not observed in any other radiating organ, although Leydig ('79, p. 369) mentions having occasionally seen simple organs with pigment sheath of *C. sloani* thus entirely enclosed by pigment. Supposing, as one surely has a right to do, that the pigment sheath intercepts the radiation, we would have in that organ of the barbel, and in the similar ones observed by Leydig, radiating organs unable to radiate. A careful examination of these organs completely surrounded by pigment in Chauliodus may be warmly recommended to future investigators.

According to Chiarini's description ('00, p. 16, Plate **5**, Fig. 6) the simple radiating organs with pigment sheath of *Chauliodus sloani* are very similar; his figure (6) however differs somewhat from mine (Plate **9**, Figs. 43, 44). Chiarini states that in staining the superficial cylinder cells with haematoxilin-eosin the nucleus absorbs the former, the protoplasm the latter.

The compound radiating organs with pigment sheath (Plate **9**, Figs. 45, 46) on the body are directed downward. Their axis is vertical, and parallel to the median plane of the fish. Thus the angle between it and the adjacent part of the surface is much larger in the ventral rows than in the lateral. In the latter it is very small, often appearing to be nearly *nil*, the axis then being approximately parallel to the adjacent surface. In their external shape these organs resemble the compound organs of *Lychnopoles argenteolus* described above. They are composed of a proximal spherical (Plate **9**, Fig. 45 A) and a distal paraboloidal part (D). These parts are separated by a sharp and well-defined stricture (C) of considerable depth. The proximal part forms about three quarters of a very regular sphere. The distal part is short, broad, and cut off obliquely at the base, where it abuts on the surface. With the exception of the oblique terminal face of the distal paraboloidal part, the whole organ is enclosed in a stout pigment sheath (Plate

9, Figs. 45, 46 p). The cells composing the sheath contain brown pigment. They are very closely packed towards the inner well-defined and perfectly smooth surface. Towards the outer side they are farther apart and this surface is not so well defined, the pigmented tissue passing here somewhat gradually into the unpigmented tissue surrounding the pigment sheath. In the distal paraboloidal part of the organ a lustrous reflecting layer (Plate 9, Fig. 45 r) composed of slender fibres, is found within the pigment sheath. In the proximal spherical part no such reflecting layer could be made out. A connective-tissue membrane (Figs. 45, 46 c) clothes the whole organ. In the proximal spherical part it appears to rest immediately on the pigment sheath, in the distal paraboloidal part it rests on the reflecting layer. Distally this membrane merges into the transparent connective tissue (Fig. 45 d) which occupies the triangular space between the distal limit of the radiating cell mass proper and the outer surface of the fish. From the whole of the connective-tissue capsule fine radial septa extend inward.

The radiating cell mass proper is composed of three regions, an inner (Fig. 45 i), a middle (m) and an outer (o). The inner region occupies the whole of the proximal spherical part of the organ with the exception of a distal conic sector. It is composed of large, elongate pyramidal cells (Figs. 45, 46 pc). These are arranged radially in a very regular manner and nearly vertical to the connective-tissue capsule, on which their bases rest. They do not quite reach the centre to which they converge. This is occupied by a plug-shaped mass of small cells (Plate 9, Figs. 45, 46 a) which appears to be connected with the radial septa extending inward from the connective-tissue capsule enclosing the radiating cell mass. These septa can often be made out between the pyramidal cells. In sections large blood vessels (Plate 9, Fig. 46 b) are frequently seen extending radially inward from the surface to the central cell mass. Here they continue their course between the latter and the proximal ends of the pyramidal cells, and seem to give off exceedingly fine branches which extend radially outward between the pyramidal cells (Plate 9, Fig. 46) along the connective-tissue septa, separating the latter from one another. The pyramidal cells themselves (Plate 9, Figs. 45, 46 pc) are occupied at their distal end by protoplasm staining deeply with haematoxylin (Plate 9, Fig. 46 pt) whilst their central and proximal parts (ph), about five sixths of the whole, show no great affinity for haematoxylin and other stains. The protoplasm occupying this central part of the cell is, however, not hyaline but distinctly granular. In the distal highly stainable terminal part of each cell one rather small nucleus (nu) is situated.

The middle region (Plate 9, Fig. 45 m) occupies the distal sector of the proximal spherical part of the organ and the proximal portion of the distal paraboloidal part. The proximal limit is conic, the distal limit very regularly convex. The cells occupying the space between these limits (l) are well defined and polyedric in shape. The distal ones are small. From here they increase in size inwardly, the innermost ones being four to five times as large as the outermost ones. The protoplasm of these cells is homogeneous, not granular, and hardly stainable with haematoxylin. It shows a great affinity to picric acid and the whole cell mass of this region appears bright yellow in sections stained with picric acid-haemotoxylin. The nucleus is nearly spherical and larger in the large cells than in the small.

The distal limit of the outer region is nearly a plane vertical to the axis of the organ, and so, its inner limit being concave and some distance away, the outer region (Plate 9, Fig. 45 o) has the shape of a thick plane concave lens. From the mass of connective tissue which abuts distally on the outer region, septa, nearly vertical to the limiting surface and parallel to the axis of the organ, extend inward, dividing the outer region into prismatic facets rounded off distally. These facets are occupied by small elongated cells, the protoplasm of which behaves towards stains in a similar manner as the protoplasm of the cells of the middle region.

The compound radiating organs of Chauliodus were first studied in *C. sloani* by Leuckart ('64, pp. 153–155). According to his description these organs of *C. sloani* are similar to those of *C. barbatus*. Leuckart chiefly studied the branchiostegal radiating organs (l. c., p. 154). These are cylinders, 1 mm. long and 500 μ broad. Their distal portion is occupied by a structure Leuckart considers as a lens. From the proximal face of this a conic protuberance arises, penetrating some distance into the inner cell mass; as mentioned above such a cone is also observed in *C. barbatus*. The reflecting layer consists of hexagonal pavement cells occupied by numerous crystals. In the outer part of the distal mass, that is, in the "lens," Leuckart claims to have seen fibres, whilst the inner part, and the proximal cone are composed of closely packed rods 5 μ thick radiating from the apex of the cone. The substance composing these rods is highly refractive. No fibres or rods of this description occur in the middle and outer regions, which correspond to Leuckart's "lens," in the compound organs of *C. barbatus*. The proximal mass which Leuckart terms "Glaskörper," and which corresponds to the inner region, is composed of large crystal-clear radial cones similar to cells; Leuckart, however, does not consider them as such, not having been able to find a nucleus in them. Each organ is supplied by a slender nerve. Leuckart considers these organs as accessory eyes, "Nebenaugen." It is noteworthy that in the discussion following the reading of this paper Claus (Leuckart, '64, p. 155) drew attention to the similarity between these organs and the well-known structures of Euphausia, which were at that time also considered as accessory eyes.

Ussow ('79, pp. 94–97, Plate 1, Figs. 1, 2, Plate 4, Figs. 25, 26) has also described the structure of the compound radiating organs of *C. sloani.* He finds them composed of two semispherical parts, the outer one of which is occupied by a gelatinous mass, colorless and transparent in the living fish, but coagulating and becoming opaque on being treated with the reagents used for preserving the specimen. Below this gelatinous mass a mushroom-shaped "lens" (79, Plate 2, Fig. 6 Kl) is seen, the cylindrical stalk of which extends inwards, whilst the semispherical upper part, composed of conic elements, protrudes into the outer gelatinous mass. This "lens" appears to correspond to our middle region. The conic elements of its distal, semispherical part are according to Ussow attenuated proximally to fine threads, which extend inward parallel to the axis of the organ and form the stalk of the mushroom, in which they are connected with granular multipolar cells. Concerning the inner region Ussow merely corroborates the previous statements of Leuckart. These, however, he does not seem correctly to have understood. Ussow also states that a slender nerve leads to each organ. His description and also his figures are very different from what subsequent authors have seen in these organs of *C. sloani* and show very little similarity to the structure of these organs in *C. barbatus* described above.

Leydig ('79, pp. 365–382, Plate 15) examined the radiating organs of *C. sloani* simultaneously with and independently of Ussow. His material, a specimen preserved in spirits for several years, was not good, but nevertheless his results were more valuable than those of Leuckart and Ussow. He also chiefly studied the compound organs; his notes on the others have been referred to above. The compound organs are surrounded by annular blood vessels and a slender nerve branch leads to each. The distal portion of the compound organ is composed of two parts, an outer cap and a lower mass.

The proximal cone described by Leuckart is part of this latter. In the distal cap club-shaped cells are met with, the distal end of which is the thicker one. It is laterally enclosed by stout cell walls, but destitute of a terminal membrane. The thin proximal end passes into a fine thread of considerable length. The nucleus is situated in the lower end of the thick part of the cell. The cells of the lower mass of the distal portion are of greater size, more finely granular, and have a larger nucleus. The proximal cone appears to be composed of processes of these cells which converge towards its apex. This cell mass is traversed by fibrous strands, extending inward from the surface and forming a kind of scaffolding which has the shape of a honey comb. The cells of this honey comb evidently correspond to the connective-tissue facets described above of *C. barbatus.* The cones occupying the proximal part (inner region) of the organ are cells. Leydig found a nucleus in their granular outer end. The centre to which these conic cells converge is occupied by a finely granular substance ("Punktsubstanz"). Leydig thinks that the nerve leading to the organ terminates in this "Punktsubstanz" and that the cells both above (cone of the middle region) and below (inner region) are connected with it. A portion of the reflector forming half a ring outside the stricture has a distinctly golden lustre. Leydig calls these organs accessory eyes, but uses this term ("Nebenaugen") with a certain amount of mistrust. From this and from a quotation of Willemoes-Suhm, which he publishes, one can conclude that he was already at that time, although calling these organs eyes, quite open to the view that they had in fact a radiating function.

The descriptions given by these authors are based on material insufficiently preserved and studied without the application of modern methods. They can therefore claim hardly more than an historical interest. Now, however, we have to review the papers by Brandt (1899) and Chiarini (1900) in which the compound radiating organs of *Chauliodus sloani* are described in a far more exact manner.

According to Brandt's description ('99, pp. 447–450) these organs of *C. sloani* seem to be identical in structure with those of *C. barbatus.* He considers the cells of the inner region as gland cells in which a secretion is formed and then oxidized whereby light is produced, whilst the middle and outer region have no other function than that of conveying the radiation produced to the outer world.

Chiarini ('00, pp. 14–17, Figs. 6–7) also describes the radiating organs of

C. sloani in detail. To his statements concerning the simple organs we have referred above. The compound organs of this fish ('01, pp. 14, 15, Fig. 7) consist, according to him, as in *C. barbatus*, of a proximal, nearly exactly spherical part, to which a funnel-shaped neck, separated by a distinct incision, is attached. In the compound organs of the body the funnel is cut off obliquely where it abuts on the surface of the body. In the branchiostegal organs transversely. Each compound organ consists of an outer pigment layer, a reflector, a connective-tissue capsule, and a central cell mass, in which three regions, an outer, middle, and inner can be distinguished. These regions correspond to the three regions in the organs of *C. barbatus*. Beyond the outer region gelatinous tissue is met with, occupying the space between its outer face and the surface of the fish. The outer region is divided by connective-tissue membranes into very narrow facets diverging distally. The middle region is clearly divided into an outer portion, occupied by polyedrical cells, and an inner portion divided into radial facets. The inner region consists of radially arranged conic cells, the larger central parts of which are fine grained and stainable with eosin but not with haematoxylin, whilst the much smaller peripheral portions forming about a quarter of the length of each cell are readily stainable with haematoxylin. Each of these cells contains one or two nuclei situated in the peripheral portion.

It will be seen from this that the structure of these organs in *C. sloani* is very similar to that in *C. barbatus*. The chief differences between them are the following: in *C. sloani* the facets of the outer region are narrow, the middle region is distinctly divided into an outer and an inner portion, and the cone cells of the inner region contain one or two nuclei; in *C. barbatus*, on the other hand, the facets of the outer region are broad, the middle region is not divided into two clearly distinct parts, and the cone cells of the inner region always contain a single nucleus.

Idiacanthus antrostomus Gilbert.

Plate 8, Figs. 41, 42.

This species was first described by Gilbert ('90, p. 54), later more in detail by Garman ('99, p. 280). It possesses two kinds of radiating organs, one without, the other with, a pigment sheath. The former are exceedingly small and arranged in two large elongate groups (Plate **8**, Fig. 41 u) on the sides of the head under the large suborbital organ with pigment sheath, and in six longitudinal rows, three on each side, of smaller groups on the body. The intervals between these small groups on the body are equal in extent to the intervals between the larger organs with pigment sheath, and the former alternate with the latter.

The radiating organs with pigment sheath have a silvery lustre. Those of the body measure about 300 μ in diameter; the suborbitals are larger. There are on each side 1 suborbital (Plate **8**, Fig. 41 so), 13 branchiostegal, 10 guttural (Fig. 42 g), 25 ventrothoracic (Figs. 41, 42 vt), 20 ventromedial (Figs. 41, 42 ve), 35 ventroanal (Figs. 41, 42 a), 25 anterior lateral (Fig. 41 al), 20 medial lateral (Fig. 41 ml), and 35 posterior lateral (Fig. 41 pl), radiating organs with pigment sheath.

The small organs without pigment sheath are spherical, enclosed in a connective-tissue capsule, and composed of radially arranged cells, which usually enclose a central cavity.

The organs with pigment sheath closely resemble the compound organs of *Chauliodus barbatus* described above. The suborbital organs are so disposed as to throw their radiation into the field of vision; the organs of the body are directed downward.

Stomias hexagonatus Garman.

Plate 10, Figs. 47–51.

This species has been described by Garman ('99, pp. 276, 277, Plate 56, Fig. 5). It possesses five different kinds of radiating organs. An organ in the barbel, a pair of suborbital organs, and on the body simple organs without pigment sheath, simple organs with pigment sheath, and compound organs with pigment sheath.

The radiating organ in the barbel (Plate **10**, Figs. 47, 48, 50), lies in a thickening 1.5 mm. long at the end of the barbel (Fig. 47, 48 L). From its distal part three short terminal threads arise. The radiating organ itself (Plate **10**, Fig. 50), is oval and placed transversely in the swelling of the barbel, the long axes of the two crossing nearly at right angles. It is enclosed in a stout connective-tissue sheath (Plate **10**, Fig. 50 c), and composed of two parts, an upper, dorsal, smaller, dorsoventrally compressed (A), and a lower, ventral, spherical part (B). The smaller upper part is enclosed in a somewhat loose pigment sheath (p), lying within the upper part of the connective-tissue sheath enclosing the whole organ. The upper portion of this pigment sheath forming the roof of the upper part is dome-shaped, the lower portion, forming its floor and separating it from the lower spherical part, is flat or even a little concave. At the circular line where the upper part joins the lower a conspicuous ring-shaped thickening of the pigment layer (pt) is observed. From this a small annular ridge extends outwards and downwards, forming the rudiment of a cup enclosing the basal, upper portion of the lower, spherical part of the organ.

The interior of the upper part of the organ is traversed by a horizontal, strongly pigmented membrane (pm), which divides it into a larger upper and a smaller lower chamber. In both these chambers large cavities (cv) are seen. In the upper one there seems to be only one such cavity. This is situated ventrally and surrounded by a special endothelial cell layer, separating it from the transparent connective tissue occupying the dorsal and lateral parts of the upper chamber. In the lower chamber more cavities than one are seen. These lie dorsally. Below them in the ventral part of this chamber large sinuous blood vessels (b) extend.

The lower part of the organ (B) is covered dorsally by the pigmented floor of the upper part of the organ and the annular rudiment of a pigment cup referred to above. Laterally and ventrally it is surrounded by the transparent connective-tissue sheath only. From the middle of the roof of this lower spherical part of the organ a cylindrical thread composed of connective tissue (z) arises which extends vertically downward to its centre. This thread is composed of longitudinally arranged, spindle-shaped connective-tissue cells with oval nuclei. Along this thread blood vessels (b) and probably also a nerve extend from above down to the centre of the sphere. The lower end of the thread is thickened to form a terminal knob in which a sinuous cavity, filled with blood corpuscles, is observed. Apart from this thread with its terminal knob the whole of the sphere is occupied by large radially arranged conic cells (pc) equal in length to its radius. In arrangement and structure these cells are similar to the conic elements in the inner region of the compound organs of *Chauliodus barbatus*. described above. They are, however, more slender. The inner seven eighths are occupied by finely granular, transparent protoplasm not readily stainable; in the outer eighth of the length coarser grained protoplasm showing great affinity to hæmatoxylin and other stains is observed. In the peripheral part of each cell one small, spherical nucleus is situated.

The suborbital radiating organs (Plate **10**, Fig. 47 so) are represented by Garman in his figure ('99, Plate 56, Fig. 3), but not mentioned in his description ('99, pp. 276, 277). The suborbital organ lies below and behind the eye; it appears nearly spherical, is 800 μ in diameter, and enclosed in a pigment sheath and a connective-tissue capsule. The pigment sheath forms a sac, the opening of which abuts on the surface of the fish. It is composed of concentric layers of rather loosely scattered cells containing brown pigment. Within this pigment sheath lies the connective-tissue capsule. The structure of the inner cell mass could not clearly be made out, as these organs were somewhat injured in the specimens at my disposal.

The simple radiating organs without pigment sheath appear as small white dots 100 μ in diameter. They are scattered in great numbers over the ventral side of the fish and also occur in the three terminal threads of the barbel mentioned above. They are more or less spherical, enclosed in connective-tissue capsules and composed of pretty large radially arranged cells with conspicuous nuclei.

The simple radiating organs with pigment sheath are met with on the hexagonal scales of the body and also on the head of the fish. They appear as dark spots and measure 300 μ in diameter. On each ventral scale a group of 7 of these organs occurs, upwards they gradually become scarcer, and near the dorsal medial line of the fish only one such organ is found on each scale. In their structure these organs resemble the simple radiating organs with pigment sheath of *Chauliodus barbatus* described above. The hyaline mass which in the latter covers the organ outside, is, however, absent in these organs of *Stomias hexagonatus*.

The compound radiating organs with pigment sheath (Plate **10**, Figs. 47, 48, 49, 51) appear as conspicuous dots with a silvery lustre and are 300–500 μ in diameter. On the whole they are largest in front and decrease in size backwards. There are on each side of the body 12 guttural (Plate **10**, Figs. 47, 48 g), 16 branchiostegal, 38 ventrothoracic (Figs. 47, 48 vt), above these in a parallel row 37 anterior lateral (Figs. 47, 48 al), 10 ventromedial (Figs. 47, 48 vc), 10 medial lateral (Figs. 47, 48 ml), and 19 ventroanal (Figs. 47, 48 a) compound radiating organs with pigment sheath.

Two different kinds of these organs can be distinguished. The first somewhat larger kind is represented by the anterior compound organs of the body which form the ventrothoracic and anterior lateral rows. All the other compound organs belong to the second, smaller kind.

The compound organs of the first kind (Plate **10**, Figs. 49, 51) are spherical and have a short process directed downwards towards the outer surface. They might be compared to spherical bottles with small necks placed upside down. The axis of the organ is vertical, parallel to the median plane of the fish. The ventral organs, that is, those belonging to the ventro-thoracic row, therefore abut nearly vertically on the surface, whilst the lateral ones, that is, those belonging to the anterior lateral row, are very oblique and enclose but small angles with the surface of the fish. In the former the "neck" appears cut off transversely; in the latter, obliquely.

The pigment sheath (Plate **10**, Fig. 51 p) enclosing the organ is rather thin and composed of cells containing brown pigment. It surrounds all parts of the organ with the exception of the terminal face of the "neck."

As in other compound radiating organs we also find in these below the pigment layer a reflecting layer. This is however not at all extensive, being confined to the distal part of the neck-shaped portion, where it forms a ring (Plate **10**, Fig. 51 r) surrounding the "neck." This reflecting layer is composed of highly refractive threads.

Within the pigment sheath and, where this is developed, the reflecting layer, a connective-tissue membrane is met with which entirely surrounds the inner cell mass and forms a perfectly closed capsule, from which diverticula extend inwards.

The greater part of the interior of the proximal, spherical part of the organ is occupied by large radially arranged conic cells which converge towards the centre of the sphere. These cells are very similar to the conic elements in the inner region of the compound organs of *Chauliodus barbatus* and like them consist of a long, proximal, finely granular part (ph) not readily stainable, and a short, distal part (pt) showing great affinity to haematoxylin. The nucleus is remarkably small and situated in the distal staining part of the cell. These cells are divided from each other by fine connective-tissue membranes extending from the outer connective-tissue capsule radially inward towards the centre. In these membranes small radial blood vessels (b) can be made out.

The "neck" of the organ (Plate **10**, Fig. 51 cy) above referred to is a stout cylinder, circular in transverse section, the axis of which coincides with the axis of the whole organ. This cylinder is surrounded by an extensive annular cavity (s) dividing it from the connective-tissue capsule forming the innermost layer of the outer covering of the organ. The outer, distal, terminal face of the cylinder is rounded off, simple, convex; the inner, proximal face is drawn out to form a regular cone about as high as broad, which penetrates the mass of radial conic cells occupying the proximal spherical part of the organ. The apex of this cone lies a little way above the centre of this sphere. The whole appears as a cylindroconic plug (Plate **10**, Fig. 51). From that part of the connective-tissue capsule of the organ which covers the terminal face of this plug, diverticula extend inwards parallel to the axis. These form parallel facets. The central (axial) facet (cc) is the longest; it extends to the apex of the cone, whilst towards the sides of the cylinder the facets become shorter. Transverse (Plate **10**, Fig. 49) and longitudinal axial (Plate **10**, Fig. 51) sections of the plug-shaped outer part of the organ show that the contents of the central facet (Plate **10**, Figs. 49, 51 cc) are different from those of the other facets (pc). In staining with Van Gieson's haematoxylin-picric acid-fuchsin one finds that the latter take up haematoxylin and acid-fuchsin very readily, whilst the substance in the central facet absorbs only the picric acid. It also stains with eosin. In the distal parts of the outer facets nuclei and cell limits can be distinctly seen; here pretty large elongate cells are situated. In transverse sections of the distal part of the plug one sees two or three cell sections lying side by side in each facet (Plate **10**, Fig. 49). In the proximal parts of the outer facets and throughout the whole length of the central facet cell limits cannot be made out and nuclei are hardly to be seen.

Ussow ('79, p. 91) has described these organs in *Stomias barbatus.* He says that they are similar to those of Chauliodus, but that the middle region, which he represents as a mushroom-shaped body (see above) in *Chauliodus sloani,* is absent in *Stomias barbatus.*

Organs similar to these have been described by Chiarini ('00, p. 12, Fig. 3) from *Maurolicus poweriae.* He says that each of the cells of the inner spherical part and also of the cylindroconic plug, that is, the "neck" of the organ, often contain *two* nuclei. These cells are always mononuclear in *Stomias hexagonatus.* In longitudinal sections the limits between the cells are often so indistinct that one can indeed be easily misled on this point and imagine that the two or three nuclei seen imbedded in an apparently continous protoplasmatic mass belong to one and the same cell. Transverse sections, however, show, at least in the distal part, the cell limits well enough and make it clear that here each nucleus belongs to a separate cell.

The compound radiating organs of the second kind which are met with on the hinder part of the body have the same structure as the compound organs of *Chauliodus barbatus* described above. It is therefore not necessary to give a detailed account of them.

(2) THE FISHES WITH RADIATING DISCS.

Bassozetus nasus Garman.

Plate 4, Figs. 14-17.

This species has been described by Garman ('99, pp. 159, 361, Plates 77, 78). Its head shows a number of deep depressions (Plate **4**, Fig. 14). On removing the semitransparent skin from it a number of subdermal, clearly defined, white, somewhat elongated, rhombical patches 1–3 mm. long are exposed to view. A stout nerve fibre leads to each one of these. There are on each side of the head 3 maxillary, 6 orbital, 3 ethmoidal, 3 frontal, 5 occipito-parietal, 5 mandibular, and 4 opercular patches of this kind. These I designate as radiating discs.

Each radiating disc appears as a thickening of the membrane which lies close to the bone and can be easily withdrawn therefrom. The basal part of the thickening, that is, the part lying next the bone, contains pigment cells, which form a pretty continuous basal layer (Plate **4**, Figs. 15–17 p). Numerous blood vessels (Plate **4**, Fig. 17 b), enter the thickening from all sides and form a dense capillary reticulation in its central part, just below the upper surface. The stout nerve (Figs. 15–17 n), mentioned above, which I designate as the main disc nerve, also enters the thickening at its margin. Without appreciably diminishing in width it extends through the basal part of the thickening to its centre where it abruptly divides into a number of fine branches. These lie in a paratangential plane and radiate in all directions in it. Repeatedly ramifying they approach the margin of the thickening where they become obscured by the pigment cells which form a dense reticulation (Figs. 15, 16 p), lying at a rather lower level than the nerves. No peculiar histological differentiation could be made out within the disc. In transverse sections (Fig. 17) one merely sees faint paratangential lines and elongated nuclei also disposed paratangentially. Thus it appears to be composed of paratangentially extended plate-like or fibrous cells overlying each other in several layers. Between these cells the nerve branches extend. Judging from the appearance of the whole organ one should say that the radiation — supposing that a radiation is really emitted from it — is produced by the nerve branches themselves and that the paratagential cells are merely packing.

These organs of Bassozetus resemble the basal part of the radiating discs of Halosaurus to be described below and so one might suppose that the superficial layer of cylindrical cells there present also occurs here but has been lost *post mortem.* It must however be remarked that no trace of a previous presence of such a cell layer could be made out in transverse sections of the radiating discs of *Bassozetus nasus.*

Leucicorus lusciosus Garman.

Plate 3, Figs. 10-13.

This species has been described by Garman ('99, pp. 148, 361, Plates 38, 74, Fig. 1). After removing the semitransparent skin of the head the radiating discs underlying it are exposed to view. They appear as roundish white spots 1.5–3 mm. in diameter overlying the bones of the skull. They are remarkably hygroscopic. If one places one of the discs preserved in alcohol in water it rapidly increases in size and swells to the bulk of a pea. On each side of the head there are 3 maxillary, 4 orbital, 2 ethmoidal, 3 frontal, 7 occipitoparietal, 4 mandibular, and 5 opercular radiating discs.

These organs are similar to, but in their finer structure more highly differentiated than, those of *Bassozetus nasus* described above. A very stout nerve (Plate **3**, Figs. 11, 12 n) enters the disc from the side and extends, as in Bassozetus, to its centre without decreasing in thickness. Besides this main disc nerve there are other smaller nerves (Figs. 11–13 n′), which enter the disc in a similar manner. In some cases it appeared as if the latter connected different discs with each other. Numerous large blood vessels (Figs. 11–13 b) are met with. These chiefly extend from two opposite sides towards the centre of the organ and here, bending abruptly at nearly right angles, and ramifying, form a vascular ring of rhomboidal shape. From this ring numerous branches are given off towards the interior which supply the central part of the disc. These blood vessels form a dense superficial reticulation (Fig. 13).

The large main disc nerve extends through the basal part of the disc and terminates in the centre of the rhomboidal space surrounded by the blood-vessel ring. Here it abruptly divides into numerous branches all diverging radially in a paratangential plane. In the central part of the lower portion of the disc numerous large cavities, which appear empty in sections (Fig. 13 cv), are observed. At the base of the disc a layer of scattered pigment cells (Fig. 13 p) occurs. No particular structures could be made out in the tissue forming the disc itself. In transverse sections (Fig. 13) through it one sees paratangentially orientated plate-like or spindle-shaped elements, probably connective-tissue cells, sections of nerves and blood vessels and here and there granular elements which look like nerve cells.

As in the case of Bassozetus (p. 198), also here in *Leucicorus lusciosus* the possibility of the discs examined being incomplete must be taken into consideration. If the discs as observed were covered by a layer of cylindrical cells these organs of Leucicorus would become very similar to those of Halosaurus described below. Such a cylinder cell layer may have been present on these organs during life; I failed however to find any trace of it in the sections.

Halosaurus radiatus Garman.

Plate 11, Figs. 52–57.

This species has been described by Garman ('99, pp. 298, 364, Plate 60, Figs. 2, 2 a, Plate 84, Figs. 3–6). The radiating discs are situated on the head and, according to Garman ('99, p. 298, Plate 60, Fig. 2, Plate 34, Figs. 3–6), also in a longitudinal row on each side of the body. They lie under the skin and are spindle-shaped, the long axis being disposed paratangentially. The largest are 3 mm. long. On each side of the head there are 7 maxillary, 7 orbital, 8 ethmoidal, 4 occipitoparietal, 4 mandibular, and 9 opercular radiating discs. Those on the body could not be made out in the somewhat injured specimen at my disposal.

In *Halosaurus radiatus* the radiating discs are obviously connected with the slime-canal system. They are in fact local differentiations of the walls of certain slime canals. The cephalic slime canals in which the organs of the head lie, extend as usual paratangentially below the outer skin. These slime canals are enclosed in a stout, apparently structureless sheath (Plate **11**, Fig. 56 s). Within this a layer of connective tissue (Figs. 56, 57 c) is met with, in which slender, probably spindle-shaped cells arranged paratangentially can clearly be made out. This connective-tissue layer is stouter on the lower side, that is, in the floor, than on the upper side, that is, in the roof of the canal (Fig. 56 cv). The outer structureless sheath of the canal is separated from the periost of the bone on which it rests by a thin layer of scattered pigment cells (Fig. 56 p). The radiating disc is situated in the floor of the canal. Seen from the surface (Plate **11**, Figs. 53–55) it has the shape of a rhomboidal spindle with obtuse points. The most important part of it is a single layer of slender somewhat irregularly cylindrical cells (Plate **11**, Figs. 56, 57 d) which form an epithelial layer. A stout main disc nerve (Plate **11**, Figs. 53–56 n) and one or two smaller accessory nerves (Figs. 53–55 n′) lead to this cylinder cell layer. The main nerve rises obliquely towards the centre of the cylinder cell layer, arrived at the base of which it suddenly divides into numerous radiating branches extending paratangentially below the cylinder cell plate. Here also an exceedingly dense capillary network (Figs. 56, 57 b) is met with forming a conspicuous blood-vessel layer between and under the basal parts of the cylinder cells. The large vessels leading to this network (Figs. 53–56 b′) are very conspicuous, particularly in surface views (Figs. 53–55).

The cylinder cell plate (Figs. 56, 57 d) is perhaps not wholly composed of cylinder cells equal in length to the thickness of the plate. There is a marginal zone (Fig. 56 m), where in transverse sections through the plate the cells appear to be polyedrical and to form several layers. It is probable, however, that also here the cells are in reality cylindrical and form a single layer and that the appearance seen is only the consequence of the marginal cells not extending, as the others do, in the plane of the section. They would therefore not, as the cells of other parts of the plate, be cut longitudinally, but more or less transversely, and thus assume the appearance of polyedrical elements lying in several layers. Also in the centre of the plate there seems to occur a slight irregularity.

The greater part of the elongated rhomboidical plate formed by this cell layer is flat. Its margins, in which the apparent multiplication of cell layers mentioned occurs, are markedly raised. In the middle, along the short diagonal of the elongate plate, a transverse groove extends. All the cylinder cells with the exception of the marginal ones, arise vertically from the floor of the plate. Most of them show a distinct curvature increasing towards the upper end (Fig. 57). In the central groove the cylinder cells lie close together, in the other parts of the plate they are apparently separated by intercellular spaces of considerable width (Fig. 57). Possibly this appearance is merely the expression of the presence of thick lateral cell walls similar to those observed by Leydig and others in certain cells of the ocellar radiating organs described above. If on the other hand intercellular spaces are really present — and the appearance is in favor of this assumption — the question arises whether they are present in these cell plates in life or merely artifacts produced *post mortem* by transverse cell shrinkage. In the lower end of each of these cells a large oval granular nucleus is observed. These nuclei form a single layer in the basal part of the plate. In the marginal zone nuclei are also observed higher up, and the same is the case in the central groove, where a few nuclei are likewise seen at a higher level. It is doubtful, however, whether these latter belong to the cylinder cells. It seems rather that they are the nuclei of slender spindle cells here interposed between the cylinder cells. The protoplasm of the cylinder cells is pretty granular and stainable with acid-fuchsin and haematoxylin. These stains are taken up more by the terminal than by the central parts of the cells. The cells of the central groove show a marked affinity for picric acid; other stains are hardly at all absorbed by them.

Transverse sections (Plate **11**, Figs. 56, 57) show that the intercellular spaces between the cylinder cells above mentioned do not extend quite to the upper surface of the cell plate. Here the upper ends of the cells, in most cases considerably curved, are in direct contact with each other and form a superficial pellicle apparently quite continuous and in sections somewhat resembling a cuticle.

I have previously described ('87, pp. 309–313, Plate 73, Figs. 45–48, 54–64) the structure of the radiating discs in another species of Halosaurus, *H. macrochir*. In this species a pair of large glandular radiating organs also occurs under the gill covers. These have a different structure. The smaller spindle-shaped discs on the sides of the body, however, resemble the radiating discs on the head of *H. radiatus* pretty closely. These are in *H. macrochir* attached to the outer side of the scales over the great lateral slime canal. Below the centre of each disc the scale is perforated by an oblique tube through which a nerve and blood vessels ascend to the base of the disc. In the disc itself a lower layer, chiefly occupied by an exceedingly close reticulation of capillary blood vessels, and an upper composed of slender cells arising vertically, standing side by side, and forming a high epithelium can be distinguished. The individual elements of the latter are spindle-shaped or irregularly cylindrical. In transverse sections through the disc these cells appear separated by clear intervals wider than in the cylinder cell plates of the cephalic discs of *H. radiatus*. In *H. macrochir* the upper ends of these cells are strongly curved and pass into a superficial pellicle which looks as if it were composed of the upper ends of the cells themselves, drawn out in a thread-like fashion and laid down tangentially.

Macrurus canus Garman.

Plate 5, Figs. 18–20.

This species has been described by Garman ('99, pp. 217, 364, Plates 49, 84, Figs. 1, 2). The radiating discs are situated in the floors of the cephalic slime canals. In surface views they appear elongate hexagonal (Plate 5, Figs. 19, 20). They are 2–4 mm. long, white in color and very conspicuous. The wall of the slime canal is lustrous and the part surrounding the discs occupied by large and richly ramified dark brown pigment cells (Figs. 19, 20 p) so that they stand out as brilliantly white patches from a dark surrounding. On each side of the head there are 3 maxillary, 6 orbital, 2 ethmoidal, 16 occipitoparietal, 7 mandibular, and 6 opercular radiating discs. A stout nerve, the main disc nerve, (Plate 5, Figs. 19, 20 n) approaches each of these organs from the side and extends through its basal part towards its centre, where it abruptly divides into numerous paratangentially extending branches. These discs are exceedingly tender structures, and unfortunately not sufficiently well preserved to allow of their minute structure being clearly made out. A square patch occupying the central part of the hexagonal disc is much less transparent than the remainder (Figs. 19, 20), and it seems that the ramifications of the main disc nerve are confined to this. The discs here are certainly not so simple in structure as in Leucicorus and Bassozetus and seem to approach those of Halosaurus. They probably have a structure similar to that of Halosaurus.

Ipnops agassizii Garman.

Plate 1, Figs. 3–5.

This species was described by Garman ('99, p. 259, Plate H, Figs. 2, 2 a). On the upper side of its dorso-ventrally compressed head a whitish patch 12 mm. long and equally broad, composed of two symmetrical halves, a right and a left one, is met with (Plate 1, Figs. 3–5 d). Moseley ('87, pp. 269–276, Plates 67, 68) has found similar discs in another species of this genus, *I. murrayi*, and has examined and carefully described their minute structure. In the material of *I. agassizii* at my disposal these discs are not sufficiently well preserved to allow of their minute structure being studied. All I can say is that I have seen nothing in them that would justify one in supposing that they differed in any way from the organs described by Moseley in *I. murrayi.* The hexagonal cylinder cells of the discs of *I. agassizii* are about 20 μ long and 5 μ thick.

(3) THE FISHES WITH TUBULAR RADIATING ORGANS.

Malthopsis spinulosa Garman.

Plate 1, Figs. 1, 2, Plate 2, Figs. 6-9.

This species has been described by Garman ('99, p. 106, Plates 21, 24). It is (Plate **1**, Figs. 1, 2) a flat fish of horseshoe-shape with a stout conic tail. The organ here to be described which may have a radiating function is a medial tentacular papilla on the forehead just above the mouth (Plate **2**, Fig. 6 te). Garman ('99, p. 106) states that this papilla is contractile and can be extended and retracted at the will of the fish. In the state observed by me it is about 6 mm. long and 1.5 mm. thick. This papilla is situated in a depression so that it protrudes when retracted only slightly beyond the general surface of the fish. The apex of the papilla is divided into three lobes, an upper somewhat leaf-shaped one and a pair of lower massive ones.

The trilobed terminal part of the tentacular papilla of the only specimen of *Malthopsis spinulosa* at my disposal was cut into a series of transverse sections. These (Plate **2**, Figs. 7, 9) show that its trilobed distal part is supported by four stout longitudinal rods of semicartilaginous tissue (Figs. 8, 9 s). The two lower ones are separate, the two upper ones joined to form a band-shaped structure. These rods are enclosed in sheaths of connective tissue from which septa (Figs. 7, 8, 9 c) radiate, chiefly into the massive ventral lobes, the interior of which is divided by them into a number of longitudinal compartments. In the middle of the ventral surface connecting the two ventral lobes a conspicuous longitudinal ridge is observed, the interior of which is occupied by a pair of longitudinal muscles, lying close together (Figs. 8, 9 m). These are, no doubt, the muscles which retract the tentacular papilla, while its extension is probably brought about by the elasticity of the semicartilaginous rods described above or the accumulation of blood in the large longitudinal, sinus-like bloodspace (Figs. 8, 9 b′) which occupies the centre of the tentacular papilla. Other smaller blood vessels (Figs. 8, 9 b) are met with in its superficial parts.

The longitudinal chambers formed by the connective-tissue septa mentioned above, are large and dorsoventrally depressed in the dorsal leaf-like part, whilst they are radially arranged like a fan in the two lower lobes. The connective-tissue walls of these chambers are clothed by a high epithelium composed of a single layer of cylindrical cells. In the sections this cell layer (Figs. 7, 8, 9 pc) is, however, by no means in direct contact with the connective-tissue walls, but separated from them by an apparently empty space of considerable extent (Figs. 7, 8, 9). Thus these cylinder cells form tubes lying within the likewise tubular chambers formed by the connective-tissue septa. The lumina of these tubes (Figs. 7, 8, 9 cv) are narrow and either empty or occupied by a structureless mass, apparently a secretion. The cylinder cells themselves contain a pretty transparent protoplasm, which is strongly stained with picric acid, but hardly at all with haematoxylin. The large, oval, granular nucleus lies in the outer (lower) termination of the cell. Pigment is found chiefly in the outer skin of the dorsal leaf-shaped lobe.

In structure these organs resemble the inner portions of the suborbital organs of *Pachystomias microdon* (Lendenfeld '87, p. 320–322, Plate 71, Figs. 30, 31), where however the cells forming the tubes are not so high. It is particularly to be remarked that also in this part of the suborbitals of *P. microdon* one finds in the sections the tubes formed of these cells separated from the connective tissue surrounding them, by apparently empty spaces.

Chun ('03, pp. 568, 569) has mentioned the occurrence of a frontal tentacular papilla in other species of Malthopsis. He thinks that the organ may emit light, but is doubtful on this point.

On the margin of the body of this fish bud-like protruding organs of peculiar structure (Plate **1**, Figs. 1, 2, Plate **2**, Fig. 6 o) occur, which I will not describe here, being of the opinion that their function is not to radiate. They are ramified, rich in blood vessels, and may be accessory gills, or sense organs. These structures are dealt with in the Appendix.

3. CONCLUSIONS.

The results of the examination of the minute structure of the organs of the fishes collected by the "Albatross" which one can, with more or less certainty, consider as radiating, as described above, illustrate again their great diversity. Not only do the ocellar, disc-shaped, and tubular organs fundamentally differ, but even within these three main groups very great variations are met with.

The best known of those organs are the ocellar. A highly developed organ of this kind, such as the compound organ of Chauliodus is — apart from the connective-tissue support, the nerves and blood vessels — composed of a pigment sheath, a reflecting layer, an inner region of large, highly specialized conic cells, and a middle and an outer mass of specialized polyedrical cells of another kind. Apart from the blood vessels, nerves, and connective tissue, which, as occurring in all organs, of course do not concern us here, *none* of these structures are found in *all* of the ocellar organs described above as radiating. The pigment sheath is absent in the smallest organs of Chauliodus itself. In these, and in others with a pigment sheath, the reflecting layer is absent. The large conic cells of the inner region are absent in the simple organs and in the highly differentiated compound organs of Argyropelecus. The polyedrical cells of the middle and outer region of the compound organs of Chauliodus which usually occur in simple organs are replaced by long spindle-shaped cells in all the compound organs of Lychnopoles and in the anterior compound organs of Stomias.

An analogous diversity is met with in the radiating discs. Whilst in Halosaurus and Ipnops highly specialized cylindrical or spindle-shaped elements, obviously forming a very essential part of the organ, are met with, such cells seem to be entirely absent in the discs of Bassozetus and Leucicorus.

In the tubular organs the diversity is not so great, although here also we find the cells forming the walls of the glandular tubes sometimes high, as in Malthopsis, and sometimes low, as in Pachystomias.

Even the rule, in general holding good, that the outer covering of these organs is transparent and suited to allow the radiation to pass, is not universally applicable, for we have found at least in one instance in Chauliodus — and Leydig has found the same in other instances — organs, otherwise identical with simple ocellar radiating ones, entirely enclosed in a pigment sheath and therefore unable to radiate at all.

The diversity is in fact so great that we are forced to assume that either not all the organs described as radiating really emit ethereal waves, or if they do, that the waves emitted by different organs are either differently produced, or different in character, or both. Although direct observations of the radiation of these organs are but few, we know (*1*) that some of them at least do emit light, and (*2*) that the light emitted by different organs is often different in color.

It is remarkable that such observations have not been made more frequently, and that Chun who took every deep sea fish caught immediately to the photographic dark chamber, so often failed to observe any light emitted from these organs.

On the whole I should consider it most probable — although very far from scientifically certain — that: (*1*) The organs produce a radiation. (*2*) In the simple ocellar organs and the radiating discs this radiation is an ethereal wave movement directly emitted into the surrounding water. (*3*) In the compound ocellar organs this radiation is either also such a movement or an emission of corpuscles (electron bombardment) and originates in the inner part. It is here not emitted directly into the surrounding water, but acts on the outer part and induces this to phosphoresce and emit ethereal waves. (*4*) The length of the ethereal waves thus directly or indirectly produced by one and the same organ is always the same; that of the ethereal waves produced by different organs is often different. (*5*) In some cases the wave length lies within the visible part of the spectrum; in other cases it may be smaller or greater, and then the radiation is invisible. (*6*) The ethereal waves of the invisible radiations are probably of greater length than those producing the red end of the spectrum because such probably penetrate the water to greater distances and because the remarkable telescopic eyes of some deep sea animals seem to be peculiarly adapted to their perception. (*7*) These long ethereal waves may (if not too long) be of the nature of (ultra red) light, or (if longer) of the nature of electricity.

4. LITERATURE.

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APPENDIX.

THE STRUCTURE OF THE BUD-LIKE ORGANS OF MALTHOPSIS SPINULOSA GARMAN.

By EMANUEL TROJAN.

Among the Albatross fishes sent to Professor von Lendenfeld for examination was a specimen of Malthopsis spinulosa Garman. This fish is provided with peculiar bud-like sense organs, which, on account of their function apparently not being a radiating one, were not described in Professor von Lendenfeld's report. Professor von Lendenfeld entrusted me with the examination of the minute structure of these organs. The results are given below.

Garman (1899, pp. 106, 107, Plates XXI, XXVI) has described and figured this species. The body is dorsoventrally compressed, the tail has a circular transverse section. Thorn-like scales cover the surface. The lateral line extends along the narrow lateral margin of the body, and is continued on the tail. It appears as a distinct lateral furrow. The margins of this furrow bear fringes. In the furrow itself a row of bud-like protuberances is observed. Above and below each one of these a lobular excrescence with fringed margin is met with. The fringes of the margins of the furrow and the lobes are composed of filiform parts, richly pigmented and dark in color. Garman's description and illustrations of the bud-like protuberances are insufficient. He mentions them only from the lateral line and the symphysis below the mouth. Closer inspection shows that they also occur on the head. There are on each side (text figs. 1, 2): in the lateral line (furrow) of the body 12 ventral (v); between the 9 and 10 of the lateral line, one above the other, 2 lateral (1); in the lateral line of the tail 12 caudal (c); in a horizontal row behind the corner of the mouth 4 mandibular (m); in a line parallel to and above the preceding one 7 maxillary (x); between the 4 organs of the two last named rows 1 inframaxillary (i); and on the lower jaw 4 inframandibular (n); together 84 bud-like organs.

The bud-like organs are cream colored, button-shaped, and composed of a short, stout, cylindrical peduncle only 70 μ long and on a semispherical head 400–500 μ in diameter. The histological structure of these organs can best be made out in longitudinal, axial sections (Fig. 3). The corium is very highly developed and covered by a pavement epithelium with large nuclei as in other parts of the skin. It forms two different kinds of papillae. In the one the corium predominates and the epithelium is only slightly developed,

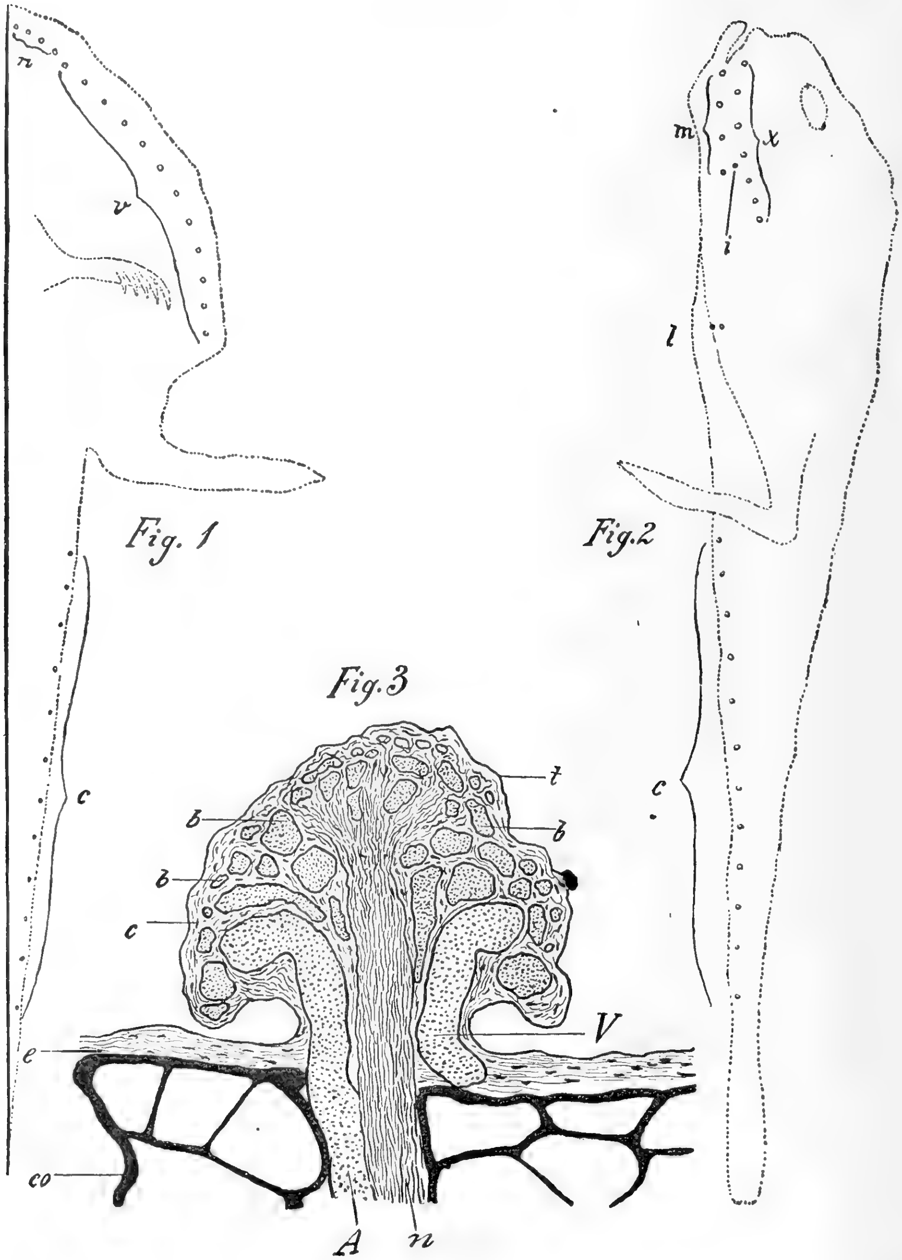

FIG. 1 VENTRAL, AND FIG. 2 LATERAL VIEW OF THE FISH.

Natural size. x, maxillar; i, inframaxillar; m, mandibular; n, inframandibular; v, ventral; l, lateral; c, caudal bud-like organs.

FIG. 3. AXIAL SECTION THROUGH A BUD-LIKE ORGAN.

Magnified 1 : 125. A, artery; V, vein; b, capillary blood vessels; c, connective tissue; co, corium; e, pavement epithelium; n, nerve; t, cuticle.

in the other the reverse is the case. The papillae of the first kind are very numerous, they form the "scales"; those of the second are less numerous and smaller, they form the basal parts, that is, the peduncles of the bud-like organs here described. Each bud-like organ is supplied with a nerve about 70 μ thick (Fig. 3 n) which traverses the layers of the corium. These layers bend outward around it and thus form a tubule. Besides the nerve also the artery passes through this tube. The terminal thickened part, the head of the organ, consists principally of spindle-shaped connective-tissue cells with oval nuclei (Fig. 3 c) and blood vessels (Fig. 3 b). On entering the organ the artery (Fig. 3 A) immediately divides to form a capillary network. These capillaries decrease in width from the centre towards the periphery; the narrowest are 12 μ wide. The capillaries unite to form a vein (Fig. 3 v) which has the same width as the artery. This vein extends for a considerable distance subcutaneously and does not pass through the tube in which the nerve and the artery are contained. The branching of the nerve commences at a higher level than the branching of the artery, above the centre of the head. Its proximal parts bear no branches. Just beyond the centre of the head it splits up into several bundles of primitive fibres. These ramify and thus a mass of separate nerve fibres are produced, interlacing with the capillary blood vessel net which is densest at the apex of the organ. The final termination of the nerves could not be made out, on account of the specimen not being specially preserved for the purpose. A continuous cuticle covers the whole organ (Fig. 3 t).

Organs comparable to these have been described by F. Leydig (1850, p. 172, 1851, pp. 235–239) as "Nervenknöpfe." These differ, however, in several respects from the bud-like organs of Malthopsis examined by me. The differences in shape and size would not be important; but the cylinder epithelium which forms a principal part of the "Nervenknöpfe," and to which the authors attach so great an importance, is missing in the buds of Malthopsis. If we were to imagine the organs of Malthopsis covered by a sensitive cylinder epithelium they would be "Nervenknöpfe," still, however, differing from those described by F. Leydig (l. c.) in some respects. Leydig found the "Nervenknöpfe" always in slime canals; whilst the organs of Malthopsis, are free. The "free lateral organs" described by F. E. Schulze (1870, p. 71), which might also be compared to the buds of Malthopsis, are superficial swellings in the floor of the lateral canals. According to B. Solger (1880, Plate XVI, Fig. 6) they are oval plates. Thus these organs also differ considerably from those of Malthopsis. Neither can the "Nervenknöpe" of *Lepidoleprus coelorhynchus* (Leydig 1850, pp. 235–239) be compared with them. The term "Nervenknöpfe" is hardly applicable to the organs of Malthopsis because their heads are not endswellings of nerves, but composed of connective tissue and abundant blood vessels. In so much as they are richly innervated distally, they correspond to the "Nervenknöpe" of *Acerina cernua,* but Leydig (1879, p. 163) says concerning these that the connective tissue of the swelling, which surrounds the nerves and blood vessels is tender, nearly gelatinous. It seems therefore that they do not belong to the class of structures designated as "Nervenknöpfe." The essential difference, the absence of a cylinder epithelium in the buds of Malthopsis, can in so far not be relied upon, as it may be present in the living fish and absent in the specimen examined only because it has fallen off on account of its perishable nature; the circumstances however that the organs are entirely surrounded by a cuticle and that the tender and perishable sensitive epithelium would, if present, be coverless and exposed, make it appear improbable that such is the case.

Concerning the physiological function of the organs it must be borne in mind that they must either be radiating or sensory, because so rich an innervation must have some purpose. The general appearance of the organs, their semispherical shape and the abundance of connective tissue in them are in favor of the latter view and make it probable that the function performed by them is the perception of hydrostatic pressure, a knowledge of which must be of great importance to any fish able to live only within certain bathymetrical limits.

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PLATE 1.

Figs. 1, 2. Malthopsis spinulosa Garman.

Fig. 1. The ventral side of a specimen. Drawing; slightly reduced; o, doubtful bud-like marginal organs.

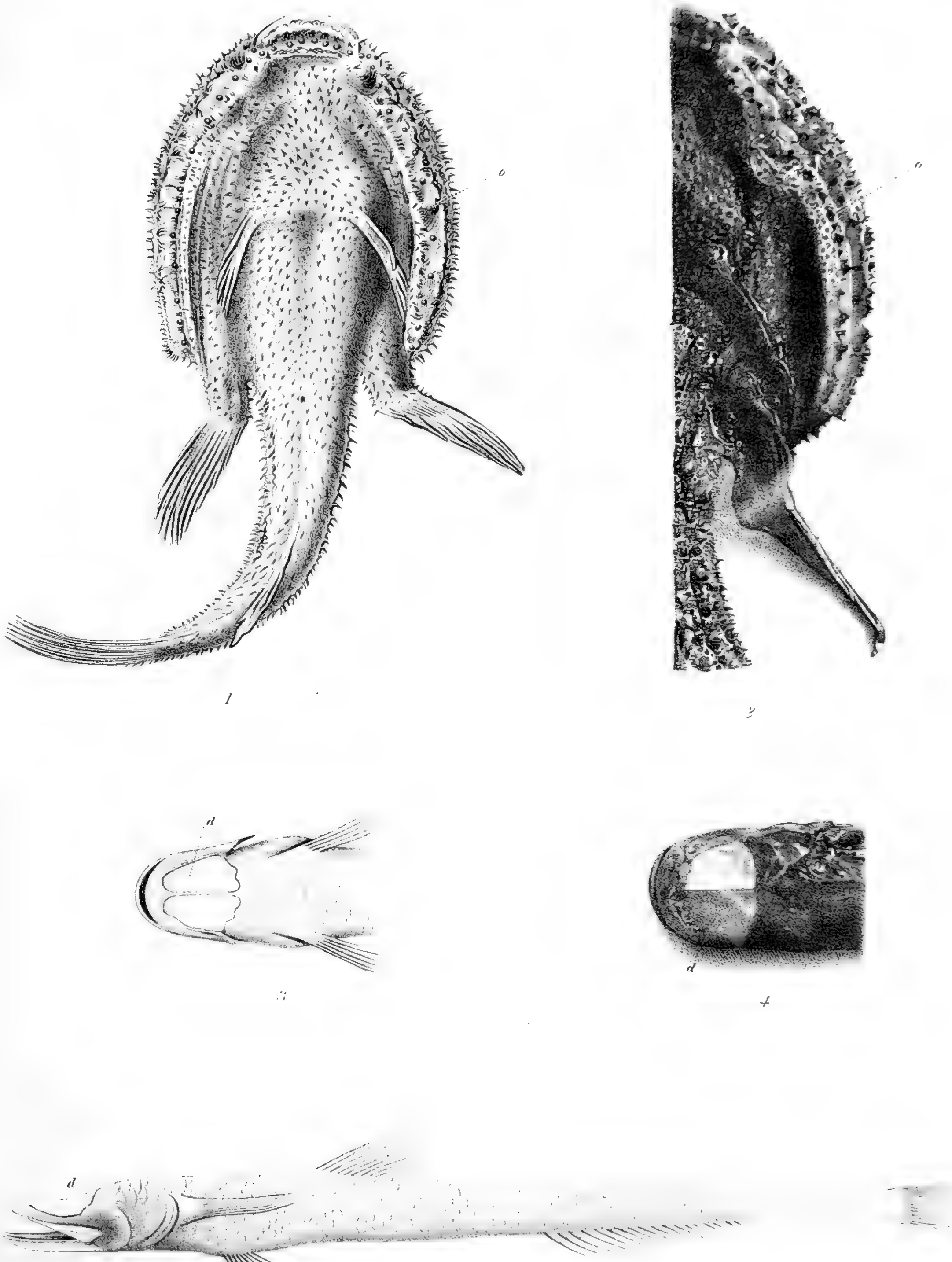
Fig. 2. Ventral side of the left half of a specimen. Photograph; slightly magnified; o, doubtful bud-like marginal organs.

Figs. 3–5. Ipnops agassizii Garman.

Fig. 3. The head seen from above. Drawing; natural size; d, radiating discs.

Fig. 4. The head seen from above. Photograph; slightly magnified; d, radiating discs.

Fig. 5. The fish seen from the side. Drawing; natural size; d, radiating disc.



1,2 MALTHOPSIS SPINULOSA Garm 3-5 IPNOPS AGASSIZII Garm

PLATE 2.

Plate 2.

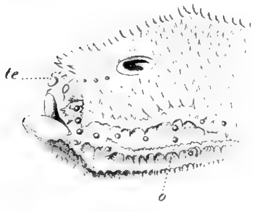
Figs. 6–9. Malthopsis spinulosa Garman.

Fig. 6. The head in three quarter profile. Drawing; natural size; o, doubtful bud-like marginal organs; te, frontal tentacular papilla.

Fig. 7. Part of a transverse section of the interior of one of the ventral lobes of the distal trilobed part of the frontal tentacular papilla. Stained: haematoxylin-picric acid-fuchsin. Drawing. c, connective-tissue septa between the longitudinal chambers; cv, lumina of the glandular tubes; pc, walls of the glandular tubes composed of cylindrical cells.

Fig. 8. Transverse section of the distal trilobed part of the frontal tentacular papilla. Stained: haematoxylin-picric acid-fuchsin. Photograph, magnified 1 : 41. b, peripheral blood vessels; b′, large central sinuous blood vessel; c, connective-tissue septa between the longitudinal chambers; cv, lumina of the glandular tubes; m, muscles; p, groups of pigment cells; pc, walls of the glandular tubes composed of cylindrical cells; s, longitudinal strands of semicartilaginous tissue.

Fig. 9. Transverse section of the distal trilobed part of the frontal tentacular papilla. Stained: haematoxylin-picric acid-fuchsin. Drawing, magnified 1 : 41. b, peripheral blood vessels; b′, large central sinuous blood vessel; c, connective-tissue septa between the longitudinal chambers; cv, lumina of the glandular tubes; m, muscles; p, groups of pigment cells; pc, walls of the glandular tubes composed of cylindrical cells; s, longitudinal strands of semicartilaginous tissue.



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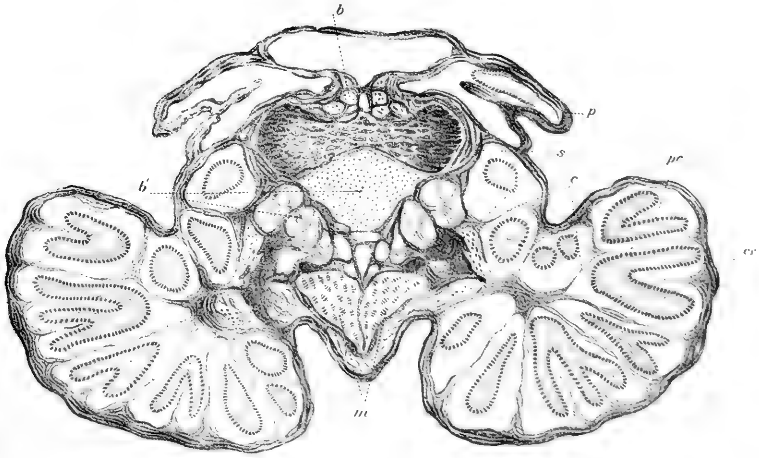

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6-9 MALTHOPSIS SPINULOSA Garm.

PLATE 3.

PLATE 3.

Figs. 10–13. Leucicorus lusciosus Garman.

Fig. 10. The fish seen from the side. Drawing; natural size.

Fig. 11. A radiating disc in transmitted light. Photograph; magnified 1 : 41. b, blood vessel; n, main disc nerve; n′, smaller accessory disc nerves.

Fig. 12. A radiating disc in transmitted light. Photograph, magnified 1 : 21. b, blood vessels; n, main disc nerve; n′, smaller accessory disc nerves.

Fig. 13. Transverse section of a radiating disc. Stained: haematoxylin. Drawing; magnified 1 : 42. b, blood vessels; c, paratangentially arranged connective-tissue cells; cv, cavities in the basal part of the radiating disc; n′, small accessory disc nerve; p, pigment cells.

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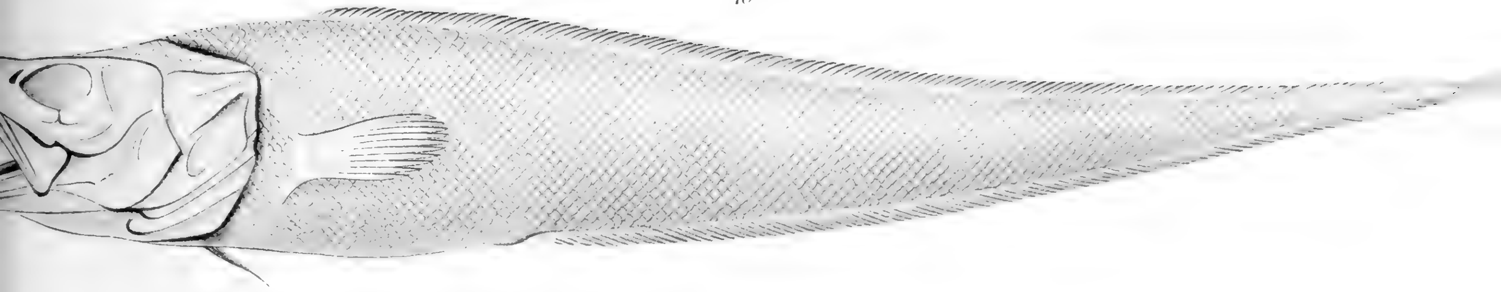

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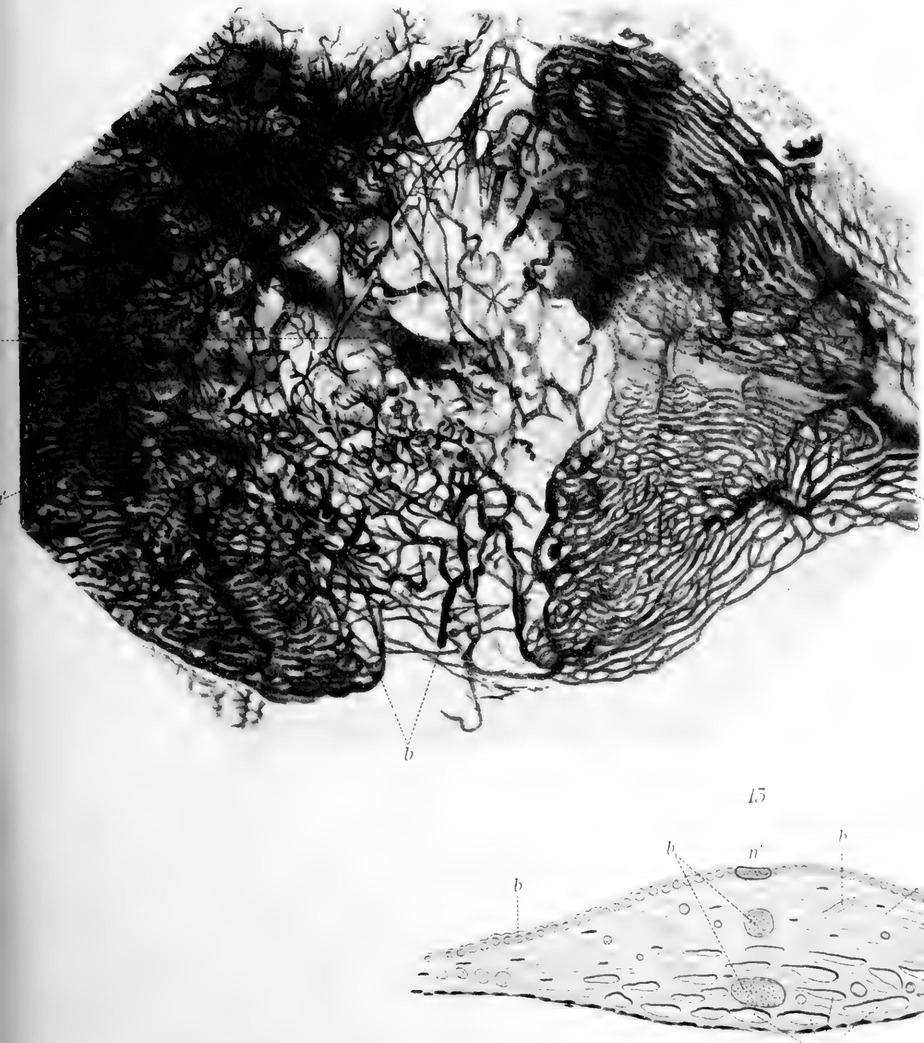

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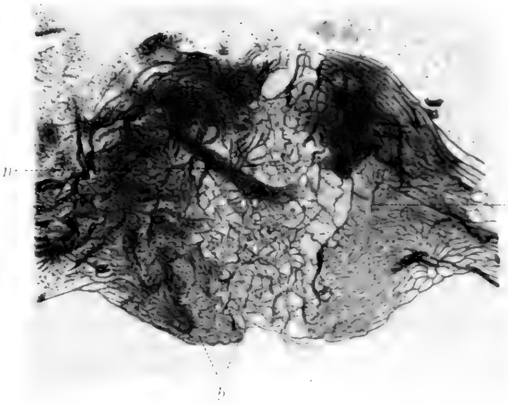

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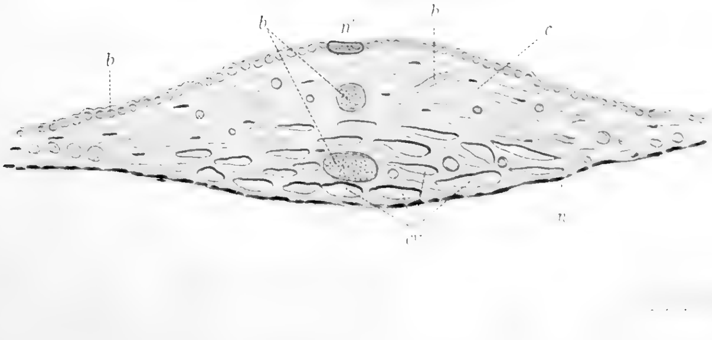

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10-13 *Leucicorus lusciosus* Garman

PLATE 4.

PLATE 4.

Fig. 14–17. Bassozetus nasus Garman.

Fig. 14. The fish seen from the side. Drawing; natural size.

Fig. 15. A radiating disc in transmitted light. Photograph; magnified 1 : 58. n, main disc nerve; p, reticulation formed by the pigment cells with their long processes.

Fig. 16. A radiating disc in transmitted light. Photograph; magnified 1 : 27. n, main disc nerve; p, reticulation formed by the pigment cells with their long processes.

Fig. 17. Transverse section of a radiating disc. Stained: haematoxylin. Drawing; magnified 1 : 42. b, blood vessels; c, paratangentially arranged connective-tissue cells; n, main disc nerve; p, basal pigment cells.

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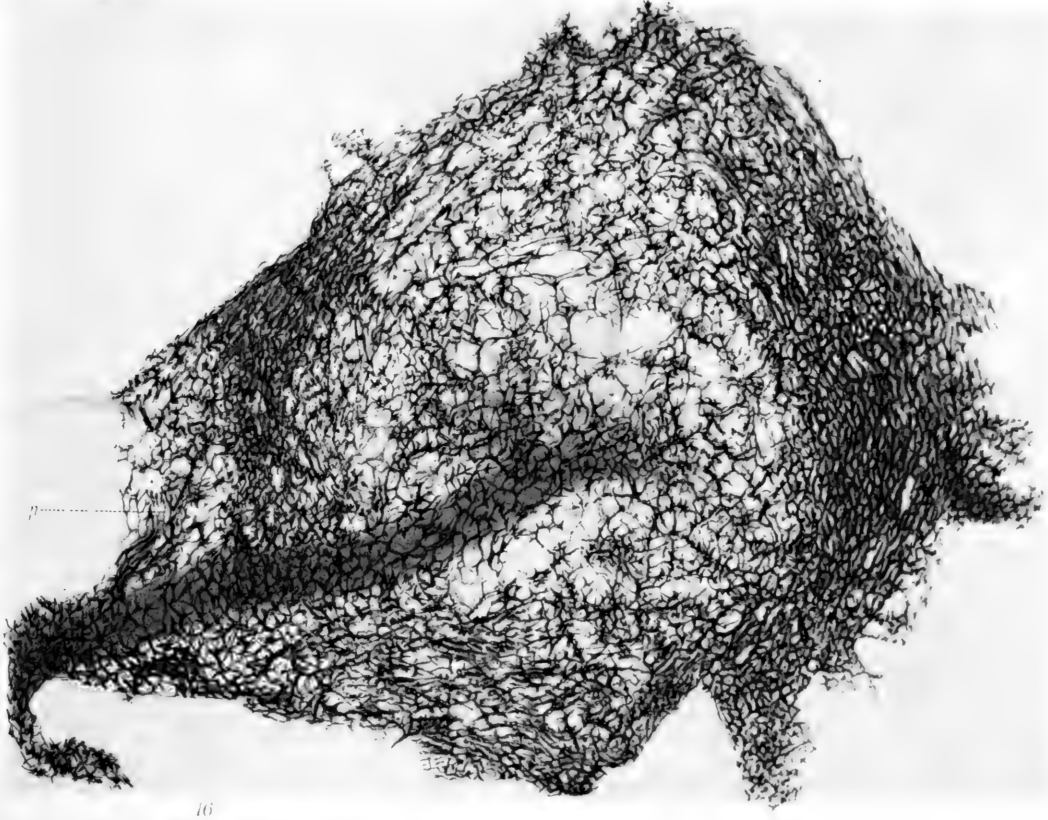

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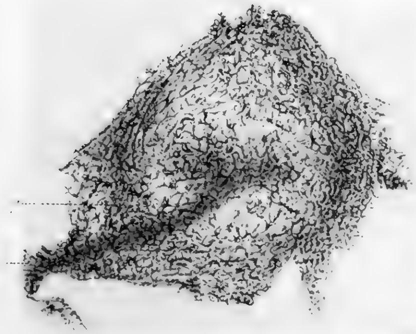

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14-17 *Bassozetus nasus* Garman

PLATE 5.

PLATE 5.

Figs. 18–20. Macrurus canus Garman.

Fig. 18. The fish seen from the side. Drawing; natural size.

Fig. 19. A radiating disc in transmitted light. Photograph; magnified 1 : 41. n, main disc nerve; p, branched pigment cells.

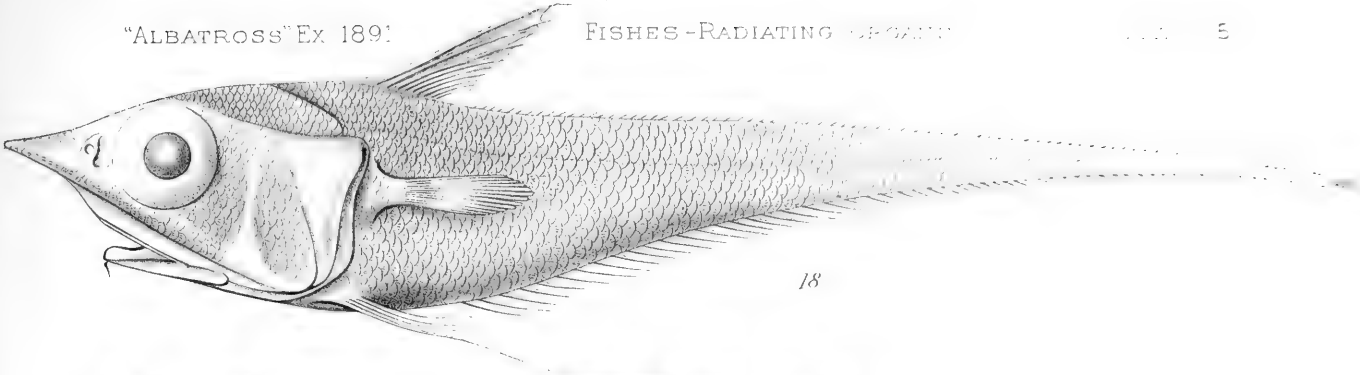
Fig. 20. A radiating disc in transmitted light. Photograph; magnified 1 : 17. n, main disc nerve; p, branched pigment cells.

Figs. 21–23. Myctophum aurolaternatum Garman.

Fig. 21. The fish seen from the side. Drawing; natural size. al, anterior lateral radiating organs; ma, mandibular radiating organs; ml, mediolateral radiating organs; op, opercular radiating organs; pe, pectoral radiating organs; pl, posterior lateral radiating organs; va, anterior ventroanal radiating organs; vc, ventrocaudal radiating organs; ve, ventromedial radiating organs; vp, posterior ventroanal radiating organs.

Fig. 22. The fish seen from below. Drawing; natural size. al, anterior lateral radiating organs; ma, mandibular radiating organs; ml, mediolateral radiating organs; op, opercular radiating organs; pe, pectoral radiating organs; pl, posterior lateral radiating organs; va, anterior ventroanal radiating organs; vc, ventrocaudal radiating organs; ve, ventromedial radiating organs; vp, posterior ventroanal radiating organs.

Fig. 23. Axial section vertical to the median plane of the fish through a posterior lateral radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 140. b, blood vessels; c, connective tissue of the interior of the organ; p, section through the outer horseshoe-shaped pigment cell band; pc, radiating cells; pp, internal pigment cell layer; si, scale underlying the radiating organ; ss, scale covering the radiating organ; t, section through the H-shaped thickening of the covering scale.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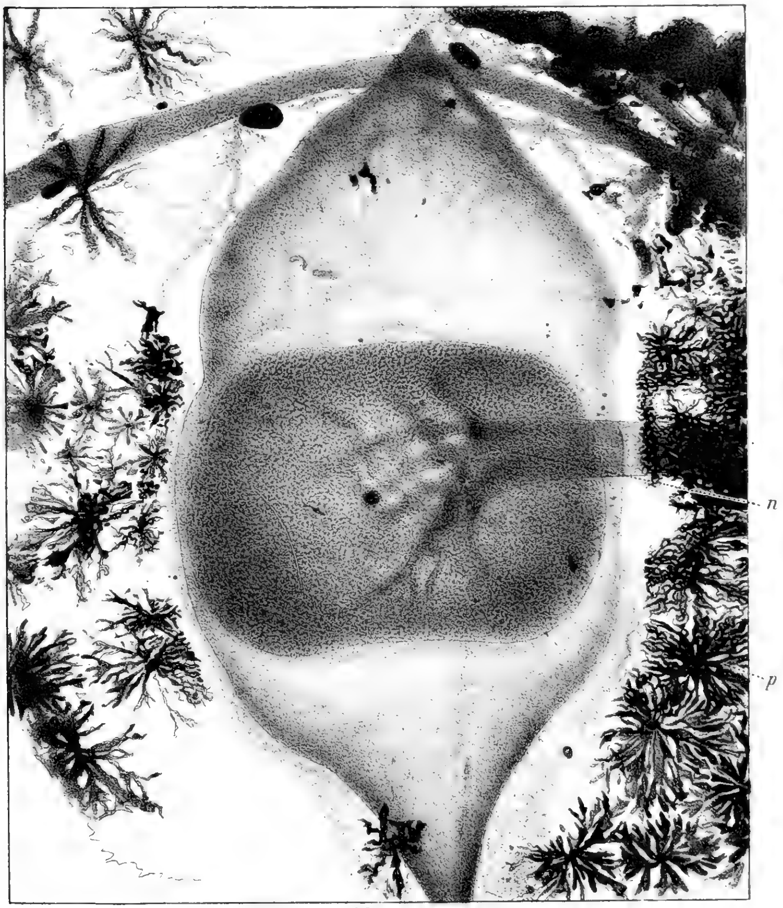

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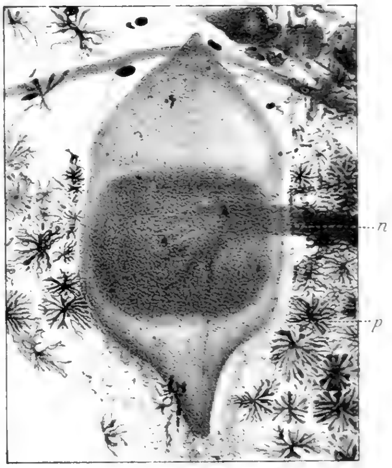

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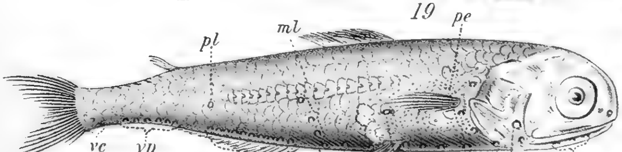

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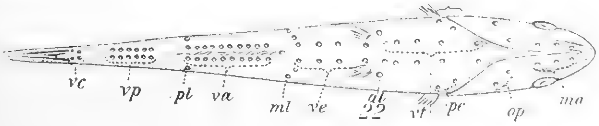

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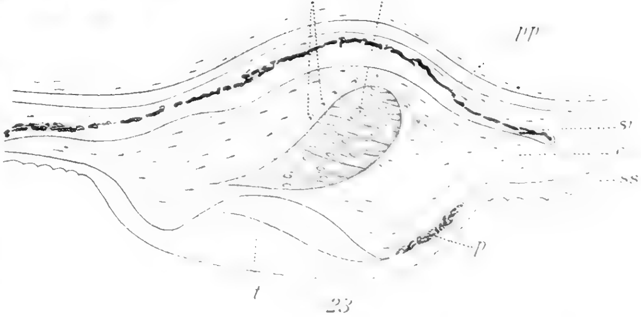

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18-20 MACRURUS CANUS Garm. 21-23 MYCTOPHUM AUROLATERNATUM Garm.

PLATE 6.

PLATE 6.

Figs. 24, 25. Argyropelecus lychnus Garman.

Fig. 24. Axial section vertical to the median plane of the fish through an anterior lateral radiating organ. Stained: picric acid-carmin. Drawing; magnified 1 : 84. A, proximal oval part of the organ; B, zigzag fibres of the reflecting layer; C, constriction between the proximal and distal part of the organ; D, distal paraboloidal part of the organ; g, inner region; l, middle region; p, pigment sheath; r, reflecting layer; s, outer region.

Fig. 25. The fish seen from the side. Drawing; natural size. a, anal radiating organs; al, anterior lateral radiating organs; ao, anteorbital radiating organs; br, branchiostegal radiating organs; ml, medial lateral radiating organs; op, opercular radiating organs; pc, pectoral radiating organs; po, postorbital radiating organs; vc, ventrocaudal radiating organs; ve, ventromedial radiating organs; vt, ventrothoracic radiating organs.

Figs. 26, 27. Sternoptyx obscura Garman.

Fig. 26. The fish seen from the side. Drawing; natural size. a, anal radiating organs; al, anterior lateral radiating organs; br, branchiostegal radiating organs; op, opercular radiating organs; pl, posterior lateral radiating organs; vc, ventrocaudal radiating organs; vē, ventral radiating organs; vt, ventrothoracic radiating organs.

Fig. 27. Axial section vertical to the median plane of the fish through a ventrothoracic radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 42. g, inner region; gl, gelatinous tissue occupying the distal part of the organ; l, middle region; p, pigment sheath; r, reflecting layer; s, outer region.

Figs. 28–30. Cyclothone acclinidens Garman.

Fig. 28. The fish seen from the side. Drawing; natural size. a, ventroanal radiating organs; ve, ventromedial radiating organs; vt, ventrothoracic radiating organs.

Fig. 29. The fish seen from below. Drawing; natural size. a, ventroanal radiating organs; br, branchiostegal radiating organs; ve, ventromedial radiating organs; vt, ventrothoracic radiating organs.

Fig. 30. Axial section vertical to the median plane of the fish through a ventrothoracic radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 520; b, blood vessel leading to the organ; c, connective-tissue capsule within the pigment sheath; cd, transparent connective tissue forming the superficial covering of the organ in the orifice of the pigment sheath; cr, distal part of the connective-tissue capsule covering the mass of radiating cells outside; l, cylindrical cells of the outer zone; m, central part of the organ composed of small irregularly arranged polyedrical cells; p, pigment sheath; r, outer part of the organ composed of cells arranged in regular rows; t, transparent intermediate zone.

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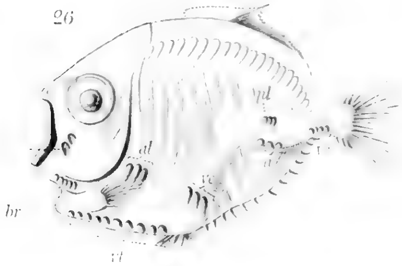

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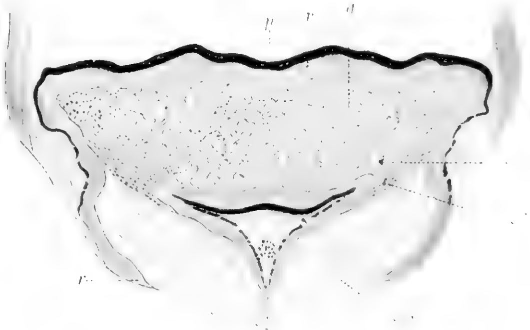

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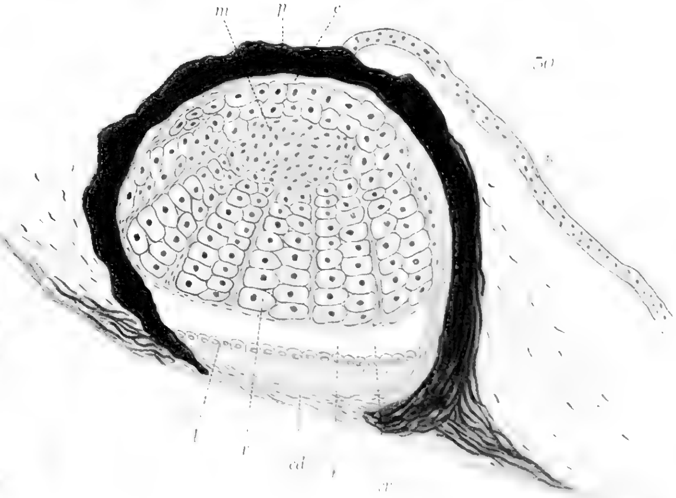

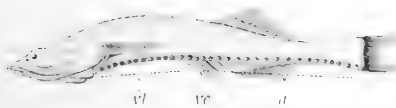

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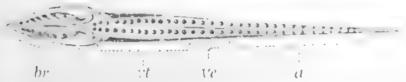


29

E. Trojan del.　　Lith.Anst.v.Werner & Winter, Frankfurt ᵃ/M.

24. 25 *Argyropelecus lychnus* Garm.,　　26. 27 *Sternoptyx obscura* Garm.,
28-30 *Cyclothone acclinidens* Garm.

Plate 7.

PLATE 7.

Figs. 31–37. Lychnopoles argenteolus Garman.

Fig. 31. The fish seen from the side. Drawing; natural size. a, anal radiating organs; al, anterior lateral radiating organs; ao, anteorbital radiating organs; ml, medial lateral radiating organs; op, opercular radiating organs; pl, posterior lateral radiating organs; vc, ventromedial radiating organs; vt, ventrothoracic radiating organs.

Fig. 32. The fish seen from below. Drawing; natural size. a, anal radiating organs; al, anterior lateral radiating organs; ao, anteorbital radiating organs; ma, mandibular radiating organs; ml, medial lateral radiating organs; op, opercular radiating organs; pl, posterior lateral radiating organs; vs, ventromedial radiating organs; vt, ventrothoracic radiating organs.

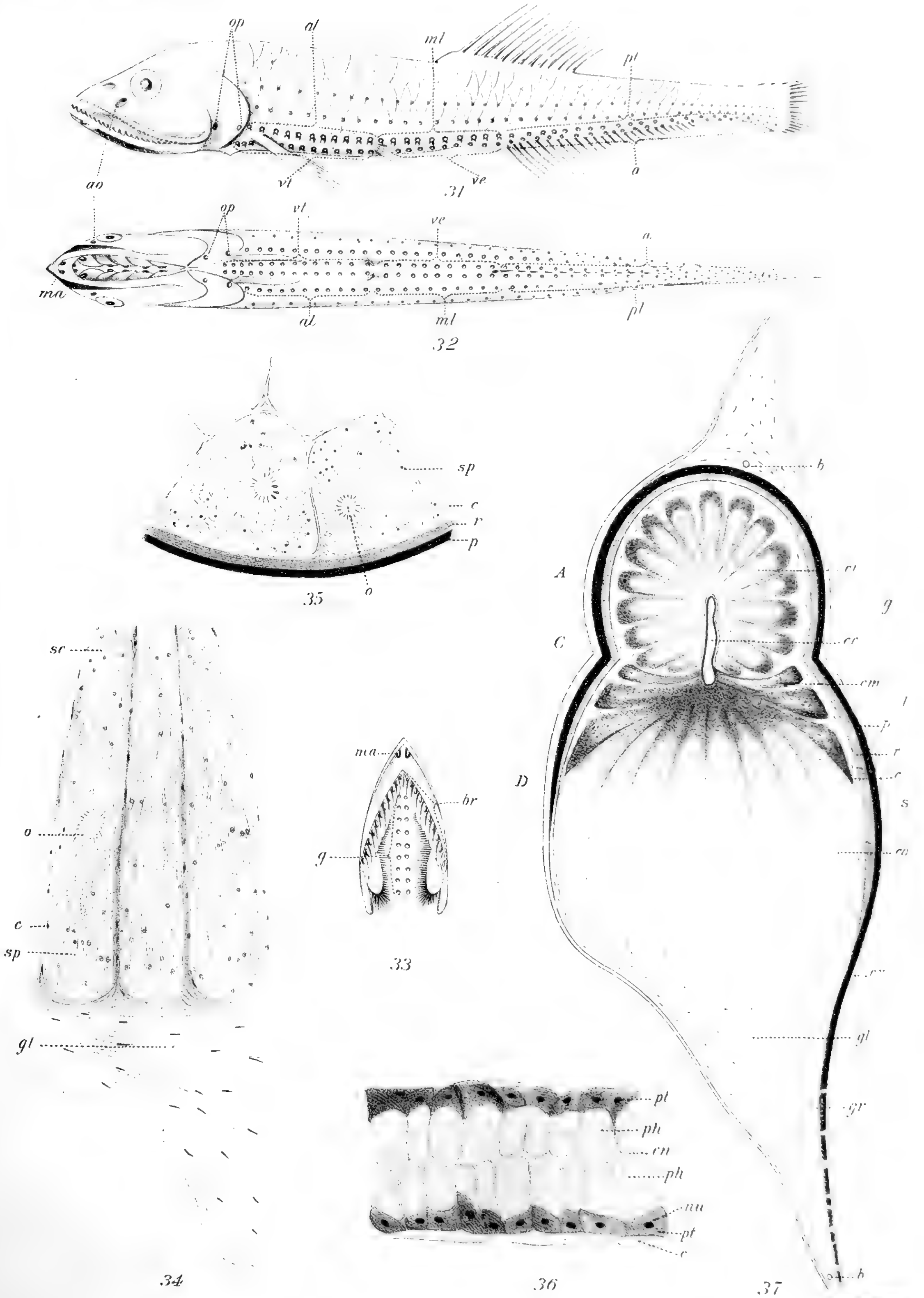
Fig. 33. The head of the fish with distended lower jaw seen from below. Drawing; natural size. br, branchiostegal radiating organs; g, guttural radiating organs; ma, mandibular radiating organs.

Fig. 34. Part of an axial section vertical to the median plane of the fish through a medial lateral radiating organ showing the outer region. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 180. c, connective-tissue membrane forming the walls of the facets; gl, gelatinous tissue occupying the distal part of the organ; o, cavity in the central part of the facets; sc, curved oblique cells in the proximal part of the facets; sp, straight longitudinal spindle-shaped cells in the distal part of the facets.

Fig. 35. Transverse section of the outer region of a medial lateral radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 350. c, connective-tissue membrane forming the walls of the facets; o, cavity in the central part of a facet; p, pigment sheath; r, reflecting layer; sp, straight longitudinal spindle-shaped cells in the distal part of the facets.

Fig. 36. Part of an axial section vertical to the median plane of the fish through a medial lateral radiating organ showing part of a facet of the middle region in longitudinal section. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 700. c, connective-tissue membrane forming the wall of this facet; cn, slender axial canal in the facet; nu, nuclei of the cells; ph, only slightly stainable proximal portion of the cells; pt, highly stainable distal portion of the cells.

Fig. 37. Axial section vertical to the median plane of the fish through a medial lateral radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 110. A, proximal spherical part of the organ; b, blood vessels outside the pigment sheath; C, constriction between the proximal spherical and the distal paraboloidal part of the organ; c, connective-tissue capsule lying within the reflecting layer; cc, tubular cavity in the axial portion of the proximal part of the organ; ci, radiating facets of the inner region of the organ; cm, radial facets of the inner part of the middle region; co, longitudinal facets of the outer part of the middle region; cr, outer connective-tissue sheath of the organ; D, distal paraboloidal part of the organ; g, inner region of the organ; gl, gelatinous superficial portion of the tissue occupying the distal part of the organ; gr, granular basal portion of the tissue occupying the distal part of the organ; l, middle region of the organ; p, pigment sheath; r, reflecting layer; s, outer region of the organ.



B Meisel [illegible]

31-37 LYCHNOPOLES ARGENTEOLUS Garm

PLATE 8.

PLATE 8.

Figs. 38–40. Chauliodus barbatus Garman.

Fig. 38. The fish seen from the side. Drawing; natural size. a, ventroanal compound radiating organs; al, anterior lateral compound radiating organs; ao, anteorbital compound radiating organs; Ba, simple radiating organs with pigment sheath in the barbel; ml, medial lateral compound radiating organs; so, suborbital compound radiating organ; vc, ventromedial compound radiating organs; vt, ventrothoracic compound radiating organs; x, simple radiating organs with pigment sheath on the side of the head.

Fig. 39. The fish seen from below. Drawing; natural size. a, ventroanal compound radiating organs; al, anterior lateral compound radiating organs; Ba, simple radiating organs with pigment sheath in the barbel; g, guttural compound radiating organs; ml, medial lateral compound radiating organs; u, groups of simple radiating organs without pigment sheath; vc, ventromedial compound radiating organs; vt, ventrothoracic compound radiating organs.

Fig. 40. The lower jaw seen from below. Drawing; magnified 1 : 2; Ba, simple radiating organs with pigment sheath in the barbel.

Figs. 41, 42. Idiacanthus antrostomus Gilbert.

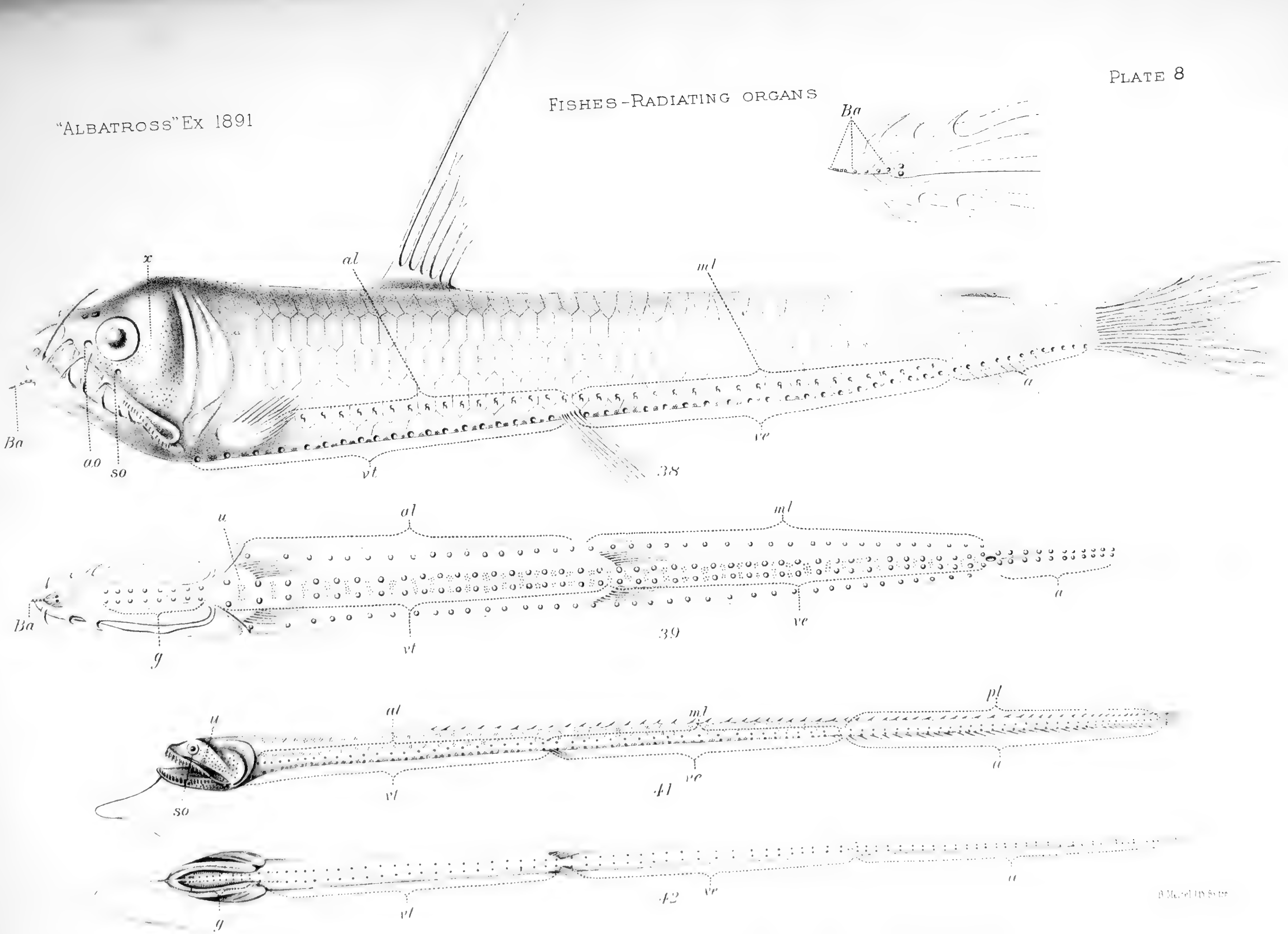
Fig. 41. The fish seen from the side. Drawing; natural size. a, ventroanal radiating organs with pigment sheath; al, anterior lateral radiating organs with pigment sheath; ml, medial lateral radiating organs with pigment sheath; pl, posterior lateral radiating organs with pigment sheath; so, suborbital radiating organ with pigment sheath; u, suborbital group of small radiating organs without pigment sheath; vc, ventromedial radiating organs with pigment sheath; vt, ventrothoracic radiating organs with pigment sheath.

Fig. 42. The fish seen from below. Drawing; natural size. a, ventroanal radiating organs with pigment sheath; g, guttural radiating organs with pigment sheath; vc, ventromedial radiating organs with pigment sheath; vt, ventrothoracic radiating organs with pigment sheath.

"ALBATROSS" EX 1891

FISHES-RADIATING ORGANS

PLATE 8



38 39.40 CHAULIODUS BARBATUS Garm.

41.42 IDIACANTHUS ANTROSTOMUS Gilb.

PLATE 9.

PLATE 9.

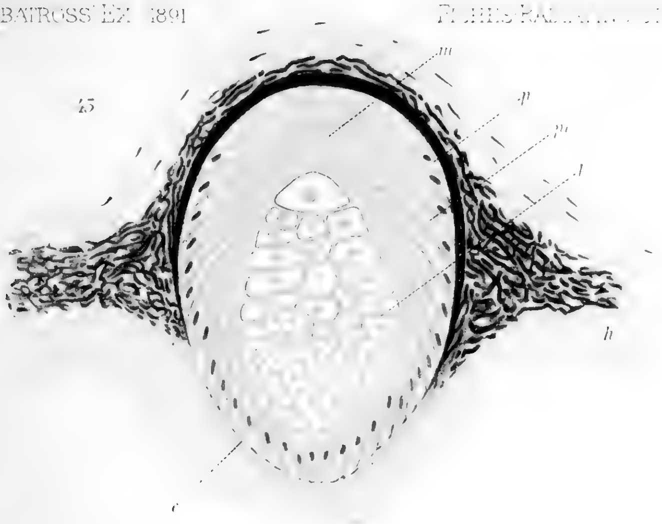
Figs. 43–46. Chauliodus barbatus Garman.

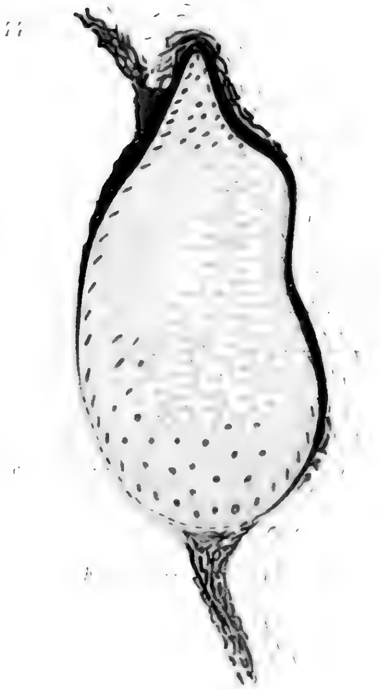
Fig. 43. Axial section vertical to the median plane of the fish through a regular simple radiating organ with pigment sheath. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 280. c, connective-tissue membrane forming the covering of the mass of radiating cells on the outer side; h, outer apparently structureless covering of organ; l, central mass of polyedrical cells; m, granular protoplasmic mass at the base of the organ; p, pigment sheath; pc, peripheral cylindrical radiating cells.

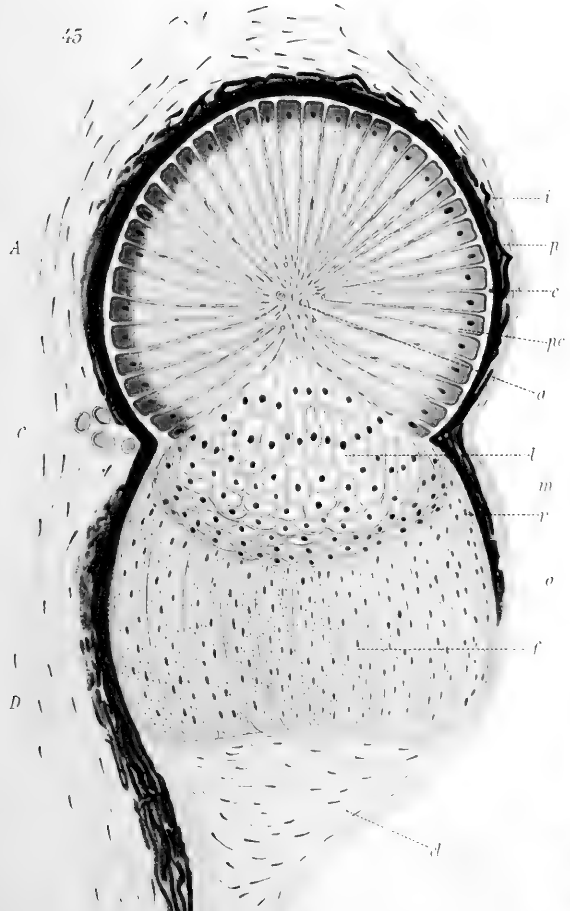
Fig. 44. Axial section vertical to the median plane of the fish through an irregular simple radiating organ with pigment sheath. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 280. c, connective-tissue membrane forming the covering of the mass of radiating cells on the outer side; h, outer, apparently structureless covering of organ; l, central mass of polyedrical cells; m, granular protoplasmatic mass at the base of the organ; p, pigment sheath; pc, peripheral cylindrical radiating cells.

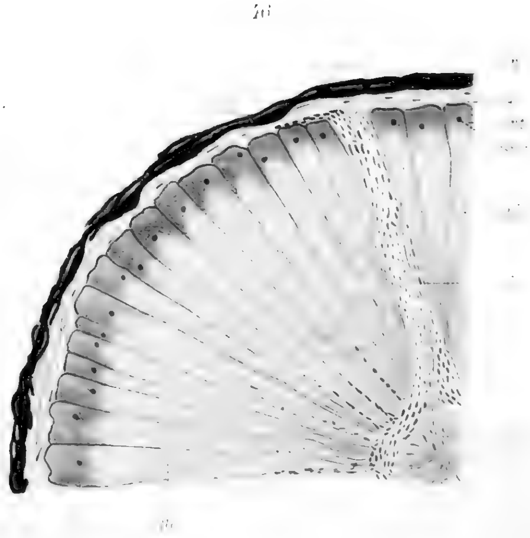
Fig. 45. Axial section vertical to the median plane of the fish through a medial lateral compound radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1: 140. A, proximal spherical part of the organ; a, mass of small cells in the central portion of the proximal spherical part of the organ; C, constriction between the proximal and distal parts of the organ; c, connective-tissue capsule within the pigment sheath; D, distal paraboloidal part of the organ; d, gelatinous connective tissue occupying the distal part of the organ; f, cells in the facets of the outer region; i, inner region; l, cells composing the middle region; m, middle region; o, outer region; p, pigment sheath; pc, large conic cells of the inner region; r, reflecting layer.

Fig. 46. Transverse section through the centre of the proximal spherical part of a medial lateral compound radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 340. a, mass of small cells in the central portion of the proximal spherical part of the organ; b, blood vessels extending radially to the centre of the sphere; c, connective-tissue capsule; nu, nucleus of the conic cells; p, pigment sheath; ph, proximal only slightly stainable part of the conic cells; pt, peripheral highly stainable part of the conic cells.









B. Troyer del.

43-46 *Chauliodus barbatus* Garman

PLATE 10.

Plate 10.

Figs. 47–51. Stomias hexagonatus Garman.

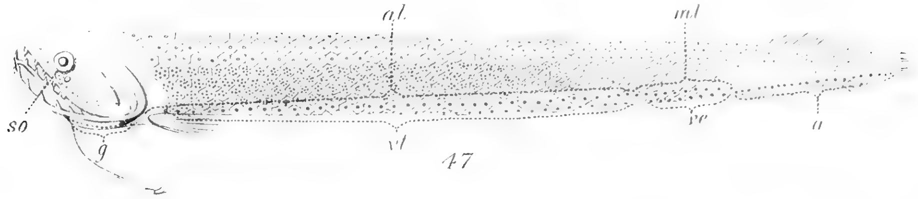
Fig. 47. The fish seen from the side. Drawing; natural size. a, ventrocaudal compound radiating organs; al, anterior lateral compound radiating organs; g, guttural compound radiating organs; L, radiating organ of the barbel; ml, medial lateral compound radiating organs; so, suborbital radiating organ; ve, ventromedial compound radiating organs; vt, ventrothoracic compound radiating organs.

Fig. 48. The fish seen from below. Drawing; natural size. a, ventrocaudal compound radiating organs; al, anterior lateral compound radiating organs; g, guttural compound radiating organs; ml, medial lateral compound radiating organs; ve, ventromedial compound radiating organs; vt, ventrothoracic compound radiating organs.

Fig. 49. Transverse section through the outer distal part of the cylindroconic plug-shaped part of a ventrothoracic compound radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 280. cc, central facet of cylindroconic plug; pc, transverse sections of cells in the outer facets of the cylindroconic plug.

Fig. 50. Axial section transverse to the barbel through the radiating organ of the barbel. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 120. A, upper (dorsal) part of the organ; B, lower (ventral) part of the organ; b, blood vessel following the axial thread, and sinuous blood vessels in the lower chamber of the dorsal part of the organ; c, connective-tissue sheath inclosing the organ; cv, cavities in the upper part of the organ; p, dorsal pigment sheath; pc, large radial conic cells of the lower spherical part of the organ; pm, pigmented membrane traversing the upper part of the organ; pt, annular thickening of the pigment layer; z, axial thread in the lower spherical part of the organ.

Fig. 51. Axial section vertical to the medial plane of the fish through a ventrothoracic compound radiating organ. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 160. d, blood vessels in the septa between the conic cells of the proximal spherical part of the organ; c, connective tissue covering the distal part of the organ on the outer side; cc, central facet of cylindroconic plug forming the distal part of the organ; co, conic proximal end of the outer plug-shaped part of the organ; cy, cylindroconic plug-shaped outer part of the organ; p, pigment sheath; pc, longitudinally elongated cells in the outer facets of the plug-shaped distal part of the organ; ph, inner only slightly stainable part of the radiating conic cells in the proximal spherical part of the organ; r, annular reflecting membrane surrounding the plug-shaped distal part of the organ; s, annular cavity surrounding the plug-shaped distal part of the organ.



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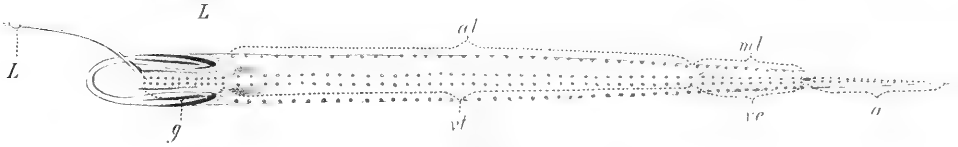

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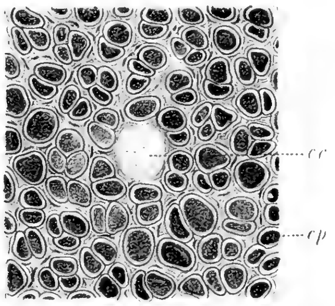

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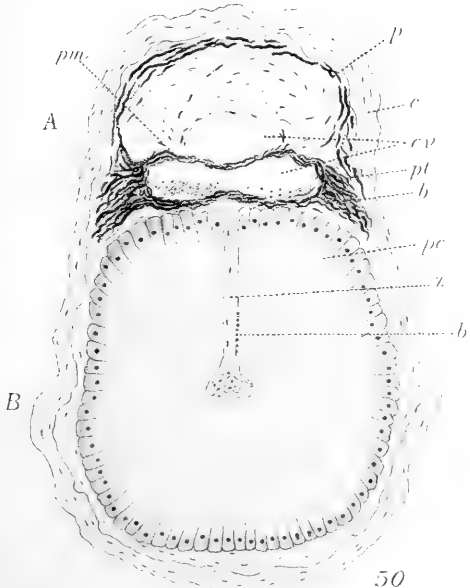

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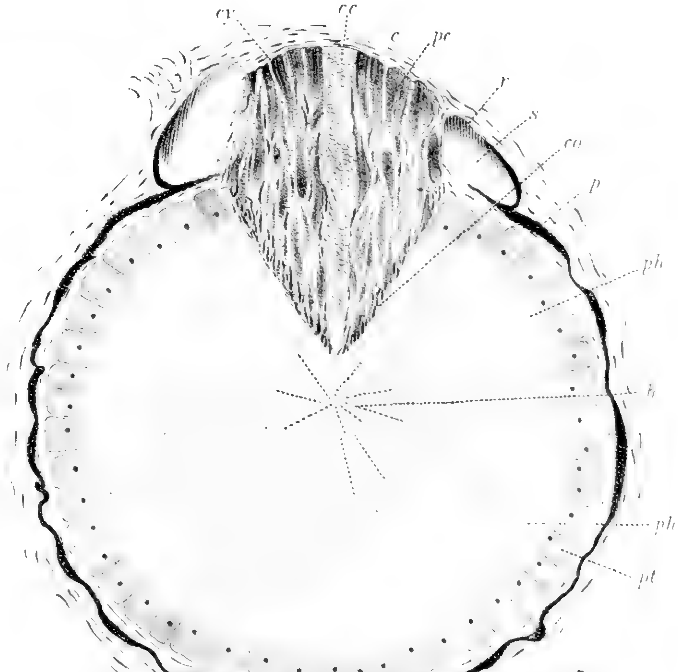


51

B. Meisel, lith Boston.

47-51 STOMIAS HEXAGONATUS Garm.

PLATE 11.

PLATE 11.

Figs. 52–57. Halosaurus radiatus Garman.

Fig. 52. The fish seen from the side. Drawing; natural size.

Fig. 53. Radiating cephalic disc in transmitted light. Photograph; magnified 1 : 17. b′, large blood vessel leading to the disc; n, main disc nerve; n′, smaller accessory disc nerves.

Fig. 54. Radiating cephalic disc in transmitted light. Photograph; magnified 1 : 41. b′, large blood vessels leading to the disc; n, main disc nerve; n′, smaller accessory disc nerves.

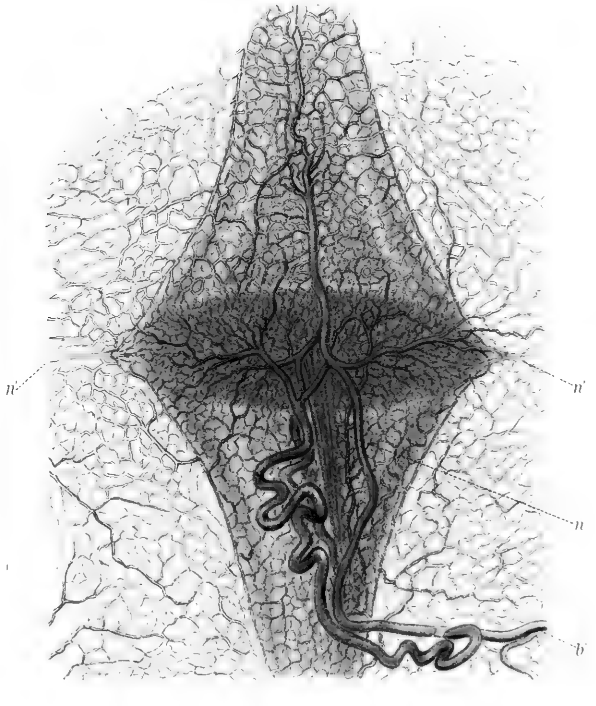
Fig. 55. Radiating cephalic disc in transmitted light. Photograph; magnified 1 : 17. b′, large blood vessel leading to the disc; n, main disc nerve; n′, smaller accessory disc nerves.

Fig. 56. Transverse section through a cephalic radiating disc along its longer axis. Stained: haematoxylin-picric acid-fuchsin. Drawing; magnified 1 : 42. b, close capillary network of blood vessels underlying the cylinder cell layer; b′, large blood vessel leading to the disc; c, thickened connective tissue of the inner wall of the slime canal on which the cylinder cell layer rests; cv, cavity of slime canal; d, cylindrical cells of the radiating disc; m, marginal zone of the radiating disc; n, main disc nerve; s, outer wall of slime canal.

Fig. 57. Part of a transverse section through the cylinder cell layer of a cephalic radiating disc. Stained: haemotoxylin-picric acid-fuchsin. Drawing; magnified 1 : 200. b, close capillary network of blood vessels underlying the cylinder cell layer: c, thickened connective tissue of the inner wall of the slime canal on which the cylinder cell layer rests; d, cylindrical cells of the radiating discs.

52

54



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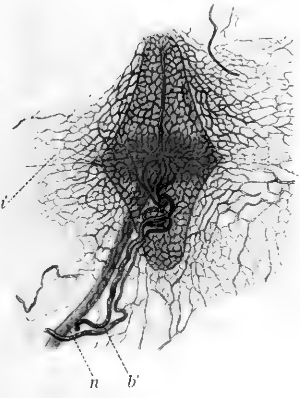

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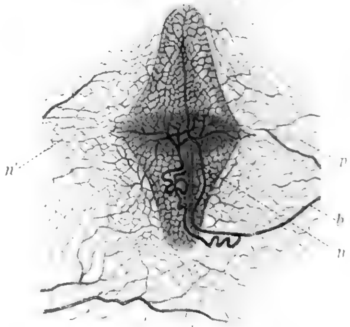

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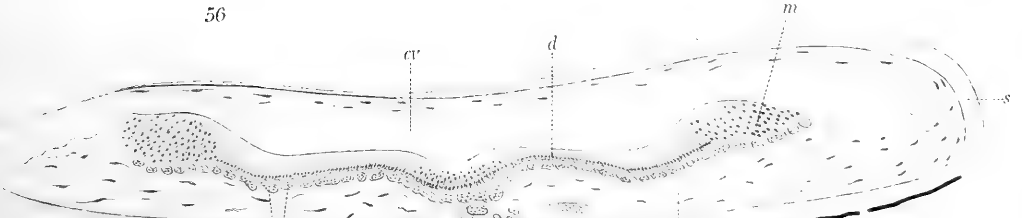

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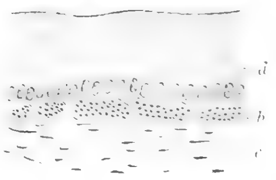


E. Trojan del.

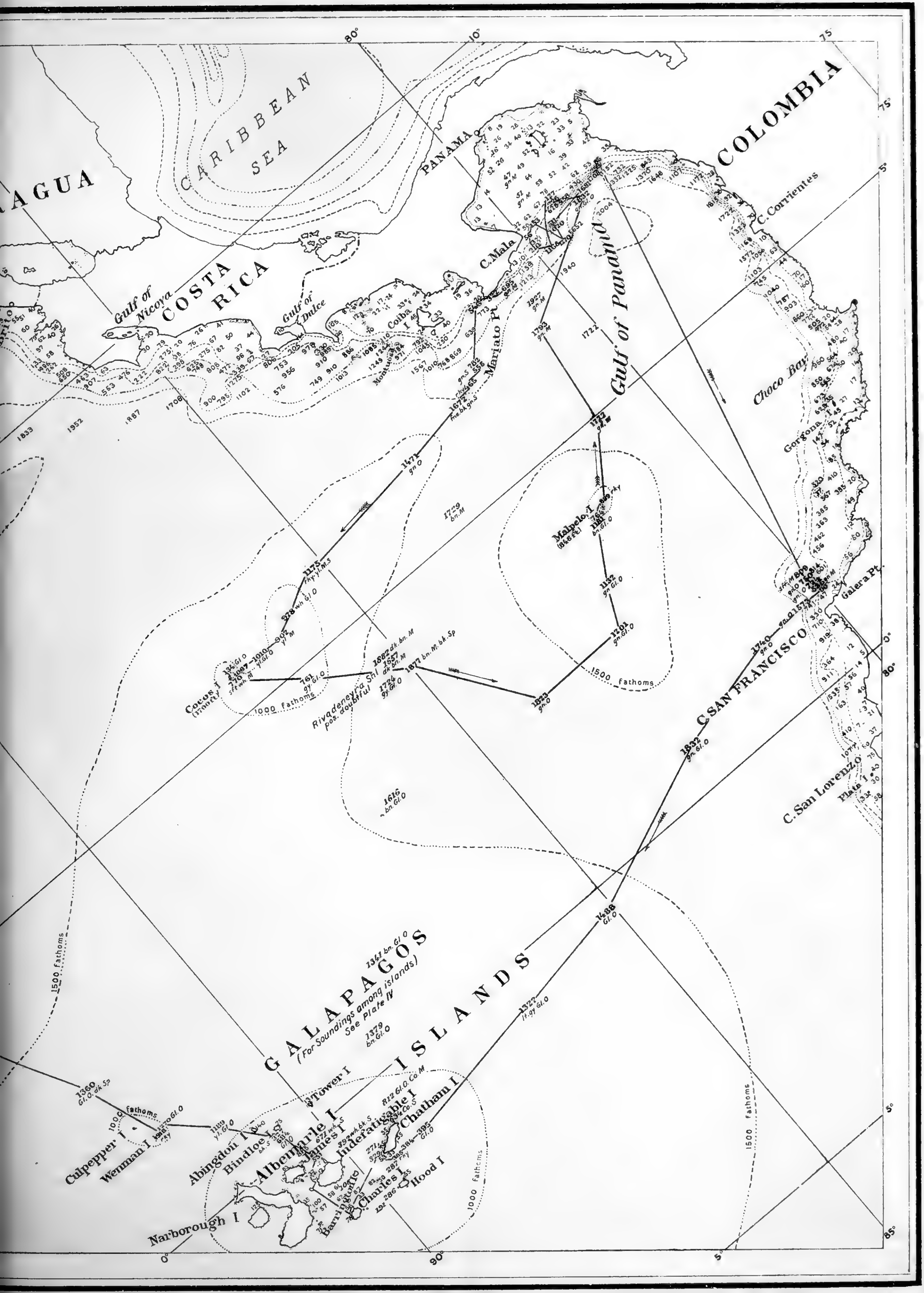
Lith. Anst. v. Werner & Winter, Frankfurt a/M.

52-57 *Halosaurus radiatus* Garman.

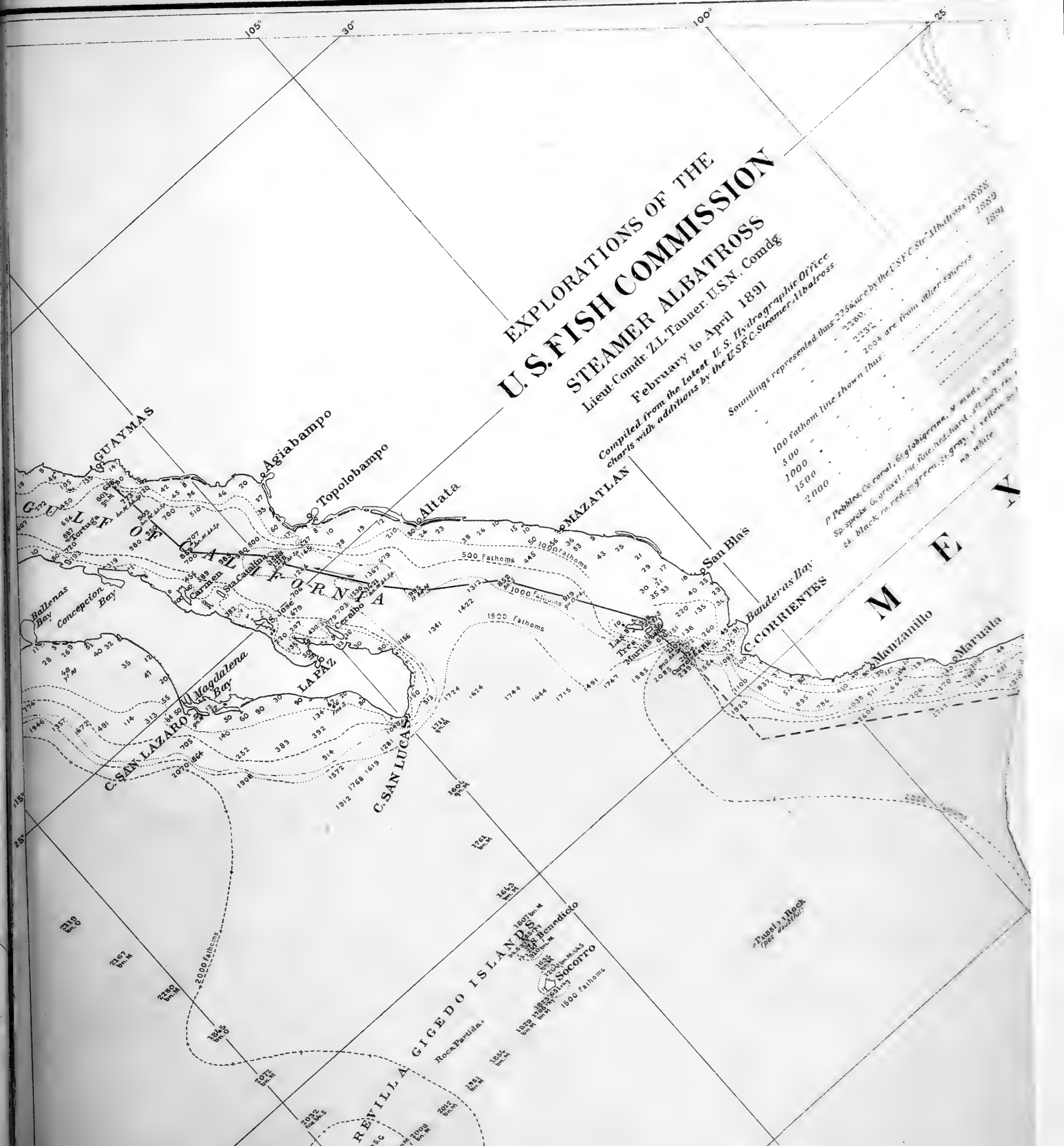
PLATE 12.

Plate 12.

Hydrographic Sketch of the Pacific from the Gulf of California to Northern Ecuador, with the Track of the "Albatross," February 22 to April 23, 1891.


CARIBBEAN SEA
AGUA
COSTA RICA
Gulf of Nicoya
Gulf of Dulce
Coiba I
Montuosa I
C. Mala
Mariato Pt
PANAMA
Gulf of Panama
COLOMBIA
C. Corrientes
Choco Bay
Gorgona I
Galera Pt.
C. SAN FRANCISCO
C. San Lorenzo
Plata I
Malpelo I (846 ft)
Cocus I (Island)
Rivadeneyra Shl pos. doubtful
1000 fathoms
1500 fathoms
GALAPAGOS ISLANDS
(For Soundings among islands) See Plate IV
Tower I
Culpepper I
Wenman I
Abingdon I
Bindloe I
Albemarle I
James I
Indefatigable I
Chatham I
Barrington I
Charles I
Hood I
Narborough I
80°
75°
10°
5°
0°
85°
90°

95°
20°
90°
GULF OF MEXICO
MEXICO
GUATEMALA
HONDURAS
SALVADOR
Acajutla
La Libertad
S. Jose
Champerico
La Puerta
TEHUANTEPEC
Salina Cruz
P. Angeles
ACAPULCO
Petacalco Bay
100 fathoms
500 fathoms
1000 fathoms
2000 fathoms
sand. Sh shells.
rocky. brk. broken.
brown. dk. dark. lt. light
Track of the U.S.F.C. Str. "Albatross"
105°
10°
100°
5°


EXPLORATIONS OF THE
U.S. FISH COMMISSION
STEAMER ALBATROSS
Lieut. Comdr. Z.L. Tanner, U.S.N., Comdg
February to April 1891
Compiled from the latest U.S. Hydrographic Office charts with additions by the U.S.F.C. Steamer Albatross.
Soundings represented thus 2256 are by the U.S.F.C. Str. Albatross 1888
2280 1889
2232 1891
2004 are from other sources
100 fathom line shown thus
500
1000
1500
2000
P Pebbles, Co. coral, Gl globigerina, M mud, O ooze, S
Sp. specks, G. gravel, fne. fine, hd. hard, sft. soft, crs.
bk. black, rd. red, gn. green, gy. gray, yl. yellow,
wh. white
GULF OF CALIFORNIA
MEXICO
GUAYMAS
Agiabampo
Topolobampo
Altata
MAZATLAN
San Blas
Banderas Bay
C. CORRIENTES
Manzanillo
Maruata
Tres Marias Is.
Tortuga
Carmen
Sta. Catalina
S. Jose
Ceralbo
LA PAZ
Ballenas Bay
Concepcion Bay
Magdalena Bay
C. SAN LAZARO
C. SAN LUCAS
500 fathoms
1000 fathoms
1500 fathoms
2000 fathoms
REVILLA GIGEDO ISLANDS
S. Benedicto
Socorro
Roca Partida
Clarion
"Tunel's Rock (pos. doubtful)
105°
30°
100°
25°
115°
20°
15°
110°

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. XXX. No. 3.

REPORTS ON AN EXPLORATION OFF THE WEST COASTS OF MEXICO, CENTRAL AND SOUTH AMERICA, AND OFF THE GALAPAGOS ISLANDS, IN CHARGE OF ALEXANDER AGASSIZ, BY THE U. S. FISH COMMISSION STEAMER "ALBATROSS," DURING 1891, LIEUT. COMMANDER Z. L. TANNER, U. S. N., COMMANDING.

XXXVI.

EIN BEITRAG ZUR MORPHOLOGIE DES TIEFSEEFISCHGEHIRNES.

Von EMANUEL TROJAN.

MIT SECHS TAFELN.

[Published by Permission of Marshall McDonald and George M. Bowers, U. S. Commissioners of Fish and Fisheries.]

CAMBRIDGE, U. S. A.:
Printed for the Museum.
October, 1906.

INHALTSVERZEICHNIS.

EIN BEITRAG ZUR MORPHOLOGIE DES TIEFSEEFISCHGEHIRNES.

EINLEITUNG.

Nachdem die in Bd. 30 Nr. 2 dieser Memoirs veröffentlichte Beschreibung der Leuchtorgane der gelegentlich der Expedition des "Albatross" in 1891 unter *A. Agassiz* erbeuteten Tiefseefische vollendet war, übergab mir mein verehrter Chef, für den ich die Vorarbeiten zu jener Beschreibung durchgeführt hatte, mit Zustimmung des Herrn Professor *A. Agassiz*, diese Fische, und versetzte mich so in die Lage, ihr Gehirn und ihre Sinnesorgane, an denen mir bei jenen Vorarbeiten einige interessante Besonderheiten aufgefallen waren, zu studieren.

Ueber das Ergebnis der die Hautsinnesorgane von *Malthopsis spinulosa* betreffenden Untersuchungen habe ich bereits berichtet,[1] über Auge und Gehör werden im folgenden einige Angaben gemacht.

Besondere Aufmerksamkeit verdiente das Gehirn der Tiefseefische, von denen mir *Leucicorus lusciosus*, *Mixonus caudalis*, und *Bassozetus nasus* zur Verfügung standen, da bisher erst zwei Tiefseefischgehirne einer genaueren Untersuchung unterzogen worden sind. Die eine stammt von *Handrick* und betrifft *Argyropelecus hemigymnus* (1901), die andere von *Gierse, Cyclothone acclinidens* behandelnd (1904). Beide ausgezeichnete Arbeiten haben viel Neues und Interessantes zutage gefördert. An diese zwei Gehirne reihen sich nunmehr die von mir untersuchten drei an, wodurch an sich eine bedeutende Bereicherung des einschlägigen Materials eingetreten ist, was aber relativ freilich noch nicht allzuviel, namentlich im Hinblicke auf die Frage, ob, und wenn ja, in welcher Weise das Gehirn der Tiefseefische in seinem Baue von dem der Seichtwasserfische abweicht, besagen kann.

---

[1] Sitzungsber. d. D. nat. med. Ver. "Lotos" i. B., Bd. XXIV, S. 99–105, m. 3 Fig. i. T., 1904. "The structure of the bud-like organs of Malthopsis spinulosa." Mem. Mus. Comp. Zoöl. Harvard College, Vol. XXX, p. 209–214, 1905.

Für die Ueberlassung dieses mir hochwillkommenen und wertvollen Materiales muss ich an dieser Stelle Herrn Professor *A. Agassiz,* und meinem hochverehrten Chef, Herrn Professor Dr. *R. von Lendenfeld,* Vorstand des Zoologischen Institutes, meinen ergebensten Dank aussprechen. Durch die zahlreichen Winke und Ratschläge, durch die Unterstützung, die er mir weiterhin während meiner Arbeit in liebenswürdigster Weise zuteil werden liess, wurde ich zu ganz besonderem Danke verpflichtet, dem hier Ausdruck zu geben mir mehr als Pflicht ist. Meinem Kollegen Dr. *Ludwig Freund,* Assistenten am hiesigen Tierärztlichen Institute, danke ich für das der Arbeit entgegengebrachte Interesse.

MATERIAL.

Die obengenannten Fische entstammen der durch die Tiefsee-Expedition des "Albatross" im Jahre 1891 zusammengebrachten Sammlung, und sind von *Garman* (1899) in den Ergebnissen jener Forschungsreise näher beschrieben. Sie waren in Alkohol konserviert, der ihre Gehirne noch keineswegs derart beeinflusst hatte, dass eine richtige Untersuchung derselben unmöglich gewesen wäre. Freilich wären die Ergebnisse bei einer anderen Art der Konservierung und einer kürzeren Zeit bis zur Bearbeitung reichere gewesen.

METHODEN.

Der kleinste von den drei Fischen, *Bassozetus,* wurde entkalkt. Obgleich ich mich hiebei bloss einer 1% Salpetersäure bediente, dauerte der Prozess nicht lange, da das Skelett dieses ausgesprochenen Tiefseefisches vorwiegend aus Knorpeln besteht. Die beiden grösseren Exemplare, *Leucicoris* und *Mixonus,* wurden derart behandelt, dass nach dem Oeffnen der Cranialhöhle und eines Teils des Rückenmarkkanals das Gehirn aus der Schädelhöhle herausgehoben wurde, was mit einiger Gefahr betreffs der Erhaltung des Pinealapparates und der Hypophyse geschah. Der erste war bei dieser Art der Behandlung zum Teil verloren, die letzte keineswegs. Alle Gehirne wurden in Celloidin eingebettet und in Querschnittserien zerlegt. Die Dicke der Schnitte betrug 20 oder 40 μ. Gefärbt wurde entweder Schnitt für Schnitt oder in toto mit Delafieldschen Hæmatoxylin. Zur Anfertigung der Bilder für die Totalansichten der Gehirne dienten Photographien der herauspräparierten Gehirne, Zeichnungen, und Plattenmodelle.

Das Gehirn von Leucicorus lusciosus.

Taf. 1, Fig. 1-8, Taf. 2, Fig. 9-13.

Folgende Bemerkung *Garmans* war es (1899, S. 140), die mich auf diesen Fisch aufmerksam machte: "Eye rudimentary, apparently without pupil or iris and with the ball greatly reduced and covered with black pigment. The eye differs greatly in appearance from that of other species of Brotuloids and suggests a possible adaptation to sensation from phosphorescence, or perhaps a modification fitted for the production of phosphorescent light."

Es war mir nun daran gelegen, festzustellen, welche von diesen beiden Vermutungen hier zutreffend ist, anderenteils interessierte es mich, inwieweit die Reduktion der Augen den Bau des Gehirnes beeinflusst hat. Das Ergebnis meiner Untersuchungen war die Bestätigung der ersten und die Widerlegung der zweiten Vermutung.

Offenbar verleitete das Fehlen der Iris und der Pupille, eine Tatsache aber, die seit *Brauers* wertvollen Untersuchungen "Ueber den Bau der Augen einiger Tiefseefische" (1902) gar nicht absonderlich erscheint, *Garman* zu der Annahme, die Augen von *Leucicorus lusciosus* könnten Leuchtorgane sein. Auf Grund meiner mikroskopischen Untersuchungen kann ich erklären, dass diese von *Garman* angezweifelten Augen tatsächlich der Lichtperzeption dienen. Der Umstand, dass es sich um einen ausgesprochenen Tiefseefisch handelt — er wurde aus einer Tiefe von 3436 m hervorgeholt — sowie das Fehlen der Iris mit der Pupille riefen in mir den Gedanken wach, ob nicht in den vorliegenden Gebilden sogenannte Teleskopaugen zu suchen wären. Diese Annahme erschien aber alsbald widerlegt sowohl durch die Gestalt — sie sind ellipsoide, und nicht cylindrische Gebilde — als auch durch die Lage der Augenöffnung — sie ist ausgesprochen lateral und nicht rostral wie bei den Teleskopaugen. Nur die stark vorgetriebene Cornea, die mich einen weiteren Schluss bezüglich der Gestaltung der Linse ziehen lässt, würde für ein Teleskopauge sprechen. Wenn auch *Garman* keine Erwähnung von einer Linse tut, so zweifle ich ihr Vorhandensein nicht an, da ich auch das Ligamentum pectinatum vorgefunden habe. Sie dürfte sehr gross und kugelig sein und hat, wie es bei solcher Gestaltung Regel ist, mit ihrer Vorderseite die Cornea stark vorgetrieben, mit der Hinterseite die Entstehung der Iris unterdrückt.

Im übrigen sind jedoch die Bestandteile eines Auges auch hier vorhanden und in mikroskopischen Präparaten unschwer zu erkennen. Die Sklera als äusserste Wand verknorpelt an keiner Stelle wie es sonst bei Fischen der Fall zu sein pflegt. Der Chorioidea fehlt die Silberschicht. Gefäss- und Pigmentschicht sind vorhanden, die letzte sogar in sehr dicker Lage. Das Pigment befindet sich in Dunkelstellung, nachdem der Fisch wohl kaum je aus dem Dunkel der Tiefsee herauskommen dürfte. An der Retina fällt die übermässige Länge der Stäbchen auf, die übrigens von *Brauer* (1902, S. 44) auch nicht unberücksichtigt gelassen wurde; Zapfen fehlen. Nicht festzustellen war, ob neben der Hauptretina auch eine Nebenretina vorhanden ist.

Wenn ich also meine Betrachtungen über das Auge von Leucicorus lusciosus zusammenfasse, so führen sie zu dem Resultate, dass jener Fisch im Besitze wirklicher Augen, die mit Leuchtorganen nicht das geringste gemeinsam haben, ist. Diese Augen verraten eine Anpassung an die Tiefsee, die sich auf die Cornea, Linse und Iris erstreckt und die von Brauer (1902, S. 44) für das Sehen in den Tiefen des Ozeans bei der dürftigen Beleuchtung als äusserst zweckmässig gefunden wurde.

Ob aber das Sehvermögen dieses Fisches speciell ein gutes ist, das ist eine andere Frage, die ich eher auf Grund der Untersuchung der nervösen optischen Leitungsbahnen und Zentren, als der Sehwerkzeuge beantworten möchte. Ueberraschend schwach sind die beiden die Augen versehenden Nervi optici in Anbetracht der Sehorgane, noch überraschender aber für jeden, der den Typus eines Fischgehirnes kennt, die Kleinheit der Sehherde, der Lobi optici, welch letzter Umstand dem Gehirn von *Leucicorus* ein ganz eigentümliches Gepräge verleiht.

In dem Masse, in dem sich der Gesichtssinn rückgebildet hat, scheinen sich Geruch- und Gehörsinn höher entwickelt zu haben, was namentlich in der Dicke der Nervi olfactorii und der entsprechenden Bulbi, in den mächtigen Ursprungsgebieten der Nervi accustici im Bereiche der Medulla oblongata, und der zu ihren Seiten gelegenen, grossen Sacculi zum Ausdrucke kommt.

Die Sacculi bergen Gehörsteine (Taf. 1, Fig. 8), deren Grösse mich nicht wenig überraschte. Diese Otholiten haben Bohnenform, 11 mm Länge, 7 mm Breite und 2 mm Dicke, also für einen Fisch von kaum 3 dm Länge ganz bedeutende Dimensionen. Ihr Rand ist ziemlich scharf, die Aussenseite ist glatt und die Innenseite zeigt eine konzentrische Riefung. Der grosse Gehörstein steckt locker im Sacculus und schwebt natürlich zu Lebzeiten des Fisches in der dicken Flüssigkeit des Sackraumes. Es ist eine bekannte Tatsache, dass die Sacculusotholiten der Knochenfische gross sind. In dem umfassenden Werke "Das Gehörorgan der Fische" von *Retzius* (1881) finden sich genug derlei Beispiele vor, doch in Gestalt und relativer Grösse kommt kein anderer diesem gleich.

Die mächtigen Sacculi weisen auf ein hochentwickeltes Gehörorgan hin, das bezüglich der Austrittstellen einiger Nerven eine Erscheinung hervorruft, auf die bereits *Sagemehl* (1891, S. 559) mit folgenden Worten aufmerksam macht: "Die mächtige Ausbildung des Labyrinthes bei Knochenfischen ist die Ursache gewesen, dass die vor demselben liegenden Trigeminus und Facialis näher an einander gerückt sind und teilweise Verbindungen mit einander eingegangen sind." *Handrick* (1901, S. 6) hatte die Gelegenheit, diese Erscheinung an dem Tiefseefisch *Argyropelecus* zu bestätigen und konnte überdies noch feststellen, dass sich zu den verschmolzenen Wurzeln des V. und VII. Nerven auch die des VIII. zu einem breiten Band zusammendrängen; auch der Ursprung des IX. und X. ist vereinigt. Ich fand alle diese Verhältnisse an *Leucicorus* ebenso vor.

DAS VORDERHIRN.

(Telencephalon, Prosencephalon, Hemisphaeren, sekundäres Vorderhirn) (Taf. **1**, Fig. 1, 2, 3 VH).

Schon die vielen Namen dieses Gehirnteiles verraten, dass er oft Gegenstand eingehender Untersuchungen gewesen sein muss. Und in der Tat, es hat lange Zeit gedauert, bevor die Forscher darüber ins Klare gekommen sind. Das, was die älteren Autoren wie *Camper*, *Cuvier*, *Treviranus*, und *Fritsch* dabei irregeführt hat, war der Umstand, dass dem Fischgehirne die gewöhnlich stark verdickte Grosshirnrinde abgeht. So suchten denn alle den vermissten Teil weiter hinten, wodurch keine geringe Konfusion hervorgerufen wurde. Indessen gelang es *Rabl-Rückhard* (1884, S. 21), das Homologon der Grosshirnrinde zu finden. Es ist das bei Fischen zeitlebens auf embryonalem Stadium verbleibende Pallium. *Gottsche* (1835, S. 244) kannte zwar diese einfache Epithelschichte, ohne sie aber der Grosshirnrinde gleichzusetzen. Andere Autoren übersahen sie, weil sie sie beim Abtragen der Cranialhöhle vielleicht zerstörten, was ja häufig bei dieser Art von Behandlung zu geschehen pflegt, wenn nicht genug Vorsicht angewendet wird. Mit dieser Entdeckung *Rabl-Rückhards*, die alsbald auch allgemein als richtig erkannt wurde, war der Bau des Knochenfischgehirnes analog dem der anderen Vertebraten aufgeklärt und es ist seither nicht schwer, an einem jeden Teleostier-Vorderhirn, so auch am vorliegenden, die einzelnen Teile zu unterscheiden. Um den als *Ventriculus communis* bekannten Hohlraum (Taf. **1**, Fig. 4 Vc) gruppieren sie sich in folgender Art: Den Boden und die Seitenwände bilden die *Corpora striata* (Taf. **1**, Fig. 4, 5 Cs). Diese von *Haller* (1898a, S. 617) als Basalganglien bezeichneten Gebilde nehmen hinten aus dem Thalamus des Zwischenhirns ihren Ursprung, nachdem dieser sich selbst stark verjüngt hat. Sie sind dort unscheinbar und durch einen dünnen Boden miteinander verbunden. Rostralwärts aber verbreitert sich der letzte, und dorsal lagern sich den basalen schwächeren Teilen mächtige Hirnmassen an, nicht hoch, aber *derart breit, dass sie über die basalen herüberhängen* (Taf. **1**, Fig. 5 Cs); das sind die eigentlichen Streifenhügel. Sie sind von einander durch einen schmalen Spalt, die Fortsetzung des Ventriculus communis nach vorne getrennt, bis ungefähr in der Mitte eine Verbindung durch die *Commissura anterior* oder *interlobularis* (Taf. **1**, Fig. 5 Ca) hergestellt wird. Ein Chiasma zweier Blutgefässe (Taf. **1**, Fig. 5 ch) ist ebenda auch wahrzunehmen. Vor dieser Commissur sind die Streifenhügel dorsal total miteinander verschmolzen, die basalen Teile haben hier ihr vorderes Ende. Die Verschmelzung muss dennoch ganz vorne einer Pialamelle und einem schmalen Spalt, der zur vollständigen Trennung der Streifenhügel bei allmählicher Abnahme an Hirnmasse führt, Platz machen; sie gehen in die

Tracti olfactorii (Taf. **1**, Fig. 1, 2, 3 Trol) über. Die Länge der letzten ist unbedeutend, immerhin genügt sie aber, um eine markante Grenze zwischen den *Corpora striata* und den *Bulbi olfactori* anzuzeigen. Die Tracti hängen jedoch miteinander *nicht* zusammen, sondern *divergieren.* Dies hat zur Folge, dass die Bulbi (Taf. **1**, Fig. 1, 2, 3 Bol) von einander getrennt sind, was in so hohem Masse noch an keinem Teleostier wahrgenommen wurde.

Von obenher ist der Ventriculus communis durch das bereits erwähnte *epitheliale Dach* (Taf. **1**, Fig. 4 Pa), das seitlich in die Streifenhügel übergeht, gedeckt; rostral aber mündet er frei in die Cranialhöhle aus.

"Es finden sich," schreibt *Rabl-Rückhard* (1883, S. 308) "mit Bezug auf das Verhalten dieser Hirnteile zwei verschiedene Typen des Knochenfischgehirns: solche mit lang ausgezogenen getrennten Tractus und von einander abstehenden Bulbi, sowie kurzen Nervi olfactorii (Cyprinoidentypus), und solche mit sitzenden verwachsenen Tractus und einander genäherten Bulbi, bei langen Nervi olfactorii (Salmonidentypus). In ersterem Falle stellt jeder Tractus eine geschlossene Röhre dar, die vorn mit einem Hohlraum des Bulbus, hinten mit der Spitze des Ventriculus communis in Verbindung steht und deren dorsale Wand vorwiegend epithelial, die ventrale markig ist. Im zweiten Falle sitzen die Bulbi dem vorderen Teile des Grosshirns unmittelbar auf; die Tractus sind äusserst kurz und bilden den Boden einer gemeinsamen Höhle, die eine unmittelbare Fortsetzung des Ventriculus communis nach vorne ist, und die ihrerseits in zwei seichte Divertikel übergeht, einen für jeden Bulbus. Letztere verbinden sich medial, ohne indess miteinander zu verschmelzen, indem eine senkrechte Pialamelle sich zwischen sie schiebt."

Demzufolge ist es unschwer, das Vorderhirn von Leucicorus als ein nach dem Salmonidentypus gebautes zu erkennen, das nur insofern eine Abweichung erleidet, als die Tracti olfactorii von einander getrennt, und die Bulbi einander nicht so nahe sind, wie wir es sonst zu finden gewohnt sind.

DAS ZWISCHENHIRN.

(Diencephalon, Thalamencephalon, Thalamus, Lobus opticus, primäres Vorderhirn) (Taf. **1**, Fig. **1**, **3** ZH).

Die Grenze zwischen Vorder- und Zwischenhirn ist zwar makroskopisch nicht sichtbar, wohl aber an mikroskopischen Präparaten durch das Auftreten eines *Plexus chorioideus* (Taf. **1**, Fig. 4, 6 Plch) gut gekennzeichnet. Dieser letzte scheint, was seine Ausbildung betrifft, bei Fischen den mannigfachsten Variationen zu unterliegen. So wurde seine Existenz bei Teleostiern überhaupt geläugnet. Und wieder war es *Rabl-Rückhard* (1883, S. 291) vorbehalten, sein tatsächliches Vorhandensein sicherzustellen, obzwar er anfangs mit zu denen gehörte, die es verneinten. Nach Darstellungen dieses Autors geniesst er aber weder beim Karpfen, noch beim Barsche eine besondere Ausbildung, und ist daher unvollkommen zu nennen. Wenn andere Forscher, die sich mit Fischgehirnen beschäftigten, ihn stillschweigend übergehen, kann man daraus folgern, dass sein Vorkommen eben nicht allgemein ist.

Ich selbst muss gestehen an den mir zugebote stehenden Tiefseefischen Plexus chorioidei von verschiedener Grösse bis zur verschwindenden Unscheinbarkeit gefunden zu haben. Von allen aber musste der von *Leucicorus lusciosus* durch seine Dimensionen auffallen. Das einschichtige epitheliale Dach wird durch Blutgefässe in so zahlreichen Falten in das Innere des Ventriculus tertius (Taf. **1**, Fig. 4 Plch) und zum Teil bis in den Ventriculus communis (Taf. **1**, Fig. 6 Plch) derart eingetrieben, dass es denselben nahezu *ausfüllt* wie etwa bei Dipnoern und Amphibien.

Unmittelbar hinter dem Plexus beginnen die *Ganglia habenulae* (Taf. **1**, Fig. 7 Gh). Auch diese Gebilde lassen in ihrer Entwickelung nichts zu wünschen übrig, obgleich sie von aussen nicht sichtbar sind. Sie liegen am Zwischenhirn dorso-lateral und sind vollkommen symmetrisch. Bezüglich des letzten Punktes schreibt *Haller* (1898a, S. 574) über die Haubenganglien bei Fischen folgendermassen: "Nach Goronowitsch (1834, S. 436) soll auch bei Acipenser" (wie nämlich bei den Selachiern) "eine Assymmetrie der Haubenganglien sich vorfinden und das rechte Ganglion mächtiger entwickelt sein wie das linke. So weit meine Erfahrungen reichen, kommt eine solche Assymmetrie bei Knochenfischen nicht vor, sondern es verhalten sich diese Ganglien durchaus symmetrisch wie bei den Salmoniden." Wenn auch diese Ansicht *Hallers* hier zutrifft, muss ich doch hinzufügen, dass sie keine allgemeine Giltigkeit hat. Schon *Handrick* (1901, S. 7) hat auf die Assymmetrie der Ganglia habenulae bei *Argyropelecus hemigymnus* aufmerksam gemacht. Eine weitere interessante Beobachtung diesbezüglich machte *Gierse* (1904, S. 618–619) an *Cyclothone acclinidens*. Seine Befunde an den ihm zur Verfügung gestellten 10 Fischchen drückt er in folgenden Worten aus: "Bei zwei Exemplaren war das linke Ganglion habenulae stärker entwickelt als das rechte, bei weiteren zwei Tieren waren beide Ganglien einander ungefähr gleich, während die anderen sechs deutliche Assymmetrie zeigten, indem das rechte Ganglion sich stärker entwickelt erwies als das linke. Es kommen bei Cyclothone alle drei Möglichkeiten vor, doch überwiegt die Assymmetrie und zwar mit stärkeren Ganglion dextrum habenulae."

Diese Mannigfaltigkeit dürfte meiner Ansicht nach auf verschiedene Altersstufen jener zehn Exemplare zurückzuführen sein, denn *Haller* (1898a, S. 574) fand, dass sich die Symmetrie der Haubenganglien bei Salmo erst mit zunehmendem Alter einstellt. Nach dieser Erklärung können von jenen zehn Exemplaren acht jünger und zwei älter gewesen sein.

Dass die Assymmetrie dieser Gebilde namentlich dem Embryonalstadium angehört, darüber schreibt bereits *Goronowitsch* (1888, S. 442): "Es ist aber von Interesse zu notieren, dass ich bei Salmonidenembryonen die Anlage des rechten Ganglions in einem gewissen Stadium immer grösser fand als die Anlage des linken. Es hat sich also im embryonalen Zustande des Gehirns der Knochenfische dieser primitive Charakter erhalten." Bei niederen Fischen ist die Assymmetrie konstant, wie *Ahlborn* (1883, S. 227) an *Petromyzon, Goronowitsch* (1888, S. 436) bei *Acipenser* und *Amia* (S. 442), *Eddinger* (1900, S. 140) bei anderen niederen Vertebraten nachgewiesen haben. Auch ich werde im Verlaufe meiner Arbeit Gelegenheit haben, einen neuen Tiefseefisch mit assymmetrischen Ganglien habenulae zu nennen.

Auf der Kommissur, welche das Ganglion der rechten Seite mit dem der linken verbindet, sowie weiter vorne über dem Pallium, sah ich den Stiel des *Pinealorganes* (Taf. **1**, Fig. 6, 7 Est) verlaufen. Er ist ein solider Strang. *Ein Parapinealorgan ist bei Leucicorus lusciosus nicht vorhanden.*

Soviel über die Teile des sogenannten *Epithalamus*.

Hinten lateral gehen die Ganglia habenulae in den Stammteil des Zwischenhirns, den *Thalamus* (Taf. **1**, Fig, 6, 7, T), über. Dieser ist sehr voluminös und lässt nur einen ganz schmalen Spalt für den *Ventriculus tertius* (Taf. **1**, Fig. 6, 7, 8, V III) frei. Eine scharfe Abgrenzung dieses Teiles nach vorn oder hinten ist unmöglich; darüber lesen wir auch bei *Haller* (1898a, S. 591): "Rostralwärts geht letzterer," er meint den Thalamus, "ganz kontinuierlich und ganz ohne jede Begrenzung in jenen Teil des Vorderhirns über, der für gewöhnlich als Pedunculus cerebri bezeichnet wird." Und über das hintere Ende schreibt *Edinger* (1896, S. 8): "Es gehen hier Zwischen- und Mittelhirn unmittelbar in einander über."

Zum Thalamus pflegen auch die *Lobi laterales* (Taf. **1**, Fig. 3, Taf. **2**, 9, 10 Ll) gezählt zu werden; das sind Wülste, die zu beiden Seiten desselben longitudinal verlaufen. Sie werden bei Fischen mitunter sehr gross. *Handrick* (1901, S. 8) bringt dies mit dem Sehvermögen des Fisches in Zusammenhang und meint, "dass der Lobus lateralis ein Gebilde sui generis ist, ein Produkt der im Thalamus befindlichen Sehzentren, infolge der excessiven Ausbildung der Augen." Einer anderen Ansicht ist *Haller* (1898a, S. 598). Er betrachtet den Lobus lateralis als einen dorsalen, differenzierten Teil des Lobus inferior. Beide Hypothesen werden von *Gierse* (1904, S. 626, 627) angefochten. Dieser Autor fand an *Cyclothone*, wie *Handrick* an *Argyropelecus*, dass die Lobi laterales an Masse die Lobi inferiores überragen, und er schreibt daher: "Gegen die Ansicht Hallers spricht das ungleiche Grössenverhältnis der beiden Lappen, so dass man bei meinem Knochenfische eher daran denken könnte, der Lobus inferior wäre eine Differenzierung, ein ventraler Teil des Lobus lateralis als umgekehrt. Desgleichen kann dieser seitliche Lappen kein Produkt der Volumzunahme der im Thalamus befindlichen Sehzentren sein, denn Cyclothone hat verhältnismässig kleine Augen und schwache Nervi optici."

Leucicorus lusciosus liefert hierin nun insofern ein interessantes Verhalten, als *er von jedem Charakter etwas in sich vereinigt. Einesteils sind die Lobi laterales kleiner als die Lobi inferiores* (*Salmo*), *anderenteils die Augen gross* (*Argyropelecus*), *die Nervi optici schwach* (*Cyclothone*). Allerdings ist eine solche Zusammenstellung nicht darnach angetan, uns über die ursächlichen Beziehungen der beiden Lappen näher aufzuklären. Vielleicht wird die entwicklungsgeschichtliche Forschung einst mehr Aufschluss geben können.

Der basale Teil des Zwischenhirns, der *Hypothalamus*, besteht aus der *Pars infundibularis* mit der *Hypophyse*, den *Lobi inferiores* und dem *Saccus vasculosus*.

Das *Infundibulum* von *Leucicorus* (Taf. **1**, Fig. 4, 6, 7J) ist gross. Eine starke Hirnmasse umgibt die Infundibularhöhle, die eine Fortsetzung des Ventriculus tertius nach unten ist (Taf. **1**, Figs. 4, 6, Jh). Sie hat zahlreiche Seitendivertikel, von denen die wichtigsten und längsten die hinten in den Lobi inferiores sind. Nach vorne werden die Ausstülpungen zahlreicher, aber auch kleiner, bis sie sich ganz verlieren (Taf. **1**, Fig. 4 Jh). Hier hat die Infundibularhöhle die Form einer niedrigen, horizontalen Spalte mit glatten Innenwänden, die sie umgebende Hirnmasse nimmt Trichterform an. Das ist auch die Regel, denn hiemit beginnt der

Stiel des *Hypophysenorganes* (Taf. **1**, Fig. 2, 3, Hst). Er ist bei verschiedenen Fischen verschieden lang, zum Beispiel bei *Cyprinus* unscheinbar, bei *Gadus* wohl merklich. Davon hängt auch die Festigkeit des Zusammenhanges zwischen Hypophyse und Gehirn ab, auf die schon *Gottsche* (1835, S. 435) aufmerksam macht; je länger der Hypophysenstiel, um so leichter reisst die Hypophyse bei Herausnahme des Gehirnes aus der Cranialhöhle ab. *Bei Leucicorus ist er mässig lang, solid und trägt an seinem Ende eine ansehnliche Hypophyse* (Taf. **1**, Fig. 3 H).

Die Lobi inferiores (Taf. **1**, Figs. 2, 3; Taf. **2**, Fig. 9, 10 Li) *übertreffen die Lobi laterales so an Grösse, dass diese in der Ansicht von unten gänzlich verdeckt werden.* Ich konnte in ihrem Inneren Hohlräume konstatieren. Diese sind nichts anderes als seitliche Ausstülpungen des Ventriculus tertius. Als solche erkannte sie auch *Edinger* (1904, S. 151), denn er schreibt: "Zwischen den Ganglien des Lobus inferior ragt der von zentralem Höhlengrau ausgekleidete Ventrikel des Zwischenhirns hinein, mit lateralen Ausstülpungen noch einmal Seitenventrikel des Hypothalamus bildend." Wer nun die mannigfach gefaltete Innenwand der Infundibularhöhle kennt, wird leicht begreifen, warum jene Ventrikel in ihrer Grösse variieren, bisweilen auch ganz und gar fehlen. Sie gehören eben nicht zu den notwendigen

Bestandteilen des Knochenfischgehirnes. Wenngleich *Cuvier* (1828, S. 427) von ihrem seltenen Auftreten spricht, fand sie *Gottsche* (1835, S. 290) an allen von ihm untersuchten Fischen vor. *Handrick* (1901, S. 8) stellte sie an *Argyropelecus* fest, bei *Cyclothone* sind sie nach *Gierse* (1904, S. 630) überhaupt nicht vorhanden. Diese Hohlräume kommunizieren bei *Leucicorus* wie bei *Argyropelecus hemigymnus*, *Esox lucius*, *Trigla gurnardus* und anderen Teleostiern mit der Infundibularhöhle, *nicht* aber durch diese mit der Hypophyse wie bei jenen Knochenfischen.

Unter allen Teilen des Hypothalamus ist der *Saccus vasculosus* (Taf. **1**, Fig. 1–4, 6; Taf. **2**, Fig. 9 Sac) der grösste. Er ist der basale Teil des Infundibulums, aufs reichlichste mit Blutgefässen versorgt und in seinem mittleren Teile so breit wie der Thalamus. Die äusserst mannigfach verzweigten Hohlräume in seinem Inneren hängen mit der Infundibularhöhle und somit auch mit dem Ventriculus tertius zusammen.

DAS MITTELHIRN.

(Mesencephalon, Corpora bigemina) besteht aus den *Pedunculi cerebri*, den *Lobi optici* und den *Tori semicirculares.*

Die *Pedunculi cerebri* beginnen im Vorderhirn, unmittelbar hinter der Commissura interlobularis, durchziehen unter steter Volumzunahme den Thalamus des Zwischenhirns und stellen bei Leucicorus die Hauptmasse des Mittelhirns vor.

Die *Lobi optici* — sie werden auch Tectum mesencephali genannt — sind es eben, die jedem Fischgehirn das charakteristische Aussehen verleihen. So schreibt *Edinger* (1892, S. 21) über sie folgendermassen: ". . . wer die kleinen Vierhügel des Menschen kennt, wird erstaunt sein, wenn er die ungeheueren Lobi optici eines Fisches oder Vogels sieht." Und so ist es auch. *Nicht wenig war ich daher überrascht, im vorliegenden Fische ein Gehirn vorgefunden zu haben, dessen Lobi optici makroskopisch überhaupt nicht zu erkennen sind.* Erst das mikroskopische Präparat zeigt ihr Vorhandensein an und zugleich ihre *ausserordentliche Reduktion* (Taf. **2**, Fig. 9, 10 Lop.). Wenn schon *Gierse* über das Tectum opticum von *Cyclothone acclinidens* (1904, S. 630, 631) schreibt: "Im Vergleich zu der starken Ausbildung des Tectum opticum bei anderen Knochenfischen, z. B. Rhodeus amarus (*Edinger*, 1900, S. 126, Fig. 183), Salmo fario (*Haller*, B. 1898, Bd. XXVI, Taf. XIII, XIV), Cyprinus carpio (*Mayser*, 1882, Taf. XIX, Fig. 35, Taf. XXI, Fig. 48, 49) ist das Tectum mesencephali bei Cyclothone bedeutend schwächer entfaltet und ragt vor allem nicht so weit nach unten, dass es noch seitlich beiderseits die Mittelhirnbasis umgreift und darüber herabhängt," so muss ich dasselbe Verhalten bei *Leucicorus lusciosus* in einem um vieles erhöhtem Masse in Anspruch nehmen, wovon auch die Darstellung der diesbezüglichen Querschnitte (Taf. **1**, Fig. 8, 9, 10) am besten Zeugnis ablegt. *Gottsche* (1835, S. 262) äusserte die Meinung, dass die Grösse der Augen mit der der Lobi optici in geradem Verhältnisse steht. Gegen diese Ansicht wandte sich *Malme* (1891, S. 10) und behauptete, dass *Gottsche*'s Regel durchaus keine allgemeine Giltigkeit habe. So weist er auf *Ammodytes tobianus* (Taf. III, Fig. 44a) mit kleinen Augen und grossen Lobi optici, und umgekehrt auf *Sebastes viviparus* (Taf. **1**, Fig. 11) mit grossen Augen und kleinen Lobi hin. *Gierse* (1904, S. 630) stimmt *Malme* bei, denn seine Befunde an *Cyclothone* sprechen ebenfalls gegen *Gottsche.* Es ist klar, dass auch ich auf die Seite der zwei letzten Autoren treten muss, nachdem Leucicorus so unansehnliche Loben bei grossen Augen zeigt.

Die Unvollkommenheit des Dachabschnittes gibt sich auch nach einer anderen Richtung hin kund. Im hinteren Teile (Taf. **2**, Fig. 12, Lop) *ist seine mittlere Partie nämlich auf eine ganz niedrige Hirnmasse reduziert, die endlich auch verschwindet und einer einfachen Membran Platz macht.* Dies ist offenbar auf das Hinterhirn zurückzuführen, das sich mit seinem Stammteil (Taf. **2**, Fig. 12 Ctr) nach vorne umlegt. Eine derartige Erscheinung ist bereits von *Klaatsch* (1850, S. 25) an *Cyprinoiden* vorgefunden worden. Jener Autor führt sie dort auf die übermässige Ausbildung der Valvula cerebelli zurück. Auch *Malme* (1891, S. 10, 11) macht eine Erwähnung von der Unvollständigkeit des Tectum opticum "bei Fischen, deren Cerebellum nach vorne gerichtet und an das Mittelhirn gedrückt ist." *Von einer äusseren Längsfurche zwischen dem rechten und linken Lobus opticus ist bei Leucicorus keine Spur vorhanden.*

Der *Torus longitudinalis* (Taf. **2**, Fig. 10 Tol), der median innerhalb des intralobulären Hohlraumes verläuft, besteht wie in der Regel aus zwei symmetrischen eng aneinander liegenden Wülsten, die förmlich eingekeilt zwischen den beiden Lobi optici liegen. *Haller* (1898a, S. 503) fand ihn bei Salmoniden stark erhaben und weit in den intralobulären Hohlraum hineinragend, bemerkt aber zugleich, dass dieses Verhalten nur bei sehr alten Tieren vorkommt. Bei *Argyropelecus* ist der Torus longitudinalis nach *Handrick* (1901, S. 9, Taf. **1**, Fig. 4–6 Tlo) ein einfacher Wulst, bei *Cyclothone* fehlt er nach *Gierse* (1904, S. 631) überhaupt.

Vom Boden und den Seitenwänden des intralobulären Hohlraumes erheben sich hinten die *Tori semicirculares* (Taf. **2**, Fig. 12 Tse) in der Weise, dass sie mit ihren konkaven Innenflächen die Valvula cerebelli (ibid. Valc) ganz einschliessen. Dieser Befund stimmt mit dem *Stiedas* (1868, S. 25) an *Lota vulgaris* und *Handricks* (1901, Taf. **1**, Fig. 6–9) an *Argyropelecus* überein. Ungewöhnlich stark entwickelte Tori semicirculares fand *Klaatsch* (1850, Fig. 84, 85) an *Cyprinus carpio*, und *Gierse* (1904, S. 632, Taf. XIV, Fig. 1, 2, 3 Tse) an *Cyclothone* vor. Namentlich bei dem letzten Fische ist ihr Verhalten merkwürdig, denn sie treten frei hervor, während sie im allgemeinen von den unteren seitlichen Abhängen des Tectum opticum vollkommen verdeckt werden (*Mayser*, 1882, bei Cyprinus carpio, Taf. XXI, Fig. 48 Tor. sem; *Edinger*, 1900, S. 126, Fig. 83, bei Rhodeus amarus; und *Haller*, B., 1898a, Taf. XIII, XIV p, bei Salmo). *Die Tori semicirculares von Leucicorus sind von aussen nicht erkennbar; sie entfalten ihre Grösse nur nach innen.*

Der *Ventriculus tertius*, den wir als schmalen Spalt im Zwischenhirn verlassen haben, geht bei diesem Fisch merkwürdigerweise auf eine kurze Strecke in einen Kanal von rundem Querschnitt über (Taf. **2**, Fig. 9 V_{III}), der sich alsbald unter dem Tectum opticum verbreitert und Divertikel nach beiden Seiten hin sendet. Die in seinem Boden median verlaufende Längsfurche (Taf. **2**, Fig. 10 Lf) gewinnt nach hinten immer mehr und mehr an Tiefe. Sie ist jedoch nur von unbedeutender Länge. Denn durch den obenerwähnten Zusammenschluss der Valvula cerebelli und der Tori semicirculares wird sie vom intralobulären Hohlraume getrennt, tauscht alsbald ihre Rinnenform mit einer im Querschnitte rundlichen ein, und wird zu einem wohlausgebildeten *Aquaeductus sylvii* (Taf. **2**, Fig. 12 AS).

DAS HINTERHIRN

(Metencephalon, Cerebellum, Kleinhirn) (Taf. **1**, Fig. 1, 3 HH) fällt durch seine Grösse auf und übertrifft in dieser Hinsicht alle übrigen Teile des Gehirns. Es besteht aus einem *unpaaren Stammteil* (Taf. **1**, Fig. 1, 3; Taf. **2**, Fig. 11, 12 Ctr) und *einem Paar Seitenteilen* (Taf. **1**, Fig. 1, 3; Taf. **2**, Fig. 11 Tl). *Gottsche* (1835, S. 462) nennt ein solches Kleinhirn ein "Cerebellum trilobatum." Aber auch vor ihm war bereits diese Dreiteilung des Kleinhirns bekannt. So bemerkt *Camper* (1774, S. 181): "Le cervelet form une espèce de cone tronqué qui a deux tuberosités láterales unies avec le cervelet." Und *Arsaky* (1813, S. 19) schreibt: "Hoc monente Cuviero semper azygon est. Vereor tamen ne vir praeclarus hic egregie falsus fuerit. Quamvis enim eum recte pronuntiasse modus, quo cerebellum avibus et quadrupedibus sensim evolvitur probare videatur, tamen plurima in piscibus exstant exempla, quae cerebellum minime tantum ex impari tubercula, sed saepissime ex tribus componi, impari scilicet in medio posito aliquoque tuberculorum pari eiusdem lateribus adstante ostendunt." Auch *Klaatsch* (1850, S. 19) liess diese Verhältnisse nicht unerwähnt.

Wiewohl im grossen ganzen das Kleinhirn von *Leucicorus* sich diesem allgemeinen Typus unterordnet, muss ich dennoch näher darauf eingehen, da es im besonderen einigermassen von dem der bis jetzt untersuchten Tiefseefische abweicht.

Der *Stammteil* (Taf. **1**, Fig. 1, 3; Taf. **2**, Fig. 11, 12 Ctr) hat die Gestalt eines Rotationselipsoids, das unter einem Winkel von 45° aufgestellt ist, von vorn nach hinten abfallend, und überragt die Seitenwülste bedeutend an Grösse und zwar derart, dass er sie von oben ganz verdeckt. Bei *Argyropelecus* sind gerade umgekehrt die Seitenwülste grösser als der Stammteil, und *Handrick* (1901, S. 9) meint, dass die Vergrösserung der ersteren auf Kosten der letzteren geschehen ist. Bei *Cyclothone* sind alle drei Abschnitte "ungefähr gleich stark entwickelt" (*Gierse*, 1904, S. 633). Dass das Vorderende des Stammteiles am Mesencephalon aufruht, habe ich bereits oben erwähnt. Das Hinterende ist scharf abgesetzt und liegt frei auf den Lobi posteriores des Nachhirns.

Die *Seitenwülste* (Taf. **1**, Fig. 1, 3; Taf. **2**, Fig. 11 Tl), identische Bildungen der *Corpora restiformia Haller's*, stehen mit der Mitte des Stammteiles in engstem Zusammenhange. Ich habe sie nur in der Seitenansicht darstellen können, weil sie an Breite weder den auf ihnen lastenden Stammteil, noch das sie tragende Nachhirn übertreffen und daher sowohl in der Ansicht von oben, als auch in der von unten verdeckt sind. In der Länge stehen sie Gebilden ihrer Art weit nach, denn sie hören noch vor dem Ende des Stammteiles auf.

Die Oberfläche des Kleinhirnes von Leucicorus ist vollkommen glatt; Längs- oder Querfurchen sind nirgends zu bemerken, obgleich sie am Teleostier-Kleinhirn nicht ausgeschlossen sind. So lesen wir bei *Gottsche* (1835, S. 459): "Gewöhnlich sieht man am Cerebellum eine mehr oder weniger deutliche Mittellinie, welche bei Gadus und Esox stark ausgedrückt ist, und häufig sieht man ebenfalls eine Querfaserung auf demselben, z. B. bei Gadus aeglefinus sehr deutlich, so dass man mit Recht behaupten kann, der

Typus der höheren Tiere verliere sich bei den Fischen nicht gänzlich." Auf *Mayser's* Darstellungen (1864, Taf. **1**, **2**, ff) ist diese Längsfurche auch mehr oder weniger ersichtlich. Sie entgieng ferner weder *Haller* (1898a, Taf. **12**, Fig. 2) an *Salmo fario*, noch *Malme* (1891, S. 13) an *Anguilla vulgaris*, auch nicht *Gierse* (1904, S. 634, Fig. 1, 20, 21) an *Cyclothone*. Querfurchen sah bereits *Cuvier* (1774, S. 182) am Kleinhirn des *Thunfisches*, und *Malme* (1891, S. 13) bei anderen *Scombriformes* (*Echeneis*, *Elacate*, *Coryphaena*).

Noch ein Bestandteil des Hinterhirns muss hier angeführt werden, der, da er an Querschnitten bereits im Bereiche des Mittelhirns sich zeigt, auch dort schon kurz von mir berührt wurde; es ist die *Valvula cerebelli* (Taf. **2**, Fig. 12 Valc). Sie gehört ihrem Ursprunge nach dem Kleinhirn an und soll daher hier näher besprochen werden. Dieses Gebilde, das nach *Haller* (1898a, S. 512) für das Teleostiergehirn charakteristisch ist, geniesst bei verschiedenen Fischen eine ungleiche Ausbildung. Eine wohlentwickelte Valvula, die weit unter die Lobi optici reicht, besitzt die Forelle (*Rabl-Rückhard*, 1883, Taf. **12**, Fig. 1; *Haller*, B., 1898a, Taf. **16**, Fig. 41); eine sehr kleine dagegen nach *Malme* (1891, S. 14) *Callionymis lyra* und *Agamus cataphractus*, " wo sie nur als zwei ganz schwach hervortretende Anschwellungen an dem Teil des Hinterhirns zu beobachten ist, der die Höhle des Mittelhirns nach hinten begrenzt." Auch bei *Cyclothone* ist sie nach *Gierse* (1904, S. 635) sehr klein und " erreicht nicht einmal den hinteren Rand des Tectum mesencephali, sondern liegt unter dem Vorderteil der Seitenwülste des Hinterhirnes auf dem hinteren Basalteil des Mittelhirnes, sowohl mit diesem als auch den Seitenwülsten (Tl) verwachsen (Fig. 20, Valc)."

Die Valvula cerebelli von *Leucicorus* ist *gut entwickelt*. Sie erreicht zwar nicht die Commissura posterior wie bei den Salmoniden, immerhin aber erfüllt sie den intralobulären Hohlraum bis zur Mitte. Ihre Oberfläche weist keine Faltung auf, sondern nur eine deutlich ausgeprägte Längsfurche. Sonst pflegt des öfteren auch eine Querfurche mit Ueberresten der Pia mater vorgefunden zu werden; diese habe ich hier nicht gesehen.

DAS NACHHIRN

(Myelencephalon, Medulla oblongata, verlängertes Rückenmark) (Taf. **1**, Fig. 1, 2, 3; Taf. **2**, Fig. 11, 12, 13 NH) ist bei *Leucicorus* das stark verdickte vordere Ende des Rückenmarkes, in welch letztes es auch unmittelbar übergeht. Dorsal sitzen ihm die beiden *Lobi posteriores* (Taf. **1**, 1; Taf. **2**, Fig. 13 Lpo) auf. Während den Seiten des Basalteiles die meisten der

Hirnnerven entspringen, birgt er in seinem Inneren den Ventriculus quartus, die Rautengrube (Taf. **2**, Fig. 11 V_{IV}), die in ihrem mittleren Teil durch die Lobi posteriores gedeckt wird, vorn und hinten aber frei liegt.

Ueber die *Lobi posteriores* kann ich einen alten Gewährsmann, *Gottsche* (1835, S. 464), hier sprechen lassen: "Gleich hinter dem kleinen Gehirn kommt ein Paar graulicher Lappen in den meisten Fischen vor, welche sich miteinander über dem vierten Ventrikel verbinden, indem sie in der Mittellinie ein Thal zwischen sich lassen. Aussen ist graue, inwendig weisse Substanz; . . ." Diese Worte passen wohl wegen ihrer Allgemeinheit auf jedes Fischgehirn, so auch auf dieses. Genaueres darüber erfahren wir schon durch *Gierse* (1904, S. 636). Bei *Cyclothone* entstehen sie "schon in der vorderen Region, bald nach dem Auftreten der Seitenwülste des Hinterhirnes" und "bilden daselbst eine Art Schaufel oder Schöpflöffel, in dessen Höhlung der hintere Abschnitt des Stammteiles vom Kleinhirn seinen Platz findet (Taf. **16**, Fig. 21)." Wie die Abbildungen desselben Autors zeigen (Taf. **14**, Fig. 1, 3) sind sie auch deutlich abgesetzt und gut ausgebildet. Dies kann ich von *Leucicorus* nicht sagen: *hier gehen sie unmittelbar ohne äussere Begrenzung aus den Seitenwülsten des Kleinhirns hervor* und nehmen ungefähr dort ihren Anfang, wo das Hinterende des Kleinhirn-Stammteiles aufruht. Das "Thal," von dem *Gottsche* spricht, ist eine longitudinal verlaufende Rinne, die durch die Neigung der beiden Loben gegeneinander hervorgerufen wird und so lang ist wie diese. Auch bei *Argyropelecus* (*Handrick*, 1901, S. 10) beginnt sie bei der Verschmelzungsstelle der Loben und dürfte auch ihr Ende erreichen. "Bei *Cyclothone* dagegen," schreibt *Gierse* (1904, S. 636), "ist die Längsfurche nur an der Verschmelzungsstelle der Lobi posteriores eine kurze Strecke deutlich (Fig. 23 Lp) und ganz am Ende derselben, wo sich infolgedessen eine deutliche Zweiteilung der Lobi nachweisen lässt (Fig. 1 Lp). Zwischen diesen beiden Einkerbungen bilden die beiden Lobi miteinander einen einheitlichen Wulst, ohne jegliche Furchung (Fig. 1, 22, 23 Lp)."

Es erübrigt noch einige Worte über die *Lobi vagales* zu verlieren. Sie sind bei *Leucicorus* äusserlich überhaupt nicht zu sehen und es verrät nur der Ursprung des Nervus vagus, wo wir sie zu suchen hätten. Ein Querschnitt an jener Stelle hat viel Aehnlichkeit mit dem von *Salmo fario* (*Haller*, B., 1898a, S. 399, Textfig. 10). Auch *Handrick* erwähnt sie an *Argyropelecus* mit keinem Worte, wohl aber *Gierse* (1904, S. 636) an *Cyclothone;* und wenn er sie auch in der Beschreibung "im Vergleich zu den Lobi posteriores schwach und unansehnlich entwickelt" nennt, zeigen doch die Abbildungen (Taf. XIV, Fig. 1, 3 Lv), dass ihr Vorhandensein schon äusserlich deutlich erkennbar ist.

Ebensowenig wie die Lobi vagales war der *Lobus impar*, der am Boden der Rautengrube verlaufen soll, aufzufinden. Er ist eben nur ein sekundäres Gebilde (*Goronowitsch*, 1896, S. 4) und fehlt bei anderen Fischen auch, was übrigens schon *Malme* (1891, S. 17) konstatierte.

Das Gehirn von Mixonus caudalis.

Taf. 3, Fig. 1-7, Taf. 4, Fig. 8-13.

Entsprechend der Grösse des Fisches — das mir zugebote stehende Exemplar misst ein halbes Meter — ist auch das Gehirn voluminöser als das des vorhergehenden. Auf den ersten Blick erkennt man, dass auch hier die Gestalt etwas Eigentümliches an sich hat. Der Grund dürfte wohl folgender sein. Die Anforderungen, die an die Augen gestellt werden, sind nicht geringer Art, denn die Sehzentren, namentlich der Thalamus und auch das Tectum opticum, sind sehr gross und verleihen dem vorderen Teil des Gehirnes ein eigentümliches Gepräge. Hinten sind die grossen Labyrinthe auf die Gestaltung der Gehirnteile von demselben Einfluss gewesen, wie ich es bereits auf Seite 223 bei Leucicorus geschildert habe. Trotzdem aber dieser Fisch den vorigen um mehr als eine Körperlänge übertrifft, messen die Otolithen hier kaum zwei Drittel der ersten (Taf. **3**, Fig. 7). In Gestalt kommen sie ihnen nahezu gleich.

DAS VORDERHIRN

Taf. 3, Fig. 1, 2, 3, VH

von *Mixonus* lässt makroskopisch zwei Teile, die *Corpora striata* und die *Bulbi olfactorii* leicht, den dritten Teil, die *Tractus olfactorii*, weniger gut erkennen. Dieser Umstand, den auch die mikroskopische Untersuchung bestätigt, weist darauf hin, dass wir es nach *Rabl-Rückhard* (1883, S. 308) "mit sitzenden, verwachsenen Tractus und einander genäherten Bulbi, bei langen Nervi olfactorii (Salmonidentypus)" zu tun haben. Die *Bulbi olfactorii* (Taf. **3**, Fig. 1, 2, 3, 5 Bol) sind im Verhältnis zur Gehirngrösse klein, gleichsam unscheinbare Anschwellungen der aus ihnen hervortretenden starken *Nervi olfactorii* (Taf. **3**, Fig. 1, 2, 3, I). Die kurzen Tracti olfactorii (Taf. **3**, Fig. 4, Trol) bilden eine verschmolzene Masse, in deren basalem Teile ein Kanal, die Fortsetzung des Ventriculus communis, nach vorne verläuft und frei in die Cranialhöhle endet. Ganz dem Salmonidentypus entsprechend gehen die letzteren nach hinten unmittelbar ohne jede besondere Begrenzung in die

Corpora striata (Taf. 3, Fig. 6, Taf. 4, Fig. 8 Cs) über. *Diese haben die besondere Eigentümlichkeit, dass die von Haller* (1898a, S. 617) *unterschiedenen Teile sich in Grösse gerade umgekehrt verhalten als sonst; es ist nämlich hier der basale Teil der breitere, während der dorsale ihn an Grösse nicht erreicht.* Lateral verläuft eine longitudinale Furche (Taf. 3, Fig. 6 F) als Grenze zwischen beiden. Bezüglich des Bodens, der das rechte Corpus mit dem linken verbindet, und der Commissura interlobularis verweise ich auf meine Schilderung auf Seite 224, um sie nicht wiederholen zu müssen, nachdem die Verhältnisse hier gleich denen dort liegen. Die hintere untere Grenze des Vorderhirnes ist durch das *Chiasma nervorum opticorum* gegeben. *Dieses zeigt aber bei Mixonus ein ganz eigentümliches Verhalten.* Die Sehnerven entspringen bekanntlich zum grossen Teile aus dem Tectum opticum (*Edinger*, 1904, S. 127). Ihre Faserbündel umziehen den Thalamus in der Richtung von hinten oben nach vorn unten, um an der Hirnbasis vor dem Infundibulum auszutreten und das bekannte Chiasma zu bilden. Die Art der Nervenkreuzung ist bei verschiedenen Tieren auch sehr verschieden. Es handelt sich zunächst darum, ob sie total oder partiell ist. *Edinger* (1904, S. 157) meint, dass sie wohl mit der Stellung der Augen in innigem Zusammenhange steht; bei frontaler Lage der Augen (Mensch, Affe) ist eine totale Kreuzung nicht unbedingt notwendig, da die Bilder der medialen Teile zusammenfallen; daher tritt in diesen Fällen nur partielle Kreuzung ein. Bei Fischen, wo die Augen vollkommen lateral stehen, sind die Gesichtsfelder total verschieden und daher die Kreuzung überall total. Es ist nun Regel bei den Knochenfischen, dass der Nervus opticus der linken Seite sich einfach über den der rechten hinüberlegt. Gleichwohl macht aber *Wiedersheim* (1898, S. 235) auf *Harengus* und *Engraulis* aufmerksam, wo der eine Nerv durch einen Schlitz des anderen hindurchtritt. Auch *Edinger* (1904, S. 158) lässt diese Erscheinung nicht ausser acht. Im allgemeinen gehen die Sehnerven nach der Kreuzung unmittelbar auseinander. *Bei Mixonus caudalis machte ich aber folgenden Befund. In dem Chiasma der Nervi optici* (Taf. 3, Fig. 3, 6 Ch) *tut sich eine derartige Verflechtung der beiden Nerven kund, dass nähere Verhältnisse der Art von Verkreuzung sich absolut nicht erkennen lassen. Als einheitlicher Stamm, und zwar ganz plattgedrückt, nicht von rundem Querschnitt, verlassen die Sehnerven die Hirnbasis. Diese Nervenplatte begleitet das Vorderhirn vom Infundibulum bis unter die Bulbi olfactorii. Erst nahe unter dem Vorderende der letzten erfolgt die Auflösung in die beiden Nervi optici* (Taf. 3, Fig. 1, II). Eine Bindegewebslage von ziemlicher Dicke umgibt das lange Chiasma von seinem Ursprunge an allseits. *Die Sehnerven gehen also hier nicht* "gleich nach der Kreuzung" (*Stannius,* 1849, S. 13) *auseinander, sondern verlaufen ein Stück des Weges gemeinsam am Boden der Schädelhöhle und verlassen sie erst später.* Einen ähnlichen Fall beschreibt *Gierse* (1904, S. 639) bei *Cyclothone.* Allerdings hat das Chiasma dort nicht die Dimensionen und die Gestalt des vorliegenden.

DAS ZWISCHENHIRN.

Taf. 3 Fig. 1, 2, ZH.

Der *Epithalamus* des Zwischenhirnes besteht aus dem *Plexus chorioidei* (Taf. **4**, Fig. 8 Plch) und den *Habenularganglien* (Taf. **4**, Fig. 9 Gh). Der erste erreicht bei weitem nicht jene Dimensionen wie bei *Leucicorus.* Die Blutgefässe treiben die einfache Epithellage vor sich hin und erzeugen auf diese Weise Falten von unbedeutender Höhe. Derartige Verhältnisse, die auch bei anderen Fischen vorgefunden werden, dürften einst manche Autoren glauben gemacht haben, dass es wahre Plexus chorioidei bei den Fischen nicht gebe.

Der zweite Teil, die *Ganglia habenulae,* nehmen die normale Lage ein, "am hinteren Seitenrand der dorsalen Zone" (*Wiedersheim,* 1902, S. 211; *Ahlborn,* 1883, S. 228; *Haller,* B., 1898a, Taf. XVI, Fig. 41 gh). Es sind zwei vollkommen symmetrische, lobuläre Gebilde von bedeutender Grösse, die auch makroskopisch dem Beobachter nicht entgehen können. Nur im hinteren Teile ist ihre Lage eine versteckte. Der Grund hiefür liegt aber nicht darin, dass das Zwischenhirn in die Tiefe gerückt und durch das übermässig ausgebildete Mittelhirn von oben her verdeckt wird — dies kommt nämlich bei Fischen sehr häufig vor (vergl. *Stieda,* 1873, S. 446) — nein, *hier ist es vielmehr der Thalamus* (Taf. **2**, Fig. 9 T), *der die Ganglia habenulae umgreift, indem er mächtig anschwillt, sie in die Tiefe drängt und schliesslich, nachdem sie selbst an Volumen zugenommen haben, hinten in sich aufnimmt.* Die Commissur (Taf. **4**, Fig. 9, 10 Com), welche das rechtseitige Ganglion mit dem linkseitigen verbindet, bildet nur vorne eine kurze Strecke eine Furche, ist aber sonst erhaben.

DER PINEALAPPARAT

von *Mixonus* setzt sich aus einem *Pineal-* und einem *Parapinealorgan* zusammen.

Es ist bis jetzt überhaupt nicht bekannt, welche Bedeutung diese Organe haben sollen. *Leydig* gebührt das Verdienst, das erstere entdeckt zu haben;

Graaf und *Spencer* haben es eingehend untersucht, und *Klinckowström* seinen nervösen Zusammenhang mit dem Gehirne und zwar den Habenularganglien festgestellt. Wenn *Haller* (1898a, S. 569, Taf. XVI, Fig. 41, Taf. XXII, Fig. 80) wie aus seinem Texte und namentlich den Abbildungen hervorgeht, den Ursprung der Epiphysendrüse bei Fischen hinter die Basalganglien, an die Grenze zwischen Dien- und Mesencephalon setzt, so weicht hierin Mixonus insofern ab, als seine Epiphyse vorne aus den Ganglien habenulae entspringt, also eine vorgeschobene Stellung einnimmt. Hier sind vielmehr die Worte *Fritsch's* (1878, S. 19) am Platze, der diesbezüglich von der Zirbeldrüse schreibt: "Sie bezeichnet gewissermassen die Grenzmarke zwischen dem Vorder- und Zwischenhirn."

Ehlers (1878), der als erster die Zirbel bei Haien und Rochen einer eingehenden Bearbeitung unterzog, unterscheidet an ihr drei Teile, die auch von anderen Forschern nach ihm stets genannt werden; es sind dies ein proximaler oder cerebraler, ein medialer, und ein distaler oder cranieller. Der erste pflegt "schwach kegelförmig gegen die mittlere Strecke sich verjüngend" zu sein, der zweite repräsentiert den Stiel, der dritte das Ende des Pinealorganes. Diese Teile werden auch bei *Mixonus caudalis* unterschieden, wenngleich sich das Ende des Pinealorganes meiner Untersuchung entzog. Die Epiphyse beginnt im rechten Ganglion habenulae wie sonst mit einer kleinen Anschwellung, die sich alsbald in einen Stiel (Taf. **3**, Fig. 1, 2; Taf. **4**, Fig. 8 Est) verwandelt. Dieser bewahrt bei *Acanthias* (*Ehlers*, 1878, S. 61) gleiche Dicke im Gegensatz zu *Raja*, wo der Stiel die Verjüngung der Ursprungsstelle bis zum feinsten Faden fortsetzt. In seinem Anfang ist er solid, wohl aber nur eine kurze Strecke; die weitaus längere ist er hohl, also ein Schlauch. Ob seine Cavität auch auf den distalen Teil übergeht, konnte ich nicht feststellen. Sollte dies aber der Fall sein, dann hätten wir dieselben Verhältnisse wie sie *Hill* (1894, S. 248) bei *Salmo fario* schildert: "The distal part and the distal portion of the stalk retain the cavity, but the proximal portion of the stalk (not shown in the figure) has become solid." Gerade umgekehrt fand es *Klinckowström* (1893, S. 563) bei *Callichthys* (asper und litoralis), wo das proximale Ende des Stieles schlauchförmig, der distale Teil des Pinealorganes solid ist. Ein massiver Stiel mit solidem distalen Ende pflegt bei Fischen öfter vorzukommen, wofür *Cattie's* (1882) Untersuchungen sprechen. Auch an dem Tiefseefische *Cyclothone* ist es so (*Gierse*, 1904, S. 623), während *Argyropelecus* einen soliden Stiel, im Endteil aber eine Cavität zeigt (*Handrick*, 1901, S. 37).

Das *Parapinealorgan* von *Mixonus* (Taf. **3**, Fig. 2, 6; Taf. **4**, Fig. 8 P) ist, wenn auch bedeutend kürzer als das Pinealorgan, doch gut ausgebildet. An der Ursprungsstelle jenem im Querschnitte gleichend, verjüngt es sich nicht, sondern schwillt keulenförmig gegen sein Ende an. Es reicht nicht über die Corpora striata hinaus. *Abweichend von den bisherigen Befunden musste ich konstatieren, dass dieses Organ bei Mixonus durchwegs solid ist.* Es fiele mir auf Grund dieser Untersuchung schwer, es als das zu erkennen, was es wirklich sein soll und ist, nach *Hill* (1894, S. 209) nämlich eine Ausstülpung des Ventriculus communis. Auf eine solche konnte es auch *Gierse* an *Cyclothone* zurückführen, denn "es ist ein in seiner ganzen Ausbildung von einem zentralen Längskanal durchzogener Schlauch, dessen Lumen beim Austritt vor das Gehirn ungefähr kreisrund ist und sich in seinem distalen Endteil in einen schlitzförmigen Spalt verengt. . . . Das Parapinealorgan von Cyclothone ist also wirklich eine Ausstülpung des Ventriculus communis (*Gierse,* 1904, S. 624)." *Handrick* (1901, S. 39) beschreibt es bei Argyropelecus mit folgenden Worten: "Es ist im wahrsten Sinne des Wortes ein kolbenförmig gestaltetes häutiges Bläschen (End), das caudalwärts in einen röhrenförmigen häutigen Stiel (E'st) ausläuft." Daraus geht aber hervor, dass für manche Fische eine dorsalwärts gerichtete Ausstülpung — Paraphyse — feststeht, wie sie übrigens bei allen Vertebraten vorhanden ist. *Edinger* hält sie noch 1904, S. 137, bei Knochenfischen für unsicher, wohl aber nur in dem Sinne, als ihr Vorkommen bei dieser Vertebratenreihe kein allgemeines ist.

Pineal- und Parapinealorgan von Mixonus verlaufen auf der Habenularcommissur nicht übereinander, sondern nebeneinander. Dieses Verhalten ist neu und äusserst wichtig für die Hypothese *Hill's.* Jener Forscher, dem die Entdeckung des Pinealorganes bei Knochenfischen vorbehalten war, kam auf Grund entwicklungsgeschichtlicher Studien an Salmo fontinalis, purpuratus, und fario zu dem Schlusse, dass die Epiphysen ursprünglich nebeneinander lagen (1894, S. 259). *Handrick* konnte sich für diese Hypothese nicht entscheiden (1901, S. 39), da am Argyropelecus eine etwas verschobene Lage des Parapinealorganes nur an einem Exemplare vorgefunden wurde. Noch weniger vermochte *Gierse* (1904, S. 625) mit *Cyclothone Hill's* Ansicht zu bestätigen, da das Pinealorgan streng median über dem Parapinealorgan verläuft. Die extramediane Lage bezieht sich nur auf einen Teil des Stieles. *Hier ist die Nebeneinanderlage, wenn auch nicht bis an das Ende, doch zum grossen Teile und zwar an einem entwickelten Tier, nicht am Embryo vorgefunden worden* (Taf. **4**, Fig. 8 P, Est).

Wenn *Edinger* (1904, S. 136) den Thalamus als die Hauptmasse des Diencephalon bezeichnet, so liefert hiefür auch *Mixonus* ein gutes Beispiel. Ich habe bereits bei den Gangliae habenulae (vergl. S. 238) auf seine übermässige Ausbildung und die Folgen derselben hingewiesen. Trotz seiner Grösse ist es aber auch an diesem Fische unmöglich, ihn nach vorn oder hinten deutlich abzugrenzen. Ja gerade im hinteren Teile steigt er zu so einer Höhe heran, dass er unmittelbar in das Tectum opticum übergeht. In seinem Inneren dehnt sich der *Ventriculus tertius* (Taf. **4**, Fig. 9, 10, V_{III}) aus, der durch Verschmälerung aus dem Ventriculus communis hervorgegangen ist und mit Ausnahme des oberen erweiterten Teiles Spaltform besitzt. Er kommuniziert unten mit der Infundibularhöhle. Die Aussenseite weist die *Lobi laterales* (Taf. **3**, Fig. 1, 3; Taf. **4**, Fig. 11 Ll) und die dem Hypothalamus bereits angehörenden *Lobi inferiores* (ibid. Li) auf. Rostralwärts sind die beiden kaum von einander geschieden und erscheinen als einziger mächtiger Wulst. Caudalwärts tritt zwischen beiden eine Längsfurche auf, die zwar in der Mitte genug tief ist, noch vor dem Ende der Loben aber verschwindet. *An Grösse stehen die Lobi laterales den inferiores nach; es wäre somit Haller's Hypothese* (vergl. S. 227) *hier zutreffend, hier speziell, da man die ersten aus den letzten vorne entstehen und hinten in ihnen aufgehen sieht.*

Der basale Teil des Zwischenhirns, der *Hypothalamus,* ist bei *Mixonus* sehr breit und ausserordentlich lang; reicht er doch über das gewohnte Mass hinaus und endet erst unter dem Hinterhirn. Seine Bestandteile sind das *Infundibulum* mit der *Hypophyse,* der *Saccus vasculosus,* und die *Lobi inferiores.*

Das *Infundibulum* (Taf. **3**, Fig. 1; Taf. **4**, Fig. 9, 10 J) bildet die Seitenwände und den Boden der mit zahlreichen Divertikeln versehenen Infundibularhöhle (Taf. **4**, Fig. 10 Jh), welche natürlich als Ausstülpung des Zwischenhirnventrikels mit diesem zusammenhängt. Median findet dieser Hohlraum seine Fortsetzung nach vorn unten in dem Hypophysenstiel, zu dem sich das Infundibulum verjüngt.

Der *Hypophysenstiel* (Taf. **3**, Fig. 1, 3; Taf. **4**, Fig. 8, 9 Hst) *ist sehr lang.* Ein solcher kommt bei Fischen, wie ich schon bei *Leucicorus* erwähnte, seltener vor. *Gottsche* (1835, S. 433, 434) war er bekannt; er fand ihn am längsten an *Lophius piscatorius* und *Clupea alosa,* verglich ihn mit einer "Nabelschnur" und nannte die an seinem Ende hängende Hypophyse eine "Hypophysis pedunculata." Andere Vertreter mit langem Hypophysenstiel führt *Malme* (1891, S. 29, 42, 43) in den Familien der *Atherinidae, Cyprinidae,* und *Characinidae* an. Von den bis jetzt untersuchten Tiefseefischen ist

Cyclothone hier zu nennen. Auffälliger aber als die Länge ist für den Hypophysenstiel von *Mixonus* der Umstand, dass er *hohl* ist. So wurde er nur noch an *Lophius piscatorius* gefunden (*Fritsch*, 1878, S. 23, Fig. 17, 18 Taf. II). Während sich *Fritsch* über die Natur des Schlauches nicht näher ausdrückt, muss ich bemerken, das der vorliegende durchaus *nervösen* Charakter aufweist.

Die *Hypophyse* (Taf. **3**, Fig. 1 H) liegt zwischen Basi- und Praesphenoid. Diese Lage ist bei Fischen, ob mit kurzem oder langem Hypophysenstiel, allgemein. *Haller* (1898, S. 60) fand sie so ursprünglich an Selachierembryonen, konstatierte aber dann, dass dieser Zustand verloren geht und die Sphenoidalknorpel miteinander verwachsen. Bei den Salmoniden bleibt jedoch nach der Angabe desselben Autors die embryonale Lage der Hypophyse zeitlebens erhalten. Das Grübchen, das die Hypophyse aufnimmt, ist bei den *Characinidae* seicht, bei den *Cyprinoidae* tief (1891, S. 43). *Mixonus* gleicht in dieser Beziehung den ersten. Seine Hypophyse hat überdies nicht die gewohnte Bohnenform, sondern die einer flachgedrückten Linse.

Der *Saccus vasculosus* (Taf. **3**, Fig. 1, 3; Taf. **4**, Fig. 11 Sac) ist unbedeutend und scheint zwischen den mächtigen Lobi inferiores nahezu ganz unterdrückt. Das Lumen des Infundibulum findet in ihm zentral seine Fortsetzung; die Wände sind reich gefaltet und mit vielen Blutgefässen versorgt. Noch vor dem Ende der Lobi inferiores, die medial bis zur Berührung aneinander treten, in einen ganz schmalen Spalt eingeengt verschwindet er.

Die *Lobi inferiores* (Taf. **3**, Fig. 1, 3; Taf. **4**, Fig. 10, 11 Li) von denen ich schon gelegentlich der Lobi laterales und des Saccus vasculosus einiges vorausgeschickt habe, biegen aus ihrer seitlichen Lage im hinteren Teile gegen die Mediane unter das Mittelhirn ein. Sie sind sehr voluminös, reichen hinten bis unter das Hinterhirn und übertreffen den Saccus an Länge. Dies letztere trifft bei Knochenfischen vielleicht ebensohäufig zu wie das umgekehrte; wenigstens gehören von den 27 Familien, die *Malme* (1891) in seiner Arbeit anführt 10 der ersten und 17 der anderen Art an; bei den übrigen halten sich Lobi inferiores und Saccus ungefähr das Gleichgewicht. Im Inneren eines jeden Lobus ist ein kleiner Hohlraum, der in Anbetracht der grossen Hirnmasse seines Trägers leicht übersehen werden kann. Das Ende der Loben weist dorsal und ventral eine kurze Längsfurche auf.

Noch eines muss hier in Bezug auf die Lobi inferiores und laterales erwähnt werden, dass sie nämlich trotz ihrer guten Entwicklung keine scharfe Abgrenzung nach vorne oder hinten zeigen; dadurch aber büssen sie den gewohnten *lobulären* Charakter, an dessen Stelle der ausgesprochen *wulstige* tritt, vollkommen ein. Ich argwöhnte anfangs, ob dieser Umstand nicht eine Folge der Schrumpfung sei, überzeugte mich alsbald von der Unzulänglichkeit meiner Annahme dadurch, dass ich nach dem Oeffnen der Cranialhöhle anderer Fische ebendieser Sammlung jene obenerwähnten Teile deutlich lobulär ausgeprägt vorfand.

DAS MITTELHIRN.

Von einem normalen Teleostier-Mittelhirn schreibt *Edinger* (1904, S. 121), dass es enorm gross ist und dass nur die Oblongata, welche alle die gewaltigen Hirnnerven des Fisches aufzunehmen hat, ihn an Ausdehnung erreicht. So trifft es auch bei *Mixonus caudalis* zu. Namentlich sind es die *Lobi optici* (Taf. **3**, Fig. 1, 2, 3; Taf, **4**, Fig. 11 Lop), die diesem Gehirnteile jene Grösse verleihen. Das Gehirn erreicht in ihnen das Maximum an Breite, so dass sie auch in der Ansicht von unten vorragen. Auffallend an ihnen ist, dass sie jeder kugeligen Ausbildung, ebenso wie die bereits genannten Loben des Zwischenhirns entbehren und *ganz flach* sind. Dies gilt von ihrer ganzen Länge, namentlich aber vom hinteren Teil, wo auch der Grund sehr nahe liegt: es ist der von oben her auf ihnen lastende Stammteil des Kleinhirns, der sie so flachdrückt. Die mediane Longitudinalfurche ist deutlich ausgebildet.

Der *Torus longitudinalis* (Taf. **4**, Fig. 11 Tol) verläuft median in der Decke des intralobulären Hohlraumes. Er ragt ganz frei hinein wie bei Salmo fario und besteht aus zwei Wülsten, denen wiederum lateral aussen je ein sekundärer Wulst aufsitzt. Ein solcher *vierwulstig r* Torus ist an Fischgehirnen bis jetzt *nicht* beobachtet worden.

Die Hirnmasse des Tectum opticum nimmt von vorn nach hinten ab. Ihr gewaltiges Volumen im vorderen Teile würde ich ebenso wie *Handrick* (1901, S. 8) "lediglich auf die excessive Ausbildung der Augen" zurückführen, wenn nicht *Gierse* (1904, S. 631) gezeigt hätte, dass auch bei kleinen Augen viel Hirnmasse im Tectum opticum vorkommen kann. Die Abnahme der Hirnsubstanz im rückwärtigen Teile des Tectum habe ich wie bei *Leucicorus* als Unvollkommenheit desselben bei Fischen mit vorgestülpten Stammteil des Cerebellums erkannt. Hier ist übrigens die Reduktion nicht so stark, da die Lobi optici der Valvula cerebelli und dem Kleinhirn nach rechts und links ausweichen, um nicht ganz unterdrückt zu werden.

Wenn ich erklären muss, dass das intralobuläre Lumen trotz der Grösse des Mittelhirndaches gering ist, so ist dies folgenden Faktoren zuzuschreiben: ausser der bereits erwähnten mächtigen Hirnmasse der Lobi optici, der stark gehobenen Pars peduncularis, und der Valvula cerebelli.

Die *Valvula cerebelli* (Taf. **4**, Fig. 12 Valc) erstreckt sich bis in die Mitte des Hohlraumes und wird seitlich von den *Tori semicirculares* (Taf. **4**, Fig. 12 Tse) zur Hälfte eingeschlossen. Diese letzten sind schwach entwickelt und zeigen ebensowenig wie bei Leucicorus eine Spur äusserer Umgrenzung. Es ist wohl anzunehmen, dass sie in den Seitenteilen des Tectum opticum aufgehen. Der Boden der Höhlung ist, wie oben erwähnt, durch die *Pars peduncularis* (Taf. **4**, Fig. 10) gehoben. Eine median in ihm verlaufende Furche (Taf. **4**, Fig. 11 Lf) ist vorhanden. Ueber eine solche schreibt *Handrick* (1901, S. 9): "Im Boden des durch die Lobi optici gebildeten Hohlraumes, über der Pars peduncularis des Mittelhirns beginnt gleichfalls eine Längsfurche, welche bei *Argyropelecus* während ihres Verlaufes nach hinten zunächst mit dem hinteren Teile des Ventriculus tertius kommuniziert und dann als Aquaeductus unter dem Kleinhirn verlaufend in den Ventriculus quartus mündet (Taf. **1**, Fig. 6–10; Lf)." Ebenso fand es *Gierse* (1904, S. 632) bei Cyclothone. Beide Autoren weisen auf *Stieda* (1868, S. 25) hin, der bei *Gadus lota* auch von jener Furche spricht; sie soll dort aber bereits *unter der Valvula cerebelli verschwinden.* Durch diese Worte wäre man zu der Annahme verleitet, dass hiedurch die Verbindung zwischen dem dritten und vierten Ventrikel aufgehoben wird. Dem ist nun nicht so; denn derselbe Autor schreibt eine Seite früher (S. 24): "Unter diesem mit einer Längsfurche versehenen Körperchen," er meint die Valvula cerebelli, "wird die Verbindung des vierten Ventrikels mit der Höhle des Sehlappens vermittelt." Ich verstehe die Worte *Stieda's* dahin, dass gerade so, wie bei *Mixonus caudalis,* die wenn auch tiefe Längsfurche im Boden des Ventriculus tertius verschwindet, *nur aber als solche,* während das übrige Lumen des Ventrikels auf einen schmalen unscheinbaren Kanal von rundem Querschnitt, den *Aquaeductus Sylvii,* reduziert wird. Die Abbildungen der Querschnitte seitens *Handrick's* (1901, Taf. **1**. Fig. 7, 8, 9) und seitens *Gierse's* (1904, Taf. XVI, Fig. 20) weisen auch eine Furche im Boden des Aquaeductus auf, die bei *Mixonus* nicht vorhanden ist.

DAS HINTERHIRN

Taf. 3, Fig. 1, 2, HH

von *Mixonus* ist der mächtigste unter allen Teilen des Gehirnes. Es vermag uns aber weniger Interesse abzugewinnen, da es nach dem gewohnten Typus eines "Cerebellum trilobatum" gebaut ist, ohne irgendwelche besondere Abweichungen zu zeigen. Die schon *Camper* bekannten drei Teile, der unpaare mittlere und die paarigen seitlichen, stehen im umgekehrten Verhältnisse als bei *Leucicorus,* denn die letzten übertreffen den ersten an Masse und Länge.

Der *Stammteil* (Taf. **3**, Fig. 1, 2; Taf. **4**, Fig. 12, 13 Ctr) hat regelmässige Halbkugelform. Sein Vorderende drängt sich (vergl. S. 242) zwischen die auseinanderweichenden hinteren Partien der Lobi optici hinein. Das Hinterende ist nicht verschmälert, sondern rund, und geht in den Lobi posteriores (Taf. **4**, Fig. 13 Lpo) auf, denn diese "schieben sich," um *Gierse's* Worte zu gebrauchen, "zwischen Stammteil und die in ihrem vorderen Abschnitte in der Mitte zusammenhängenden Seitenteile und stellen so eine Verbindung zwischen den Teilen des Kleinhirns her."

Die *Seitenwülste* (Taf. **3**, Fig. 1. 2, 3; Taf. **4**, Fig. 13 Tl), gehen vorne allmählich aus dem Stammteil hervor und sind daselbst nicht genügend abgegrenzt. Dennoch kann man annehmen, dass sie ihren Anfang ungefähr in der Mitte des Stammteiles haben. Sie biegen seitlich nach unten um und reichen weit über das Ende desselben hinaus.

Längs- oder Querfurchen sind an der Oberfläche des Kleinhirns nicht wahrzunehmen.

Die *Valvula cerebelli* (Taf. **4**, Fig. 12 Valc) gehört zu den mittelmässig entwickelten und überschreitet nicht das hintere Drittel des Tectum opticum. Dort, wo ihr die Lobi optici Platz machen (vergl. S. 243) würde sie eigentümlicherweise *frei* liegen, wenn nicht das Cerebellum hier den Abschluss bildete.

DAS NACHHIRN

Taf. 3, Fig. 1, 2, 3; Taf. 4, Fig. 13 NH

von *Mixonus* hat viel Aehnlichkeit mit dem des *Leucicorus lusciosus.* Es umgibt mit seiner Hirnsubstanz, die ganz gewaltig ist, den vierten Ventrikel (Taf. **4**, Fig. 12, 13 V_{IV}). Von seinen besonders differenzierten Teilen sind nur die *Lobi posteriores* (Taf. **3**, Fig. 1, 2, Taf. **4**, Fig. 13 Lpo) zu nennen. Sie setzen bereits zwischen dem Stammteil und den Seitenwülsten des Cerebellums ein. Eine innere Abgrenzung dieser drei Teile gegeneinander ist nicht zu erkennen; sie sind zu einer einheitlichen Masse verschmolzen und nur äussere Anschwellungen zeigen, wo sie beginnen. Unmittelbar hinter dem Stammteil des Kleinhirns öffnet sich der geräumige *Ventriculus quartus* nach oben und wird nur durch ein Choroidalgeflecht bedeckt. Die Lobi posteriores verlaufen zu seinen beiden Seiten und man sieht, dass sie mehr als mit der Hälfte der gesammten Hirnmasse des Nachhirns an dem Aufbaue des letzten beteiligt sind. Nach hinten nehmen sie an Höhe ab, gehen dafür mehr in die Breite und erlangen schliesslich die Ausbildung von dicken gegeneinander geneigten Platten, die nach der Mediane bis zur Berührung zusammenrücken, *ohne indessen miteinander zu verschmelzen.* Das "Thal" *Gottsche's* ist demzufolge während ihres ganzen Verlaufes schön zu beobachten. Die geräumige Rautengrube, die sich unterhalb der Berührungstelle der Lobi posteriores in einen schmalen Kanal verwandelt hat, erweitert sich hinten nochmals und zwingt jene Loben zum Auseinanderweichen; kurz vor den Ursprungsstellen des Vagus verschwinden sie gänzlich.

Lobi vagales und ein *Tuberculum impar* sind bei *Mixonus* nicht vorhanden.

Das Gehirn von Bassozetus nasus.

Taf. 5, Fig. 1-8, Taf. 6, Fig. 9-17.

Auch dieses Gehirn zeigt sich in der Totalansicht (Taf. 5, Fig. 1–3) weniger gut mit dem normalen Physostomentypus übereinstimmend. Einerseits muss die langgestreckte Form, dabei aber andererseits die Zusammenschiebung der einzelnen Teile auffallen. Auch hier verteilen sich die Ursprungsstellen der zehn Fischgehirnnerven auf folgende Weise: I, II, III, IV, V + VII + VIII, VI, IX + X. Auf die Ursache dieser Verhältnisse hinzuweisen hatte ich bereits bei den vorhergehenden Fischen Gelegenheit und füge hier die Fig. 8 auf Taf. 5 bei, welche die geräumigen Sacculi zu den Seiten der Medulla oblongata deutlich zeigt.

Die Cranialhöhle dieses Fisches bietet dem Gehirne bei weitem mehr Platz als dieses namentlich mit dem vorderen und mittleren Teile in der Tat einnimmt.

DAS VORDERHIRN

Taf. 5, Fig. 1, 2, 3 VH

ist verhältnismässig gross. Die Unterscheidung seiner Bestandteile, die Tracti olfactorii ausgenommen, liesse sich wohl auch mit der Lupe bereits durchführen.

Die Hauptmasse stellen die deutlich lobulär ausgebildeten *Corpora striata* (Taf. 5, Fig. 6; Taf. 6, Fig. 9 Cs) vor, während die *Bulbi* (Taf. 5, Fig. 5 Bol) und die *Tracti olfactorii* (Taf. 5, Fig. 6 Trol) ganz in den Hintergrund treten. Die letzten sind äusserst kurz, nur an mikroskopischen Präparaten erkennbar, dafür aber durch eine deutliche Grenze von den Streifenhügeln geschieden. Nach hinten nehmen aus ihnen die Pedunculi cerebri ihren Anfang, nach vorne gehen sie ohne Begrenzung in die unansehnlichen *Bulbi olfactorii* über, die sich alsbald zu den Riechnerven (Taf. 5, Fig. 1, 2, 3, I) verjüngen. Für den *Ventriculus communis* (Taf. 5, Fig. 5, 6, 7 Vc) bleibt im Vorderhirn nur wenig Platz in Form der bekannten T-förmigen Spalte übrig. Dadurch, dass das ihn deckende Pallium vorne frontal mit den Bulbi verwächst, findet er einen vollkommenen Abschluss, ohne etwa in die Cranialhöhle frei auszumünden (Argyropelecus, Leucicorus, Mixonus).

Das Vorderhirn von Bassozetus gehört unzweifelhaft dem Salmonidentypus an; eine kleine Abweichung zeigt es insofern, als die Bulbi olfactorii dorsal mit einander verschmolzen sind (Taf. 5, Fig. 5).

DAS ZWISCHENHIRN

Taf. 5, Fig. 1, 2 ZH

liegt wie überall dort, wo nicht mächtige Lobi optici darauf lasten, ganz frei (Taf. 5, Fig. 1, 2 ZH).

Der *Epithalamus* besteht aus dem *Plexus chorioidei* und den *Ganglia habenulae.* Der erste (Taf. 6, Fig. 9 Plch) kommt an Grösse dem von Leucicorus nahezu gleich, nimmt viel Raum für sich in Anspruch, weshalb die letzten zurücktreten müssen. Die *Ganglia habenulae* (Taf. 5, Fig. 7 Gh) sind äusserlich kaum angedeutet, an Querschnitten im Mikroskope sehr leicht erkennbar. Das rechte liegt weiter hinten als das linke und ist auch etwas kleiner als dieses. *Die Habenularganglien sind also hier assymmetrisch.* Die mediane Kommissur, welche die Haubenganglien miteinander verbindet, bildet eine seichte Furche, die nach hinten an Tiefe abnimmt und endlich dort, wo die Ganglien in die Seitenteile des Thalamus übergehen, sich ganz ausflacht.

DER PINEALAPPARAT

von Bassozetus weist ein Pineal- und ein Parapinealorgan auf. An dem ersten lassen sich die gewohnten drei Teile unterscheiden: 1. Der proximale Endteil (Taf. 5, Fig. 7 E'st); er geht als ein kegelförmiger Zapfen aus dem rechten Haubenganglion nahe der Mediane hervor, ist massiv, histologisch analog seinem Ursprungsherd zusammengesetzt. 2. Der Stiel (Taf. 5, Fig. 1, 2, 3, 4, 6; Taf. 6, Fig. 9 Est); er ist dünn aber lang, verläuft median, reicht weit über die Bulbi olfactorii hinaus und ist dorsoventral zusammengedrückt. Er zeigt durchwegs nervösen Charakter und schwillt an seinem Ende an. 3. Der distale Endteil (Taf. 5, Fig. 1, 2, 3; Taf. 6, Fig. 11, 12 E); er ist infolge des langen Stieles weit vorgeschoben und an die Innenseite des Schädeldaches in der Gegend der sogenannten Epiphysarspange befestigt und hat eirunde Form. Sein histologischer Bau lässt zwei von einander verschiedene Zonen, eine grob- und eine feinkörnige, deutlich unterscheiden. Die erste (Taf. 6, Fig. 11, 12 Z) bildet den Kern des Endteiles; in ihr sieht man den Stiel des Pinealorganes (Taf. 6, Fig. 11 Est), der hinten unten eingetreten ist, beinahe bis zur Spitze verlaufen. Ganglienzellen (Taf. 6, Fig. 12 G) treten in ihrem Inneren spärlich auf, gruppieren sich dagegen schön an der Peripherie. Hier sind sie sehr zahlreich, schliessen die zentrale Partie gleichsam in eine einschichtige Kapsel allseits ein und senden Fortsätze nach innen. Die äussere Zone (Taf. 6, Fig. 11, 12 z) ist nicht arm an Nervenelementen. Bipolare Ganglienzellen zu langen Ketten aneinandergereiht findet man daselbst vor. *Wenn andere Autoren den nervösen Charakter des Pinealorganes bei manchen Fischen durch den drüsigen verdrängt sehen, so muss ich von Bassozetus das Gegenteil behaupten. Von einem Lumen im Innern ist keine Spur vorhanden; es ist eben durch die zentrale Partie, die übrigens viel Aehnlichkeit mit der sonstigen Hirnsubstanz hat, ausgefüllt.*

Es freute mich, den für Teleostier neuen Befund *Gierse's* (1904, S. 623), den er an *Cyclothone* machte, auch an *Bassozetus* konstatieren zu können. Jener Autor fand nämlich, dass an dem Endteil des Pinealorganes, dort, wo es in den Stiel übergeht, zwei feine Nervenstämmchen abgehen und längs des Stieles nach dem Gehirne ziehen. So ist es auch hier (Taf. 5, Fig. 4 En). Die Hauptsache aber, um die es sich in beiden Fällen handelt, ist die *Zweizahl* und die *Symmetrie dieser Pinealnerven*, denn sonst ist bei Teleostiern nur von einem die Rede. Für Saurier sind wohl zwei von *Klinckowström* (1893, S. 266, 267) nachgewiesen; in einem Falle fand er noch überdies einen unpaaren *Tractus pinealis* vor.

Das *Parapinealorgan* des *Bassozetus* (Taf. 5, Fig. 4, 7; Taf. 6, Fig. 9 P) ist stark verkürzt, unscheinbar; erreicht es ja nicht einmal das Vorderende der Streifenhügel. Dennoch gelang es mir aber, jene gewagte Behauptung *Handrick's*, mit der er *Hill's* Erklärung des Parapinealorganes auch für

Argyropelecus bestätigt (vergl. S. 239) und für die ich mich auf Grund der Tatsachen bei *Mixonus* nicht recht entschliessen konnte, hier klar und deutlich verwirklicht zu sehen. Dort, wo der kegelförmige Anfangsteil des Pinealorganes in den Stiel übergeht (Taf. 5, Fig. 7), gerät er unter das Parapinealorgan, denn dieses vollkommen gleich einer Falte des Plexus Chorioideus — es liegt auch in dessen Bereiche — stülpt sich nach oben vor und nimmt alsbald die Form eines Schlauches mit einschichtiger, epithelialer Wand an (Taf. 5, Fig. 4 P). *So kann auch ich für Bassozetus erklären, dass das Parapinealorgan eine Ausstülpung des Ventriculus communis ist.*

Die kurze Strecke, welche Pineal- und Parapinealorgan gemeinsam verlaufen, sind sie übereinander gelagert, das erste median über dem zweiten.

Der *Thalamus*, seiner Hauptmasse nach aus den Pedunculi cerebri bestehend, ist gut entwickelt und engt den Ventriculus tertius auf einen noch kaum merklichen Spalt ein. Die ihm seitlich aufsitzenden Lobi laterales (Taf. 5, Fig. 1; Taf. 6, Fig. 10 Ll) halten in Grösse den inferiores (Taf. 5, Fig. 1, 3; Taf. 6, 10, 14 Li) das Gleichgewicht. Querschnittbilder sprechen eher für enge Zusammengehörigkeit der beiden, wenngleich das Aeussere — sie sind schärfer voneinander abgegrenzt als bei den vorhergehenden Fischen — mehr auf ihre Selbständigkeit schliessen lässt.

Der *Hypothalamus* steht an Volumen dem Thalamus nicht nach. Waren es jedoch bei *Mixonus* die Lobi inferiores, die an seiner Zusammensetzung den Hauptanteil hatten, so ist es hier der Saccus vasculosus (Taf. 5, Fig. 1, 3; Taf. 6, Fig. 10, 14 Sac). Seine vordere Grenze, die in der Regel durch das Chiasma Nervorum opticorum gegeben ist, wird hier durch eine solch unscheinbare Anschwellung des Infundibularteiles angedeutet, dass man seine Not damit hat, sie überhaupt zu erkennen, dazumal auch die Sehnerven äusserst zart sind. Deutlicher setzt der *Hypophysenstiel* (Taf. 5, Fig. 1, 3; Taf. 6, Fig. 13 Hst) gleich hinter dem Chiasma am Infundibulum an; *er ist lang, solid, und von nervösem Charakter.* Die in der Pituitargrube sitzende kleine Hypophyse (Taf. 5, Fig. 1; Taf. 6, Fig. 13 H) wird von Bindegewebe umgeben. Ihr Stiel durchsetzt diese Hülle, sowie auch ihre periphere Zone und löst sich im Inneren in zahlreiche Fasern auf (Taf. 6, Fig. 13).

Der Ventriculus tertius erweitert sich im Infundibulum zu einer Höhlung mit glatten Wänden, die nur drei Divertikel aufweist: die ersten zwei gehen in die Lobi inferiores, der dritte setzt sich in den Saccus vasculosus fort. Ich habe bereits oben die gewaltige Grösse dieses Zwischenhirnteiles erwähnt; die beste Vorstellung von ihr gewinnt man beim Anblicke des Gehirnes von unten (Taf. 5, Fig. 3); es fehlt gar nich viel, so verdeckt er, wie es bei Leucicorus der Fall ist, die über ihm gelagerten Teile des Gehirns, zu denen auch der breiteste, das Tectum opticum, gehört.

DAS MITTELHIRN.

Taf. 5, Fig. 1 MH

Ich bin überzeugt, dass mich diese Gehirnpartie von *Bassozetus*, wenn ich nicht entkalkt, sondern die Schädeldecke geöffnet hätte, ebenso überrascht hätte, wie es bei *Leucicorus* der Fall war. Wenn auch das Tectum opticum hier (Taf. 5, Fig. 1, 2, 3; Taf. 6, Fig. 10, 14 Lop) um ein weniges höher und differenzierter erscheint, ist es doch nicht das den Fischen typische. Seine Hirnmasse besitzt nur mässige Dicke, ist hinten unvollkommen, auf eine dünne Membran reduziert, was nicht ausser acht zu lassen ist, da, wie ich schon oben bemerkte, auch die Sehnerven von einer unvergleichlichen Zartheit sind. Die schwach konvexe Wölbung der Loben bringt es auch mit sich, dass die äussere mediane Längsfurche sehr seicht ist. Der unter ihr innerhalb des intralobulären Hohlraumes verlaufende *Torus longitudinalis* (Taf. 6, Fig. 10 Tol) *ist auch unansehnlich.* Er besteht aus zwei Wülsten. Die Pedunculi cerebri erreichen die Medianebene bei weitem nicht, und lassen auf diese Weise viel Raum für die Längsfurche im Boden des Hohlraumes (Taf. 6, Fig. 14 Lf). Sie ist breit und bleibt auch unter der Valvula cerebelli, im Aquaeductus Sylvii erhalten, bis sie in der Gegend der Tori semicirculares verschwindet. Diese letzten (Taf. 5, Fig. 1; Taf. 6, Fig. 14 Tse) sind leicht als das, was sie *Mayser* (1882, S. 271) mit Recht nennt, nämlich "partielle Verdickungen der Basis und der hinteren Seitenwand des Mittelhirns in seinen hinteren Abschnitten" zu erkennen. Sie umgreifen die Valvula cerebelli nahezu vollkommen, treten auch ein wenig frei hervor, dazumal die Lobi optici nicht hinreichen, um sie zu decken.

DAS HINTERHIRN

Taf. 5, Fig. 1, 2 HH

ist ein Cerebellum trilobatum, bestehend aus dem unpaaren Stammteil (Taf. 3, Fig. 1, 2; Taf. 6, Fig. 15 Ctr) und den paarigen Seitenwülsten (Taf. 5, Fig. 1, 2, 3; Taf. 6, Fig. 15 Tl). Beide Teile sind ungefähr gleich stark entwickelt und äusserlich von einander zu unterscheiden.

Der *Stammteil* wölbt sich rostralwärts vor, caudalwärts verschmälert er sich unbedeutend, senkt sich aber nicht wie sonst in die Tiefe, sondern ragt frei hervor. *Eigentümlich fand ich die daselbst befindliche Höhlung* (Taf. 6, Fig. 15 Cav).

Die *Seitenwülste* weisen nichts besonders Erwähnenswertes auf.

Die vom Stammteil nach innen entspringende *Valvula cerebelli* (Taf. 6, Fig. 14 Valc) ist gross. Vorne ragt ein schmaler Spalt zwischen ihre symmetrischen Hälften hinein und würde sie vollkommen voneinander trennen, wenn nicht eine schmale Verbindung im dorsalen Teil bestünde.

DAS NACHHIRN

Taf. 5, Fig. 1, 2, 3; Taf. 6, Fig. 17 NH

zeichnet sich wie bei allen Fischen durch seine Länge aus. Dem basalen Teile liegen dorsal die *Lobi posteriores* (Taf. 5, Fig. 1, 2; Taf. 6, Fig. 15, 16 Lpo) an. Sie zeigen insofern ein von den bis jetzt untersuchten Tiefseeteleostiern abweichendes Verhalten, als sie vorn *nicht* das Hinterende des Kleinhirnstammteiles zwischen sich aufnehmen, da jenes bei der schon erwähnten Lage mit ihnen gar nicht in Berührung kommt. Sie sind hier weit auseinander gerückt. Nach hinten kommen sie einander näher, bis sie total verschmelzen. Von da an beginnt auch ihre mächtige Hirnmasse, die in der ganzen Länge ein seichtes "Thal" aufweist, einen Wulst gegen den basalen Teil der Medulla vorzutreiben. Ganz hinten trennen sich die Lobi posteriores abermals und lassen in die Tiefe der Rautengrube hineinblicken. Im Boden der letzten gewahrt man zwei Wülste, die sich an mikroskopischen Präparaten als *Lobi vagales* erweisen (Taf. 6, Fig. 17 Lv). Sie rücken allmählich aus der Tiefe hervor, bis sie die Oberfläche erreichen, *ohne sich aber über sie zu erheben.*

Zusammenfassung.

Wenn ich nun die von mir an dem Gehirne der drei Tiefseefische Leucicorus lusciosus, Mixonus caudalis, und Bassozetus nasus gemachten Befunde überblicke, so ergibt sich folgendes: Alle drei Gehirne zeigen Formen, die vom Physostomentypus abweichen. Dies gibt sich einesteils darin kund, dass die Vorder- und Zwischenhirnteile eine vollkommene, normale Entfaltung nicht erreichen, obgleich ihnen hiezu in dem langgestreckten und geräumigen Cranium genug Platz geboten wird; so geht den Lobi optici, laterales und inferiores überall die gewohnte lobuläre Ausbildung ab. Die mächtigen Labyrinthe zu den Seiten der Medulla oblongata verursachen weniger die Zusammenschiebung der Hinterhirnteile, als die der Ursprung-stellen der Nerven. Alle drei Gehirne haben langgestielte Hypophysen; die Lobi vagales sind so gut wie nicht entwickelt.

Im besonderen ist an Leucicorus erwähnenswert: Die Tracti und die Bulbi olfactorii gehen stark auseinander. Die dorsalen Teile der Corpora striata sind so gross, dass sie seitlich über die basalen herüberhängen. Der ungewöhnlich hoch ausgebildete Plexus chorioideus füllt den Ventriculus tertius und communis nahezu vollkommen aus. Trotz der Grösse der Augen sind die Nervi optici nur unscheinbar, das Tectum opticum auf eine niedrige, flache Hirnplatte reduziert. Die Seitenwülste des Kleinhirns hängen mit den Lobi posteriores zusammen, so dass die letzteren als direkte Fortsetzung der ersteren nach hinten erscheinen.

Mixonus caudalis zeigt trotz starker Riechnerven verhältnismässig kleine Bulbi olfactorii. In den Corpora striata ist abweichend von der Regel der basale Teil der breitere und grössere, der dorsale dagegen nur ein niedriger Wulst. Das Chiasma Nervorum opticorum zieht als breite Nervenplatte unter dem Vorderhirn bis an das Vorderende der Streifenhügel, wo erst die Auflösung in die beiden Sehnerven erfolgt. Das Parapinealorgan ist solid. Pineal- und Parapinealorgan verlaufen nebeneinander. Der Thalamus ist so stark entwickelt, dass er die Ganglia habenulae in ihrem rückwärtigen Teile ganz umschliesst. Die Lobi laterales sind hier sicherlich nicht selbständige Bildungen, sondern differenzierte dorsale Teile der Lobi inferiores.

Bassozetus nasus weicht insofern von dem reinen Salmonidentypus im Vorderhirn ab, als die Bulbi olfactorii dorsal miteinander verschmelzen. Das Pinealorgan ist ein echt nervöses Organ, das mit einer Drüse nicht die geringste Uebereinstimmung hat. Es zeigt in seinem Inneren keinen Hohlraum. Zwei symmetrische Pinealnerven sind hier vorhanden. Die niedrigen Lobi optici erheben sich nur wenig über das Zwischenhirn.

Ich habe alle diese Besonderheiten leichterer Uebersicht halber hier zusammengestellt. Ihre Anzahl ist eine ziemlich grosse und zeigt zugleich, dass weitere Forschungen am Tiefseeteleostiergehirn nicht erfolglos sein dürften. Es wird noch grösserer Tierreihen bedürfen, um die einzelnen Resultate verallgemeinern und von Folgen der Anpassung an das Leben in der Tiefsee sprechen zu können. Jetzt wären derlei Schlüsse vorzeitig.

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TAFELERKLÄRUNG.

IN ALLEN FIGUREN AUF TAFEL 1–6 BEDEUTEN:

A S	Aquaeductus Sylvii.
B	Blutgefäss.
B d	Bindegewebe.
Bol	Bulbi olfactorii.
Ca	Commissura anterior.
Cav	Hohlraum.
Com	Kommissur.
Cs	Corpora striata.
Ctr	Stammteil des Kleinhirns.
E	Pinealorgan.
En	Pinealnerven.
Est	Stiel des Pinealorgans.
E'st	Stiel des Parapinealorgans.
F	Furche.
G	Ganglienzellen.
Gh	Ganglia habenulae.
H	Hypophyse.
Hst	Hypophysenstiel.
Ch	Chiasma nervorum opticorum.
ch	Chiasma der Blutgefässe.
J	Infundibulum.
Jh	Infundibularhöhle.
Lf	Longitudinalfurche.
Li	Lobi inferiores.
Ll	Lobi laterales.
Lop	Lobi optici.
Lpo	Lobi posteriores.
Lv	Lobi vagales.
MH	Mittelhirn.
NH	Nachhirn.
P	Parapinealorgan.
Pa	Pallium.
Plch	Plexus chorioideus.
Sac	Saccus vasculosus.
sac	Sacculus.
T	Thalamus.
Tl	Seitenwülste des Kleinhirns.
Tol	Torus longitudinalis.
Trol	Tracti olfactorii.
Tse	Tori semicirculares.
Valc	Valvula cerebelli.
VH	Vorderhirn.
Vc	Ventriculus communis.
V	Ventriculus tertius.
V	Ventriculus quartus.
Z	Zentrale Zone des Pinealorgans.
z	Periphere Zone des Pinealorgans.
ZH	Zwischenhirn.
I	Nervus olfactorius.
II	Nervus opticus.
V	Nervus trigeminus.
VII	Nervus facialis.
VIII	Nervus accusticus.
X	Nervus vagus.

TAFEL 1.

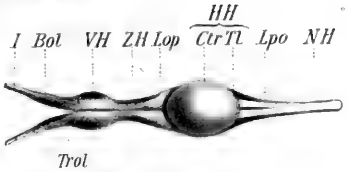
Tafel 1.

Tafel 1.

Leucicorus lusciosus.

Fig. 1. Totalansicht des Gehirnes von oben. Vergr. 2fach.
Fig. 2. Totalansicht des Gehirnes von unten. Vergr. 2fach.
Fig. 3. Totalansicht des Gehirnes von der Seite. Vergr. 2fach.
Fig. 4. Querschnitt an der Grenze von Vorder- und Zwischenhirn. Vergr. 30fach.
Fig. 5. Querschnitt durch die Corpora striata. Vergr. 30fach.
Fig. 6. Querschnitt durch das Zwischenhirn vorne. Vergr. 30fach.
Fig. 7. Querschnitt durch das Zwischenhirn in der Mitte. Vergr. 30fach.
Fig. 8. Grosser Otolith aus dem Sacculus a) von innen b) von aussen c) von oben Vergr. $1\frac{3}{4}$.

1



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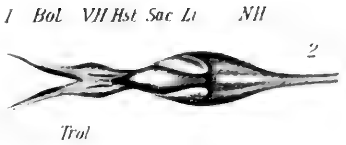

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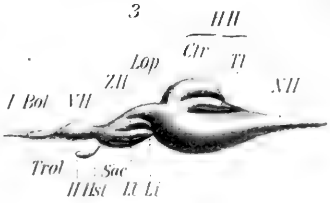

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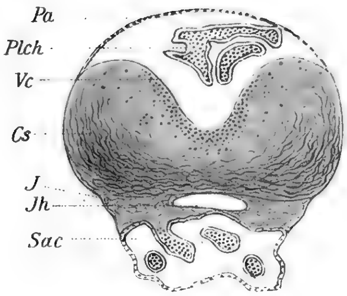

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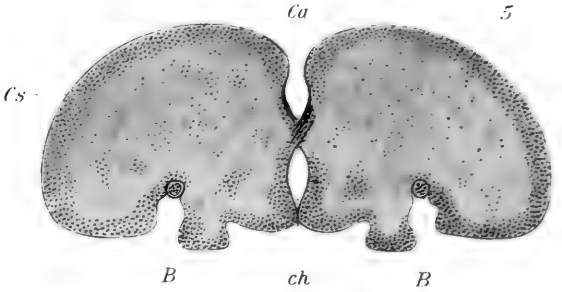

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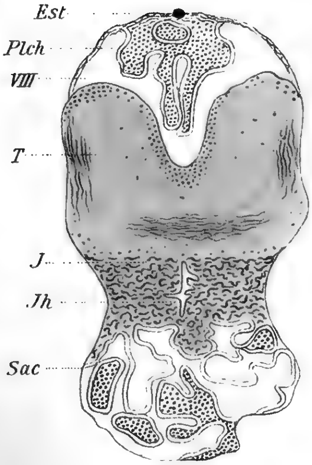

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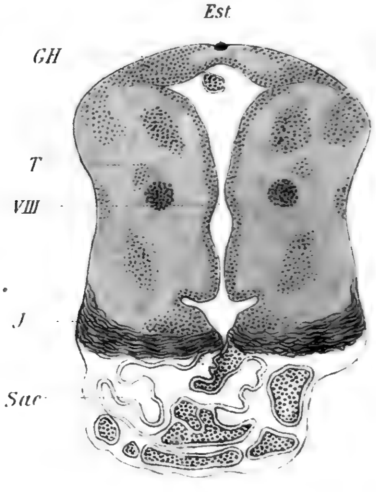

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B. Meisel lith. Boston.

LEUCICORUS LUSCIOSUS Garman

Tafel 2.

Tafel 2.

Leucicorus lusciosus.

Fig. 9. Querschnitt durch das Zwischenhirn hinten. Vergr. 20fach
Fig. 10. Querschnitt durch das Mittelhirn. Vergr. 20fach.
Fig. 11. Querschnitt durch das Hinterhirn. Vergr. 20fach.
Fig. 12. Querschnitt durch das Mittelhirn (hintere Partie). Vergr. 20fach.
Fig. 13. Querschnitt durch das Nachhirn. Vergr. 20fach.

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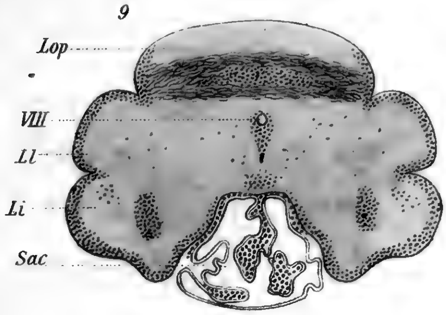

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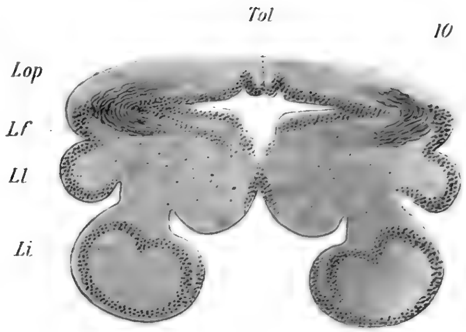

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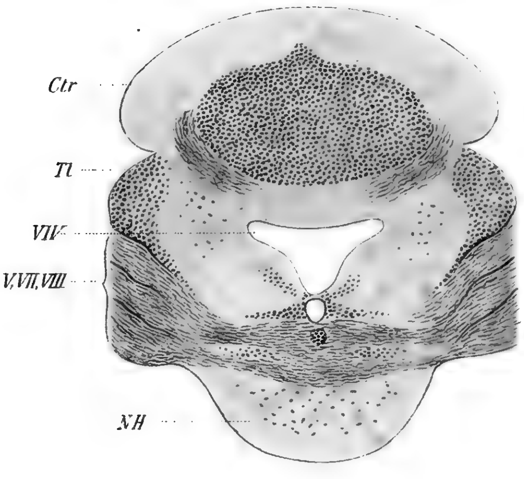

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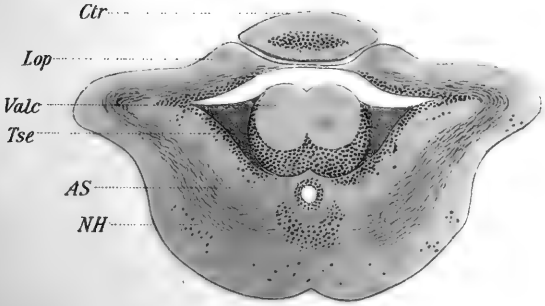

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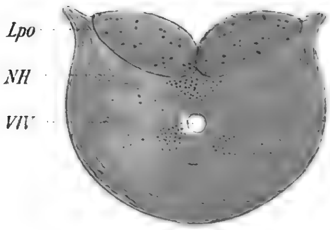

B. Meisel lith Boston

LEUCICORUS LUSCIOSUS Garman.

Tafel 3.

TAFEL **3**.

Mixonus caudalis.

Fig. 1. Totalansicht des Gehirnes von der Seite. Vergr. 3fach.
Fig. 2. Totalansicht des Gehirnes von oben. Vergr. 3fach.
Fig. 3. Totalansicht des Gehirnes von unten. Vergr. 3fach.
Fig. 4. Querschnitt durch die Tracti olfactorii. Vergr. 30fach
Fig. 5. Querschnitt durch die Bulbi olfactorii. Vergr. 30fach.
Fig. 6. Querschnitt durch die Corpora striata. Vergr. 30fach.
Fig. 7. Grosser Otolith aus dem Sacculus a) von innen b) von aussen c) von oben. Vergr. 1½.

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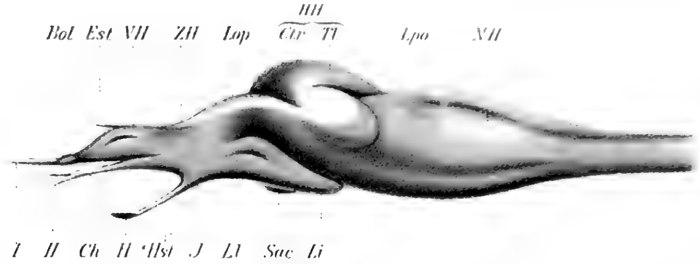

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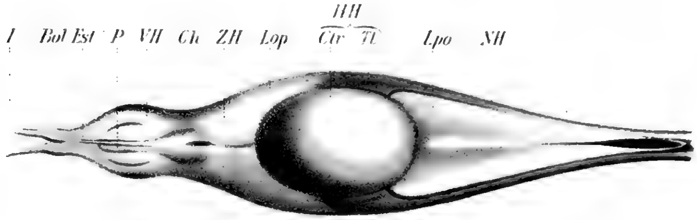

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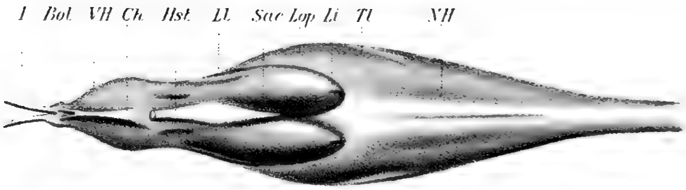

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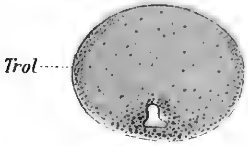

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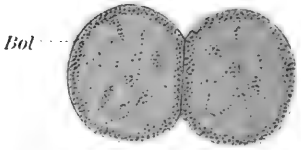

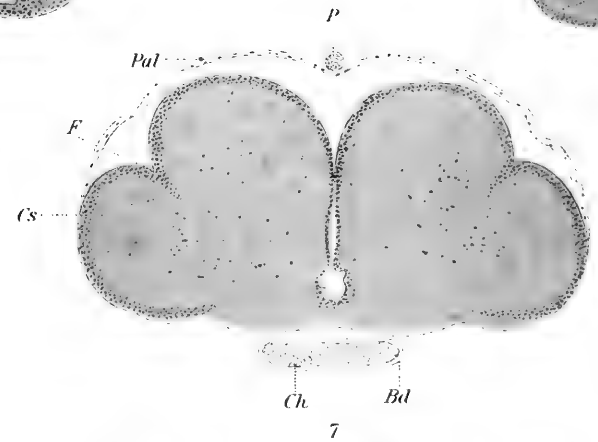

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B Meisel lith Boston.

MIXONUS CAUDALIS Garman.

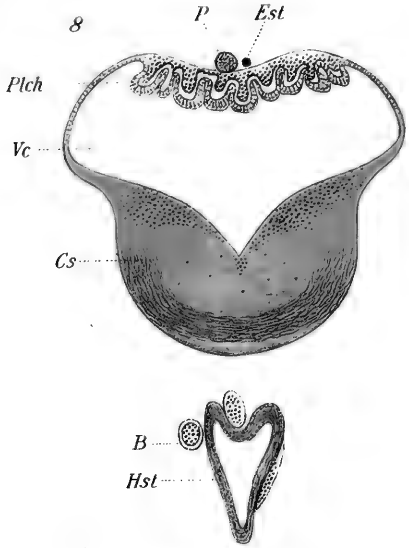
TAFEL 4.

Tafel 4.

Mixonus caudalis.

Fig. 8. Querschnitt durch das Zwischenhirn vorne. Vergr. 30fach.
Fig. 9. Querschnitt durch das Zwischenhirn in der Mitte. Vergr. 15fach.
Fig. 10. Querschnitt durch das Zwischenhirn hinten. Vergr. 15fach.
Fig. 11. Querschnitt durch das Mittelhirn vorne. Vergr. 15fach.
Fig. 12. Querschnitt durch das Hinterhirn vorne. Vergr. 15fach.
Fig. 13. Querschnitt durch das Hinterhirn hinten. Vergr. 15fach.

8



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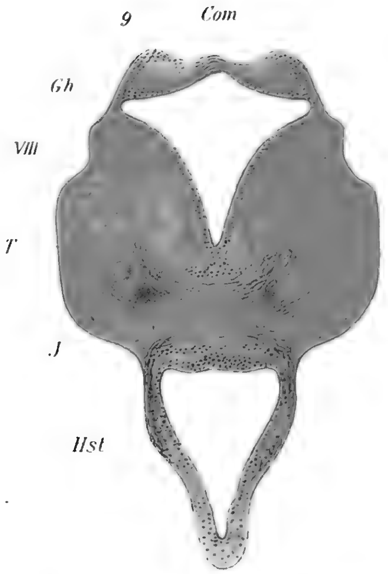

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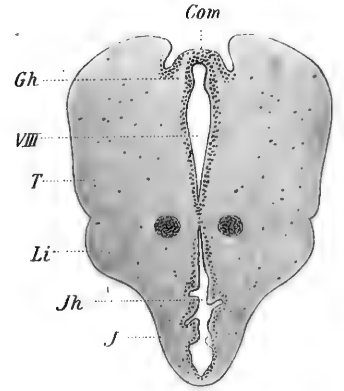

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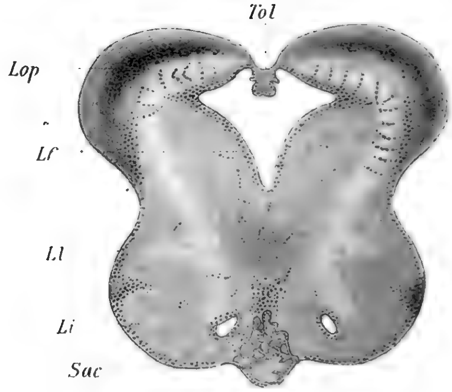

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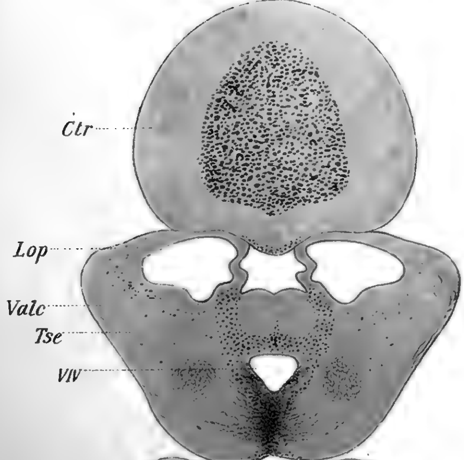

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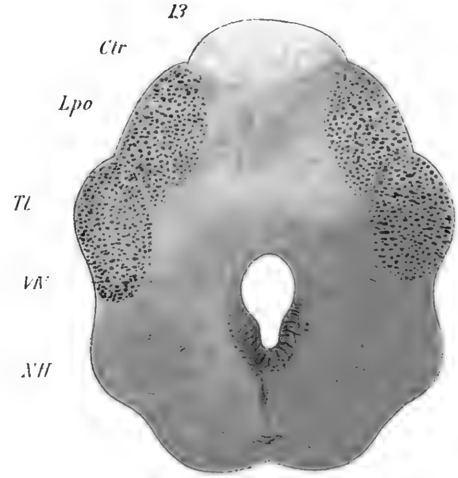

B. Meisel lith. Boston.

MIXONUS CAUDALIS Garman.

Tafel 5.

Tafel 5.

Bassozetus nasus.

Fig. 1. Totalansicht des Gehirnes von der Seite. Vergr. 8fach.
Fig. 2. Totalansicht des Gehirnes von oben. Vergr. 8fach.
Fig. 3. Totalansicht des Gehirnes von unten. Vergr. 8fach.
Fig. 4. Querschnitt durch das Parapinealorgan. Vergr. 520fach.
Fig. 5. Querschnitt durch die Bulbi olfactorii. Vergr. 20fach.
Fig. 6. Querschnitt durch die Corpora striata. Vergr. 20fach.
Fig. 7. Querschnitt durch die Ursprungsstellen des Pinealapparates. Vergr. 260fach.
Fig. 8. Querschnitt durch das Cranium. Vergr. 4fach.

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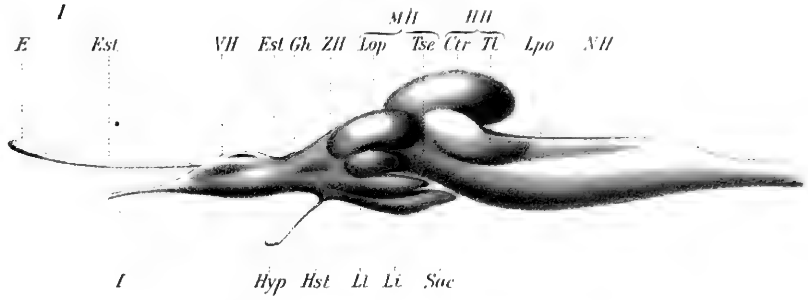

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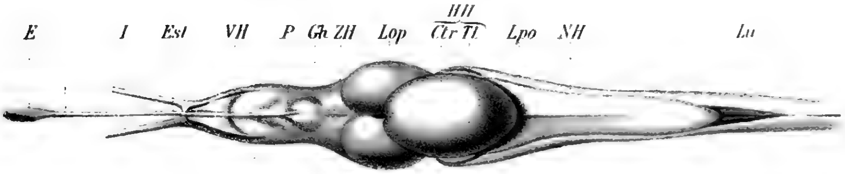

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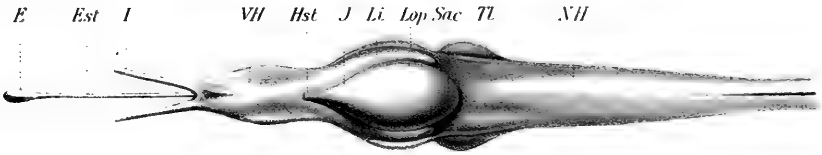

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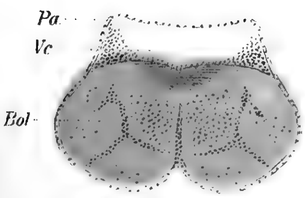

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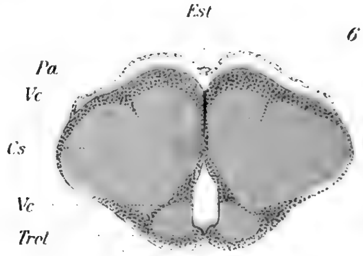

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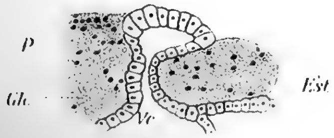

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A. Meisel lith. Boston

BASSOZETUS NASUS Garman

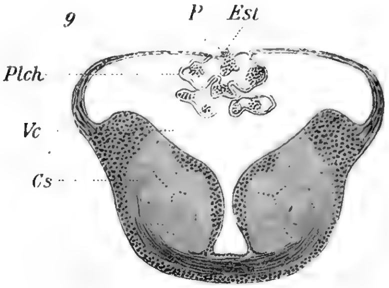
Tafel 6.

Tafel 6.

Bassozetus nasus.

Fig. 9. Querschnitt durch das Zwischenhirn. Vergr. 30fach.
Fig. 10. Querschnitt durch das Mittelhirn vorne. Vergr. 20fach.
Fig. 11. Querschnitt durch das Pinealorgan. Vergr. 50fach.
Fig. 12. Ein Teil des in Fig. 10 dargestellten Querschnittes. Vergr. 300fach.
Fig. 13. Querschnitt durch die Hypophyse. Vergr. 30fach.
Fig. 14. Querschnitt durch das Mittelhirn hinten. Vergr. 20fach.
Fig. 15. Querschnitt durch das Hinterhirn. Vergr. 20fach.
Fig. 16. Querschnitt durch das Nachhirn vorne. Vergr. 15fach.
Fig. 17. Querschnitt durch das Nachhirn hinten. Verg. 30fach.

9



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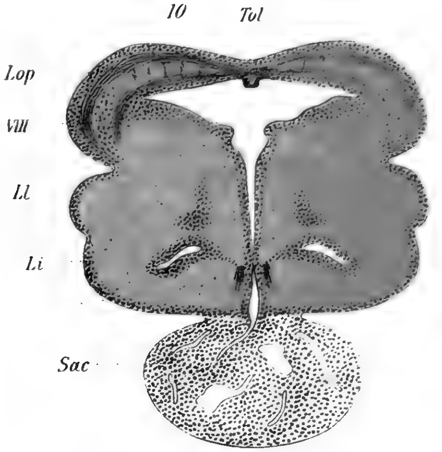

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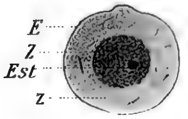

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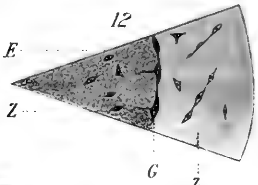

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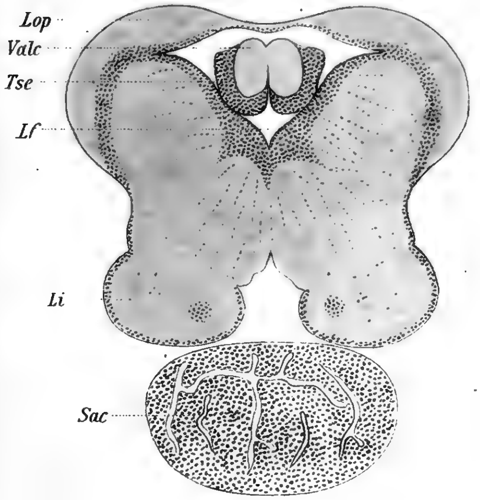

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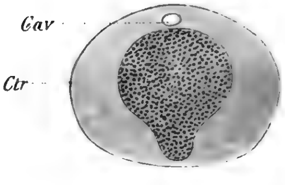

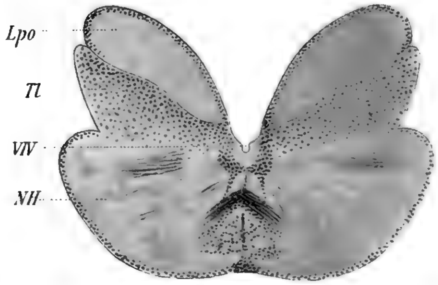

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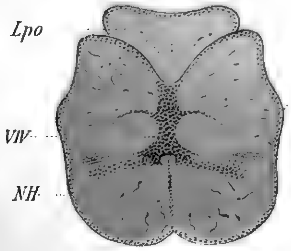

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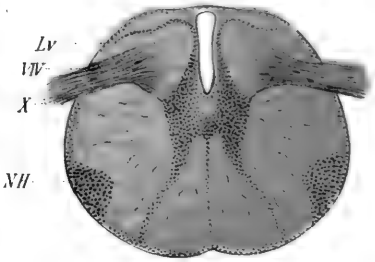

B. Meisel lith Boston.

BASSOZETUS NASUS Garman.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. XXX. No. 4.

THE GALAPAGOS TORTOISES.

BY

SAMUEL GARMAN.

WITH FORTY-TWO PLATES.

CAMBRIDGE, U. S. A.:
Printed for the Museum.
JANUARY, 1917.

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THE GALAPAGOS TORTOISES.

INTRODUCTION.

A warm interest of the Museum authorities in the Giant land tortoises has led to the acquisition of so many notable specimens, through liberal exchanges and purchases, as to demand a revision of portions of the collection, especially of that portion directly pertaining to the Galapagos Archipelago. This forms the reason for the following article. It is based mainly on partial specimens, *i. e.*, carapaces and sternums, but it is thus that these tortoises are most generally known, thus that they are most widely, and most commonly represented in descriptions, figures, and collections. A few attempts have been made at complete characterization of the species by including the anatomical features; these were founded on single specimens, and the individuals of the species are found to differ too much to admit of accurate distinctions unless confirmed by averages secured from repeated dissections, for which much of the material and the labor has yet to be supplied.

The Galapagos Islands form an isolated group in the eastern Pacific on the equator about 6° west of Ecuador, or in other words, they are situated between 89° and 92° of west longitude and between 1° 30′ south and 2° north latitude. The largest of them is about eighty miles long and at its widest is about fifty miles wide; from this the sizes vary to some that are mere points of rock or shoals. They are separated from the mainland by more than four hundred miles of deep sea, a thousand fathoms or more in depth. The wide separation from the continent, their considerable distances from one another, with great differences in altitudes and consequent variations in climate and fertility give them exceptional attractions in the eyes of naturalists. Here if anywhere they might hope to find the species of the flora and fauna distinct from those of the world around them and here it might be possible to trace their development and derivation. Questions of origin go back to the advent of the islands themselves; neither in case of lands, plants, nor animals have the questions been answered with any great degrees of satisfaction. Some authorities have decided that the islands are oceanic, that they never were connected with the continent, but were pushed up from the sea-bottom by the numerous volcanoes they contain.

This accounts for the islands alone. There are two methods of explaining the presence of the organisms: one by origin in place, another by accidental importations. If originating in place similarities in climate and other conditions might be adduced to account for affinities, but accidental importations could hardly be relied on for the development of parallel harmonious series such as are now in place on the Galapagos. The accidents would be heterogeneous, and no reason appears for limiting them in time or numbers.

Theodore Wolf, at one time Geologist of Ecuador, published an account of the Archipelago from actual study, adopted the oceanic theory and placed the appearance of the islands in the Tertiary and later, thereby enhancing the scientific interest because of the comparatively short period elapsing since the uplifts. He recognized affinities between the insular and the continental organisms, and found the rocks of the Galapagos basaltic and those of the highlands of Ecuador trachyte and andesite.

A most able recent advocate of the continental theory of origin was George Baur, 1891. For months he made collections on a majority of the islands in preparation for a comparative account of the life and conditions. His conclusion was that the Archipelago included the tops of volcanic mountains of a greater area of land at one time part of the continent, later sunken below the sea-level. All the islands were formerly connected in a single large one which by continued subsidence divided into a number, the highlands that remained above the sea. Each of the latter in a long course of time developed peculiar races, eventually species, in its plants and animals, because the conditions were not identical. As proof especial stress is laid on the harmonious distribution of the organisms. Nearly every island has its own races, and their affinities commonly turn toward the continent. In this the idea of communication and transportation between the islands is not considered.

Discovery of the Archipelago is said to have been made by Berlanga, 1535. The Giant land tortoises, then found in immense numbers suggested the name Galapagos, previously applied in Spain to fresh-water tortoises, a designation which does not appear to have been entered on the maps as a name for the islands till nearly fifty years later. The Spaniards paid little attention to the territory. For a couple of centuries it was merely a place of call for a supply of fresh meat. Among the earliest visitors were the buccaneers, Dampier and Cowley, 1684–97, who furnished accounts of portions of the group. Cowley published a map on which Spanish names were displaced by English, now perhaps the more widely known. Ecuador, the present owner, clings to the Spanish American names and the prospect is that they will ultimately prevail. The Archipelago was surveyed by Colnett, 1793. The chart, Plate 1, with the positions of the islands, directions of the currents, and the two series of names is sketched from that published under the direction of the Secretary of the Navy by the United States Hydrographic Office, 1915. From the directions of the currents it will be seen that affinities with South American organisms would be of the most natural imaginable, if dependence for origins of the flora and the fauna were placed upon the marine drift. The Spanish names of the islands with their English equivalents are as follows: —

San Cristobal (Chatham).
Española (Hood).
Santa Maria (Floreana) (Charles).
Santa Fé (Barrington).
Santa Cruz (Chaves) (Indefatigable) (Porter's).
Tortuga (Brattle).
Pinzon (Duncan).
Isabela (Albemarle).
Fernandina (Narborough).
Rabida (Jervis).
San Salvador (James).
Marchena (Bindloe).
Pinta (Abingdon).

In what ever way the balance of the fauna reached the islands, immediate concern here is with the tortoises, and there is a possibility that they may have been introduced by men. No one would care to assert that they developed from birds or even from marine chelonians. There appears to be a sort of general agreement that they reached the Archipelago as tortoises not very different from what they now are. There is no evidence as yet, in the way of fossils, that they established themselves in the Tertiary or other formations earlier than the most recent. Their affinities are so close to living species on the mainland there is hardly room for doubt their ancestors were the same if indeed a species of the continent was not the direct progenitor brought, possibly, in the times of the Incas or still earlier by the aborigines. Because of the heavy and solid structure, one would not risk the suggestion that the Jaboty had drifted across the sea; but there is greater likelihood that island forms may have been drifted from one island to another after finding lodgment in the Archipelago. Whether it was cut off with the islands, from the mainland, or transported by other means it is very likely that the ancestral form is the widely distributed Jaboty, *Testudo tabulata* (Plate 2) of South America. This is supported by the numerous features possessed by the Galapagos in common with it, and by the comparatively slight divergence. Distribution from island to island was easier in the early days; as the lands sank the distances between the islands increased. Again there is no proof whatever of inability to swim on the part of the island tortoises. They are not so different from those of the Seychelles which were proved to be good swimmers as long ago as 1801, by Grandpré, Voyage dans l'Inde et au Bengal. If animals like those of the islands of the Indian Ocean were able to swim from shore to shore leagues apart there is positively no reason for denying similar ability to wander to those on the other side of the earth, equally strong and perhaps more buoyant. Porter's testimony, concerning the tortoises thrown overboard by the crews of vessels preparing for action, in which he says "A few days afterward at daylight in the morning we were so fortunate as to find ourselves surrounded by about fifty of them which were picked up and brought on board, as they had been lying in the same place where they had been thrown over, incapable of any exertion in that element except that of stretching out their long necks" is proof only of great buoyancy, a quiet sea and absence of land in sight to direct and stimulate exertions. It certainly is no proof of inability to swim or exert themselves in the water. What would have happened with favoring winds and currents and shores in view may be readily surmised. Being thrown into the sea is not the only way of going adrift for a creature, fond of soaking in the water and of wallowing in the mud like swine, known to fall from the cliffs and to roll down the declivities.

Transportation by men has certainly played a large part in the history of these creatures. By different vessels they have been carried to the Juan Fernandez, Chile, Peru, the eastern and the western United States, Europe, the Hawaiian, Marquesas and Tonga Islands, Australia and China; though there is no evidence at hand of actual colonies being established. There is no very direct assertion of transportation of tortoises from one island to others, except such as were to be used for food, yet in the face of the evidence of mixed breeds or hybrids in collections made in comparatively recent times it is difficult to convince one that such transportations did not occur. The testimony of Wolf, 1879, concerning the cattle lessens the doubt of actual occurrence: — "Das Rind lebt in grossen Heerden auf den Hochplateaus und Bergen von Floreana und Chatham und seit einigen Jahren traf man auch einige Stücke auf dem

Gebirge von Süd-Albemarle, ohne das man wüszte wie sie dorthin gekommen sind" (Ein Besuch der Galápagos = Inseln, p. 31). Floreana was the name given by Villamiel to Santa Maria (Charles). Young tortoises of which one might carry a number in his pocket presented no such difficulties as cattle in way of distribution. Cattle like most tortoises are tolerably expert at swimming.

Sailors are fond of pets and a young tortoise or even a giant is an unfailing attraction to them. Undoubtedly they have helped to bring about the puzzling mixtures now gathered in various museums. The islands were frequently visited before the year 1800, but no attempt was made at colonization. Watkins, a sailor, was said to have been marooned for nearly a year, 1808, on Santa Maria. Villamiel's colony of 1832, on the same island, numbered several hundred people in 1835 and at this time they had continued the destruction of the multitudes of tortoises so effectively that the settlers were drawing supplies from other islands. The Beagle, 1835, got specimens from three of the islands, Santa Maria (Charles), San Cristobal (Chatham) San Salvador (James), mostly young, apparently of a single species or so very young experts were unable to distinguish the species. This colony on Santa Maria was a penal colony. Wolf, 1879, says it soon melted away until finally "der Rest der zuletzt übriggebliebenden Räuberbande rieb sich zum Theil selbst auf, zum Theil entwich er auf den anlegenden Schiffen der Wallfischfänger" (Ein Besuch, p. 4), and for a long time no traces of the colony had existed. Darwin, 1839, p. 457 says of Charles (Santa Maria), "the main article of animal food is derived from the tortoise. Their numbers in this island have of course been greatly reduced, but the people yet reckon on two days' hunting supplying food for the rest of the week." In the seventies Baldisan established a small colony on Santa Maria. He was killed by the colonists about eight years later; after his death this island was deserted. In 1865 Cobos landed a party on San Cristobal (Chatham) to gather Orchilla, a lichen used as a dyestuff; these remained till 1869, when they left the island. Ten years later Cobos returned to San Cristobal with more than a hundred men and founded a colony which appeared prosperous in 1891, and which may yet be in existence. The work of the colony was not limited to the island upon which it settled; it drew supplies from the other islands. The meat hunters, the oil collectors, and the orchilla pickers passed from island to island so frequently that it is not to be expected that any of the islands has its own unmixed race of tortoises, unaffected by mixtures from others. The older specimens, those secured before the exploitation of the islands, are perhaps the least likely to be suspected of being hybridized or mongrelized by importations, and a multitude of tortoises already established on an island might not be perceptibly influenced by the advent of a few new additions from elsewhere. The effect of the latter would be infinitesimal, but a species reduced in number of individuals, near extinction, or not yet firmly established, on another island might lose its identity through the advent of one or a few new arrivals, as may have been the case on San Salvador (James) where the species no longer agrees with Porter's description, or even on Santa Cruz (Indefatigable) in consequence of the rumored importation by Baur, himself one of the most earnest advocates of the opinion that each of the islands is inhabited by a distinct race. The few individuals that could produce an entirely distinct race in one locality might be unable to produce any effect in another. In specimens of *T. vicina* recently collected there is evidence of considerable mixtures, so also in those of *T. nigrita* and of *T. elephantopus*. The BEAGLE may or may not have secured one species on three islands; four species are located on Isabela (Albemarle). The HASSLER, 1872, obtained four species on Santa Maria that may be supposed with some confidence to have originated in four different localities, on three distinct islands.

Comparatively little definite observation by trustworthy observers has been made in regard to either length of life, rapidity of growth, or rates of increase. Waite, 1899, brought together some notes of importance in the Records of the Australian Museum, **3**, p. 95–103, pl. 20–22, in regard to a male *T. nigrita* taken by Porter to the Marquesas, thence to Tonga, thence to Sydney and thence to London where it died in 1898. This follows it nearly a century, without determining its age in 1813. In 1896 the length of the carapace was 4 ft. 2½ inches, its width 2 ft. 11 inches and its weight 575 lbs. (p. 98). Rothschild gives the length of this specimen after its death as 48½ inches. Waite also notices another of this species which weighed 56 lbs. when brought to Sydney in 1853. In 1893 it weighed 368 pounds. In 1896 according to Waite it was an egglaying female, had a length of 3 ft., a width of 2 ft. 5 inches and weighed 320½ pounds, having lost 47½ pounds in three years. Quite recently very definite information concerning rate of growth appeared in Science, December 31, 1915, p. 933, in a note by Messrs. Daggett and Heller. The specimen of *T. vicina* had been secured, by the latter, at Iguana Cove, Isabela, June, 1899, when it weighed 29 pounds and was supposed to be not much over a year old; it doubled its weight annually. Daggett says "At the time of its death [April 18, 1914] it weighed 450 lbs. and its carcass measured 41 inches long, 31 wide and 21 high." In about sixteen years the individual had attained the bulk of specimens commonly said to be 400 years of age. Further observations are needed concerning rates of increase. Colnet is to be credited with the statement that the nests never contain more than three eggs. Porter says the females without exception were full of eggs of which generally from ten to fourteen were hard, ready for extrusion. Beck says from ten to twenty eggs are ready for extrusion together, while twenty or thirty more were from one half to two thirds the normal size. The number of eggs laid by a single female in a season of course depends on her size and age; at any rate the evidence indicates she might densely populate a given locality, if beyond interference from enemies, in a very few years. Neither rate of growth nor abundance of progeny favors the conclusion that the tortoises have been on the islands from the very earliest times. Yet in estimating the numbers of the tortoises Baur quoting from Reynolds says that between October 13, 1832 and August 30, 1833, thirty-one whaleships reported at Santa Maria; he adds that if each vessel carried away but 200 it would make 6,000 from this island alone in less than a year. In a later MS. he states there is little doubt that about 10,000,000 tortoises were taken from the islands since their discovery.

The factors of the greatest importance in the differentiation of species and varieties are the differences in the altitudes, which in the various islands range to 4,000 feet more or less, with the consequent differences in temperature, moisture, dryness, food and feeding habits, soil, etc. The variations in rapidity of growth, sizes attained, increase in numbers and the like are readily traced to one or several of these agents. In some of the most superficial characters their efficiency is quite perceptible; thus for example in the epiderm, the slough, which grows in correspondence with the skin and the bones beneath it.

Sloughing is a process undergone by reptiles in general. It is part of their method of renewing and enlarging the epidermal covering. The new epiderm grows under the old one, the slough, between it and the balance of the skin. In the majority the discarded epiderm is thrown off at particular seasons. On some forms it is retained in one way or another and made to serve useful purposes, as protecting the skin or bones, or as claws or spines, and in a few it is so greatly modified as to serve as rattles. There are differences among tortoises in regard to the habit. Most of the marine forms slough early in life and subsequent sloughs are less noticeable. Soaking in the water aids in sloughing, but on the other hand a dry skin appears to be a more effectual preventive of loss and welds the various sloughs together one after another, cementing then firmly so that instead of a single thin horny layer of epiderm, of a single season, there may be a thick and strong covering that is increased in thickness by successive growths in its duration. The earliest slough in some marine tortoises is well described in Fry's remarks on *Chelonia depressa* in, 1913, Records of the Australian Museum, **10**, p. 162, "*Chelonia depressa* then, emerges from the egg with each scute covered by a 'larval shield' which, as the animal grows, becomes an areola almost identical with that found in land tortoises; this is finally shed before the turtle reaches maturity, leaving the smooth scutes described by Garman and figured on Pl. XXI–XXII. As far as I can ascertain these areolae are unique amongst Marine turtles." Günther, 1877, discussing the land tortoises of the Galapagos, says, p. 18, as long as the Tortoises are young, growth, as far as it is externally visible, proceeds along the margins of all the scutes; the sutures get broader, appearing as whitish seams, soft and very sensitive. After some time the young portion of the epidermis becomes horny, and is raised in a line (stria) running along each side of the suture. At a later period this increment takes place only (at least only conspicuously) in certain portions of the carapace." Marine and all land tortoises are hatched with the larval shield on each scute; it forms the areolar space on the scute which in the land species may or may not be shed, but which appears to be shed in marine forms at an early date. If not shed all the concentric striae remain, unless possibly affected by wear, each successive stria being the index to the amount of surface enlargement or growth, beyond the stria immediately preceding it. If there were no lateral growth, from starvation or disease, the scute, if there were no slough, might thicken by successive accretions beneath but possibly might not increase the number of concentric striae around its edges. Some specimens from dry localities, have retained the larval shield and have never sloughed; year after year they have increased by one or more the record of the striae on the scute. Other specimens appear to have kept the sloughs and striae for long periods then suddenly by a slough have lost the entire record of the series at once and from the striate and grooved condition have become smooth and polished, to begin at the edges of each scute another striated record, see Plate **27**. *Testudo clivosa,* Plate **21**, a twenty-five inch specimen may have an entire record. On the youngest specimens, a year or more of age, of most if not all of the species in the collection, no slough has occurred. The larval shield and all of the striae are in place. Larger specimens of some of the same species show plainly that through a slough the larval shield and the striae have been carried away leaving the carapace smooth; still larger ones testify to more or less regularity in sloughing and to consequent smoothness: such species are *T. nigra, T. microphyes,* and *T. macrophyes. Testudo vicina, T. nigrita,* and *T. elephantopus* and its varieties *T. abingdonii, T. becki,* and *T. duncanensis* all slough when young and afterward retain the striae as if no sloughing took place.

Evidence that may be adduced in regard to the shortness of time since separation from one another is seen in the affinities of the tortoises; likewise in this connection there is no lack of confirmation for the statement that the species of various islands have been modified by importations from others. The early specimens now in museums, nearly all of them without known localities, are very difficult to place even with the aid of the considerable numbers in recent collections from certain islands. Changes have occurred in the last century that make some of the descriptions quite contradictory. Porter, 1815, in his Journal describes the tortoises from James Island (San Salvador) as round, plump, and black as ebony, their shells "sometimes remarkably thin and easily broken but more particularly so as they become advanced in age; when, whether owing to the injuries they receive from their repeated falls in ascending and descending the mountain, or from injuries received otherwise, or from the course of nature, their shells become very rough, and peel off in large scales, which renders them very thin and easily broken." Van Denburgh, 1914, in his monograph, p. 321, says "The James Island tortoise is a very large, heavy, thick-shelled species which resembles most closely the tortoise of Jervis Island [Rabida] and the *Testudo vicina* of southern Albemarle. It is somewhat intermediate between the saddle-backed and dome-shaped races. The front of the carapace is high, but the middle of the back rises still higher. There is but little narrowing of the front of the carapace." Porter's description was made a century earlier than Van Denburgh's. Porter's description of the tortoises of Santa Maria (Charles) and Española (Hood) applies a little better to *T. elephantopus* Harlan than to *T. nigra* Dum. & Bib. now known to be the Charles Island species, of 1835. "The form of the shell of the latter is elongated, turning up forward in the manner of a spanish saddle, of a brown color and considerable thickness." How much the differences are is apparent on comparing with the descriptions and plates below. The disagreements may be accounted for by very rapid differentiation, or by modifications or replacements by importations.

The following descriptions are made for most ready comparison with those in the majority of the literature. Percentages are not given as they do not lend themselves readily to visualization, an absolute necessity in descriptions and comparisons; they are too abstract and vary too much with age and sex to be really practicable.

Excepting in the synonymy and the direct references the bibliography is not repeated; it has been worked out by Günther, Baur, and Van Denburgh.

TESTUDO TABULATA Walbaum.

Plate **2**.

Testudo tabulata Walbaum, 1782, Chelonographia, p. 122; Schoepff, 1792, Hist. Test., p. 56, 62, pl. 12, fig. 2, pl. 13, 14; Daudin, 1805, Hist. rept., **2**, p. 242; Wied., 1825, Beitr., **1**, p. 51; Abbild., pl. —; Bell, 1835, Monogr. Test., pl. —; Duméril et Bibron, 1835, Erpétol. génér., **2**, p. 89; Gray, 1844, Cat. tort., p. 5; 1855, Cat. shield rept., p. 5; Strauch, 1862, Chelon. stud., p. 80; 1865, Verth. schildkr., p. 25; Gray, 1870, Suppl. cat. shield rept., p. 4; Boulenger, 1889, Cat. Chelon., p. 157; Strauch, 1890, Bemerk. schildkr., p. 12; Goeldi, 1904, Chelonios do Brazil, p. 14.
Testudo denticulata Schoepff, 1792, Hist. Test., p. 119, pl. 28, fig. 1.
Testudo tessellata Schneider, 1792, Schr. Berl. naturf. freunde, **10**, p. 262.
Chersine tessellata Merrem, 1820, Tent., p. 31.
Testudo hercules Spix, 1824, Test. Bras., p. 20, pl. 14.
Testudo sculpta Spix, 1824, Test. Bras., p. 21, pl. 15.
Testudo carbonaria Spix, 1824, Test. Bras., p. 22, pl. 16; Bell, 1835, Monog. Test., pl. —; Duméril et Bibron, 1835, Erpétol. génér., **2**, p. 99; Strauch, 1862, Chelon. stud., p. 80; 1865, Verth. schildkr., p. 27.
Testudo cagado Spix, 1824, Test. Bras., p. 23, pl. 17.
Chersine tabulata Gravenhorst, 1829, Del. Mus. Vrat. Rept., p. 19.
Testudo boïei Wagler, 1829, Icon. Amph., pl. 13.
Chelonoides tabulata Gray, 1873, Proc. Zool. soc. London, p. 724, pl. 60, fig. 3.

The conclusion reached in this study of the Galapagos tortoises is that they were derived in comparatively recent time, much later than the Tertiary, from species of the nearer lands of the continent of South America. How their transportation was effected may not be determined at present. In order that the closeness of the relationships with one of the most widely distributed continental species may be made the more evident the following description and illustrations of a specimen of *Testudo tabulata* from Porto Rico are introduced here. They are taken from a fair representative of the species and will be useful in comparisons. The measurements in inches of the specimen are: —

M.C.Z.	Direct length	Width	Curved length	Width	Height	Sternal length	Width
12050	22½	13¾	29	25¼	10½	19½	11

The shape of the carapace of this species is more elongate than that of *T. vicina;* it has a circumference of forty-one inches and approaches the subcylindrical in shape. The sides are steep; they are nearly parallel in an upper view; longitudinally the back makes a long, low arch, which does not rise in the middle as in *T. nigrita*. The front declivity resembles that of the latter. A majority of the scutes have little convexity; they are flattened, without prominent areolar spaces. The striae persist near the areolae, except in the older specimens. On the upper half of the fifth vertebral scute there is a rounded prominence or boss and backward from it a steep nearly vertical descent. The upper and the hinder edges of the third marginal meet in a sharp angle on the present individual. The outline of the eighth marginal bends abruptly outward behind the femoral notch and then continues in a regular curvature to the caudal. The caudal is large; its lower edge is strongly convex below the contiguous marginals and its surface is prominently convex. Faint scallops are formed by the outward edges of the marginals. A faint keel is between the humeral and the femoral notches on the fourth to the eighth marginal scutes. The front edge of the fourth vertebral is less than twice as wide as the hinder. The single axillary scute on each side has faint indications of having been formed by the fusion of two; the lower is the smaller and solidly united with the upper. The inguinal scales are single.

On this specimen the sternum extends farther forward than the carapace about one and one fourth inches; it is deeply concave behind the middle and has a rounded prominence along each side of the lower surface. The nuchals are moderate, rounded in front, and have no traces of the lateral angles so noticeable on young specimens. The bones included in the humeral extension in front of the bridge are thick, strong, and curved outward on their outward margins. Compared with the swollen gulars the anal plates are thin; the deep notch between them is crescent-shaped, concave; the outer angles are produced and blunted.

The scales on the exposed portions of the legs and feet are large, somewhat imbricate and pointed. Each arm has two larger scales in front. Behind the hand there is another, and a short distance from this a smaller one about half as large. Enlarged scales cover the tail, and the exposed portions behind the thighs, similar to those on large specimens of *T. microphyes.*

Carapace black, with a small spot of yellow on the areola of the second vertebral scute. Lower surfaces and head yellow mottled with brown or black. Skin between scales brown on neck and legs.

Of this species, in Brazil, Goeldi, 1904, says "*Testudo tabulata,* o nosso jaboty, é animal imponente, cuja casca dorsal por si só póde attingir de 55 até 70 cm. de comprimento." The largest at hand is that described above, 57.15 cm.

Among the small specimens, from numerous localities between Dominica, Trinidad, Surinam, and southern Brazil, there is the same dissimilarity in the young as compared with the old of this species, or with the Galapagos tortoises of whatever ages. For example, the majority of the young of *T. tabulata* have two axillary scales on each side. They are not as seen in *T. argentina* Sclater, *T. chilensis* Gray, shown by Siebenrock, 1912, fig. 1, where the lower is the larger. The lower is much the smaller; in cases it is absent, in others, it evidently has fused with the upper, thus bringing about the condition obtaining in the Porto Rican specimen, normal in the Galapagos. There is evidence that the single axillary is not excessively rare: it was figured by Schoepff, 1792, Pl. 13–14, as *T. tabulata* Walb., by Spix, 1824, under the synonym *T. sculpta*, Pl. 15, and by Bell, 1835, Mon. Testud., Pl. —, Sowerby and Lear, 1872, Pl. 14, under *T. carbonaria* Spix, Pl. 16, another synonym. The young of *T. tabulata* vary greatly in color, from yellow to black. On the back, whether light or dark the areolae are commonly yellow to orange, the color being more limited on the black individuals. On the majority the lower surfaces are yellowish, as to a considerable extent on the Galapagos. Specimens of less than six inches have marginal denticles on a thick swollen sternum, more or less produced, notched, and angled in front, etc., and they differ in some of the same features from the large or the aged of the species and from the Galapagos of whatever size, age, or species. The typical forms described as species of the latter have most often been chosen from the adult or the aged and these have provided the distinguishing characters from those induced by age. Among the old the greater difference exists and from them the more one approaches the newly hatched the more alike the specimens appear. This is what should be expected in cases of close genetic relationship. Comparing the tortoise of northern South America with those of the Galapagos it is found that the nearer approaches from the one to the others are the farther from the egg and mainly made by *T. tabulata*. Yet it is very doubtful if such close affinities would have obtained without the aid of a common ancestor. The results of all the comparisons made in this study tend to the conclusion that the origin of the Galapagos tortoises is directly connected with the species *T. tabulata* of northern South America.

TESTUDO MACROPHYES, sp. nov.

Plates **3–5**.

Testudo microphyes GÜNTHER, 1877, Gigantic land-tortoises, p. 78, pl. 32–36, 38, 45, fig. A–C (part); BECK, 1903, 7th Ann. rept. N. Y. zoöl. soc., p. 170; SIEBENROCK, 1909, Zool. jahrb. Suppl., **10**, p. 534; VAN DENBURGH, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 329, pl. 70–83 (part); ROTHSCHILD, 1915, Nov. zool., **22**, p. 406, 409 (part).

Testudo macrophyes is the name here applied to a tortoise inhabiting the section of Santa Isabela Island (Albemarle) near Tagus Cove. The tortoise was first made known by Günther, in 1877, who described and figured it from a number of the Cookson specimens but he did not recognize the species as distinct. He made it identical with that he had characterized in 1875 under the name *T. microphyes* from a specimen of unknown origin, said at the time to be "a fully adult male" representing the "smallest of the Galapagos Tortoises" and supposed to have come from Española Island (Hood's).

Testudo macrophyes is one of the largest species. Compared with that of *T. microphyes*, Plate **11**, the carapace appears more elongate, narrower across the humeral region, broader across the femoral plates, and somewhat higher in the arches across the middle of the back, over the third and the fourth vertebrals. Viewed from above the outlines in some degree resemble those of *T. ephippium*. The convergence toward the front and the incline of the flanks are greater than on *T. microphyes* and consequently the opening in front between the carapace and the plastron approaches an angular in the nuchal section. The notch at the eighth marginal on each side appears more decided because of a slightly greater spread of the marginals over the femoral arches and farther back. The striae of growth are present on the younger; on the old they are more effaced. The straight width is about three fourths of the straight length; the curved width is little greater than the curved length. The differences in the sternum are even more patent. The humeral extension from the front of the bridge is narrowed forward; the gular plates are reduced, somewhat pointed, and are partly separated by a notch, Plate **5**, fig. 3. The femoral extension from the bridge backward is narrowed toward the anal plates, which appear small, though larger than the gulars, and are rounded to meet in front of the shallow notch.

Plate **3** shows the outlines of the carapace of the half grown specimen figured in Günther's, 1877, Plate **38**, Plate **5** those of the 27 inch female on his

Plates **35**, **36**, and on Plate **4** are those of the thirty-three and a half inch male drawn on his Plate **34** and fig. A of Plate **35**. The following measurements, in inches, were given of the Cookson specimens, all supposed to be from Tagus Cove.

Length	Width	Curved length	Curved width	Sternal length	Sternal width
25	19½	32½	34½	20½	16½
33½	24½	41	42	24½	23
33½	25	44	46	27½	25
27	22	35	38	21½	20

Testudo vicina Günther.

Plates **6**, **7**.

Testudo vicina Günther, 1875, Philos. trans. Royal soc. London, **165**, p. 277, pl. 35 A, 40, fig. B, pl. 41, fig. A, C, pl. 45, fig, C, C′, D; 1877, Gigantic land-tortoises, p. 73, pl. 31, 46, fig. B, pl. 47, fig. A, C, pl. 54, fig. C, C′, D; Boulenger, 1889, Cat. Chelon., p. 170; Rothschild, 1902, Nov. zool., **9**, p. 448; Heller, 1903, Proc. Wash. acad. sci., **5**, p. 54; Beck, 1903, 7th Ann. rept. N. Y. zoöl. soc., p. 164; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 354; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 344, pl. 93–110; Rothschild, 1915, Nov. zool., **22**, p. 406.

Testudo elephantopus Baur, 1889, Amer. nat., **23**, p. 1044; Lucas, 1891, Smithsonian rept., pl. 104, fig. —; Gadow, 1901, Cambridge nat. hist., **8**, p. 378.

Testudo nigrita Cope, 1889, Proc. U. S. N. M., p. 147; Lucas, 1891, Smithsonian rept., pl. 104, fig. —.

In the lot of young tortoises purchased by Prof. Louis Agassiz on Santa Maria Island (Charles) in 1871 there is a fourteen inch specimen of *Testudo vicina*. How it came to be on that island is not known. From the young it is very evident that this species is most closely allied to *T. nigrita*, Plate **10**. *Testudo vicina* differs from the latter in being longer, narrower, and higher, and there are other differences of which the measurements give no hint. The length over the curvature at this stage of growth about equals the width over the curvature in each species. The carapace of *T. vicina* is the more flattened, it is more depressed, that is, it has less of the dome shape on the middle of the back. The arches between the areolae of opposed costal plates are lower and broader. The curves from the nuchal notch to the areola of the fourth vertebral scale are broader and the descent from that point to the lower edge of the caudal scute is less steep. In the sternum, the two species are similar in the gular and the anal scales. The areolar spaces appear to be smaller on the back of *T. vicina*, but the striae are equally distinct. A photograph of the specimen is shown in Plate **6**. The outlines of the type, as drawn by Ford for Günther, 1875, Plate 35A, from a thirty-three inch specimen, are included in Plate 7. Specimens at hand are more curved from the middle of the fourth vertebral scale to the anterior marginals than in this drawing. In the fourth vertebral and backward the curve is sharp, but the marginals are less declivous, which is also true of the forward marginals. On both front and back the marginals are somewhat reverted, concave on their upper surfaces, in the older specimens. A number of the specimens in the M. C. Z. were secured by Webster near Iguana Cove in the southern part of Santa Isabela (Albemarle); these are compared with the figures of those secured by Van Denburgh in the same locality. The declivity from the middle of the fourth vertebral backward is usually greater than that forward from the second. The caudal plate is directed downward, and slightly forward at the lower edge. A large shallow notch partly separates the marginals of the foremost pair. The indentation at the fourth, and that at the eighth marginal, on each side are shallow, as also the grooves, compressions, extending from them. Except perhaps on specimens of greater age, the concentric striae are present. The areolar spaces vary in convexity; in cases they are prominent. The carapace is broader posteriorly; it appears subtruncate, the caudal scale being indented between the marginals at each side of it. In front the margin is the more rounded, subacuminate. Above the humeral and the femoral arches the marginals form scallops.

The sternum of the type is longer than broad; the humeral extension, in front of the bridge, is broad at the end and is somewhat concave on its lateral margins in the large specimens. The femoral extremity is shorter, broader, and is convex on the lateral margins of the abdominal plates. In both young and old the gulars thicken upward; on the aged they have a comparatively small amount of the downward swelling. The anal scutes are broader than the gulars and have an angular notch between them; they thicken and curve downward with age. The sternal concavity is deepest below the hinder portions of the abdominal scales; it is deeper on the old males.

In recent collections of specimens of this species there are appearances of considerable mixtures by transportation from one island to another. The earlier captures appear more distinct than some of the later ones. Undoubtedly the oil collectors, the orchilla pickers, the meat hunters and others were quite ready to contribute to a distribution that has left traces in various directions, and latterly the young specimens from different islands have been on sale within reach of collectors at particular localities.

Measurements.

(*In inches*).

M. C. Z.	Direct length	Direct width	Curved length	Curved width	Height
4482	$14\frac{1}{4}$	$10\frac{3}{4}$	$18\frac{1}{2}$	$18\frac{1}{2}$	7
11076	27	21	$34\frac{1}{2}$	$35\frac{1}{2}$	$14\frac{1}{4}$
11077	30	24	36	$40\frac{1}{2}$	$15\frac{7}{8}$
11078	$28\frac{3}{4}$	$22\frac{3}{8}$	$34\frac{1}{2}$	37	$14\frac{5}{8}$
11087	39	$28\frac{1}{2}$	$47\frac{1}{4}$	50	$18\frac{1}{4}$

Testudo nigrita Duméril et Bibron.

Plates **8–10**.

The Great Gallapago-Tortoise Mitchill, 1815, Med. repos., ser. 2, **2**, p. 309, 402.

Testudo nigrita Duméril et Bibron, 1835, Erpétol. génér., **2**, p. 80; Strauch, 1865, Verth. schildkr., p. 25; Günther, 1875, Philos. trans. Roy. soc. London, **165**, p. 267, pl. 33, fig. B, pl. 35, fig. C, pl. 37, fig. B, pl. 38, fig. D, pl. 39, fig. D; 1877, Gigantic land-tortoises, p. 69, pl. 30, fig. B, pl. 31b, fig. C, pl. 42–44, figs. D; Boulenger, 1889, Cat. Chelon., p. 169; Strauch, 1890, Bemerk. schildkr., p. 52; Waite, 1899, Records Austr. mus., **3**, p. 95, pl. 20–22; Heller, 1903, Proc. Wash. acad. sci., **5**, p. 50; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 531; Rothschild, 1915, Nov. zool., **22**, p. 407.

Testudo indica Gray, 1831, Syn. rept., p. 9 (part); 1844, Cat. tort., p. 5; 1855, Cat. shield rept., p. 6, part; 1870, Suppl. cat. shield rept., p. 5; Sowerby & Lear, 1872, Tort., pl. 6.

Testudo planiceps Gray, 1855, Cat. shield rept., p. 6, pl. 34; 1870, Suppl. cat. shield rept., p. 5.

Testudo elephantina Strauch, 1862, Chelon. stud., p. 83.

Testudo elephantopus Gray, 1870, Proc. Zool. soc. London, p. 708, pl. 41 (part); 1872, Appendix cat. shield rept., p. 3.

Testudo wallacei Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 351, pl. 111, 112.

Testudo porteri Rothschild, 1903, Nov. zool., **10**, p. 119; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 532; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 354, pl. 113–121.

Testudo darwini Van Denburgh, 1907, Proc. Cal. acad. sci., ser. 4, **1**, p. 4; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 533; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 319, pl. 56–63; Rothschild, 1915, Nov. zool., **22**, p. 405, pl. 36.

Testudo sp. Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 362, pl. 122.

A young specimen of this species, measuring eleven and one half inches in direct length, Plate **10**, does not differ greatly in its shapes from the smaller of the types originally described, which measured twenty-two inches, and of which the outlines are sketched on Plate **9** from the plate by Günther, Trans. Zool. Soc. London, 1875, **170**, pl. **35**, fig. C. The carapace is a short broad oval, rounded in front and over the femora, and subtruncate across the caudal section. Its height is about half of the length; the back is broadly arched. At the nuchal notch the height is about half of that in the middle of the body. The strongest vertebral declivities occur from the areolar space of the first vertebral scale forward and from that of the fourth vertebral backward. The flanks are nearly straight and bear a low keel below the areolar spaces of the costal scales from the fourth to the eighth marginals, continuous with the edges of the carapace in front and behind. This keel is not retained on old specimens to such an extent as on *T. clivosa,* Plate **21**. There is a weak notch on each side at the fourth marginal and another at the eighth; the grooves from these notches extending toward the nuchal notch and toward the caudal scale are shallow but distinct. In front of the humeral notches, and behind the femoral, the marginals form scallops. Anteriorly the marginals have a slight incline downward. All of the scales are strongly marked by striae. The amount of prominence in the areolar spaces varies; on specimens of a length of two feet or thereabout the areolars are decidedly prominent on the first and on the fourth and the fifth vertebrals. The descent from the fifth is quite steep. The striae persist on some; on other species they are nearly or completely lost, Plate **36** (*T. nigra*). The bones are light. On the sternum the concavity is absent or shallow on the young, of moderate depth on specimens more than half grown. The gular scutes are narrow and swollen above the ends which are slightly turned downward below the edge at each side of a shallow notch. The anal scutes are longer than wide and the pair are separated behind by a moderate notch; the angle on a scute is thin, sharp, and curled upward somewhat. The caudal notch persists on large specimens. Plate **8** contains the outlines of the larger of Bibron's types, a forty-one inch specimen, taken from Günther's figure B of his Plate **33**, apparently a ♀. Males of more than thirty inches have served as types for *T. wallacei, T. porteri,* and *T. darwini.* This sex is commonly the more elongate and the flanks are less full and rounded. Occasionally the curved width is less than the curved length, as in case of the type of *T. darwini* but in most cases the curved length and the curved width are nearly equal, while the direct width is two thirds to three fourths or more of the direct length. Specimens identified with this species have been collected on Santa Maria (Charles), Santa Cruz (Indefatigable), Rabida (Jervis), San Salvador (James), and on Middle and on South Isabela (Albemarle).

The color is a uniform dark brown or black, commonly without yellow markings on the lower surfaces.

In all likelihood a note by Mitchill, 1815, was the first mention of this species. The measurements he gives are impossible when applied to any known tortoise of the Galapagos, but they make their nearest approach to *T. nigrita.* Since the article *Description of the great* GALLAPAGO-TORTOISE. From Dr. Mitchill's Lectures on Natural History, contains interesting matter, and has been ignored heretofore, it is reprinted from the Medical Repository, **2**, p. 309 and 404.

"About the middle of July, 1814, the ship Essex Junior, Lieutenant Downes, of the U. S. Navy, arrived in New York. He had been on a cruise, by order of government, along the coast of Brazil, and round Terra del Fuego, and off the land of Chili and Peru, in quest of British traders and whale-men. He served under Commodore David Porter, of the frigate Essex, a vessel of war which had almost broken up the enemy's navigation and commerce, in the tract of ocean lying between Cape Horn and the Gallapagos Islands.

After visiting Valparaiso and Lima, in March, 1813, Capt. Porter proceeded to the neighborhood of this group, and cruised there between April and October, for English vessels, where he captured twelve, which were chiefly occupied in the chase of the spermaceti whale. He describes the Gallapagos Islands as "being perhaps the most barren and desolate of any known," and so utterly destitute of fresh water, that he was obliged to touch on the coast of America, during the time, to procure a supply of that necessary article. They are chiefly volcanic piles, and the water that condenses on their summits is absorbed by tufa, slag, and ashes, before it can reach the sea.

From the Gallapagos the crew took a number of the native tortoises for food. These creatures are very large, and frequent there. They inhabit the land, and seldom or never enter the water from choice. Two of them were brought alive to New York. They bore the voyage of between two and three months without taking any food. They have been carefully examined, and described. Both were females. The larger had the following characters.

The colour of the buckler and skin was a deep and uniform black.

The head was rather small in proportion to the body, and at pleasure could be drawn out of sight, and concealed behind the fore legs, approximated for its protection.

The back was very convex. The sides prominent and capacious; but the gibbosity was without knobs, asperities, or processes; and merely marked by dividing lines, among the pannels. There were five of these pannels along the back, four on each side, and twenty-three in the circumference, making thirty-six in the whole.

The length, measured over the elevation of the buckler, between head and tail, was about two feet and a half. The distance from side to side over the back was almost as great, or nearly twenty-nine inches. The height, as the animal rested on the belly or sternum, was about two feet.

The weight, when she arrived, poor, lean and famished was eighty pounds.

The fore part of the legs was covered with a thick and hard skin, that by deep indentations resembled the scales of an alligator's hide. Each of her fore feet had five claws; of the hinder, four, and the balls of her feet were prominent and puffed, as if for *walking* over the ground, and not for creeping, or crawling. Such is the *length of her legs,* that her erect posture adds about a foot to her stature.

This individual, weak and exhausted as it was, could move with the weight of a man on its back.

The fore part of the crown of the head was rough, like the legs.

It arrives in its native region, to the magnitude of three hundred pounds, and even more. When full grown and strong, it can travel away with the weight of three or four men. It is very prone to accumulate fat. In cooking the flesh there is no need of employing butter.

It can live, as is said, a year, without food or drink.

The sailors travelled two miles and more inland upon the Gallapagos Islands in search of these tortoises, or *turpins* as they called them. When they catch the animals, they carry them in their arms, or on their shoulders, to the boat. There were more than two hundred on board the Essex. The English whaling vessels that were captured, mostly had some of them. Navigators prize them highly for food, and esteem them as savoury and wholesome. One of the men told me he had seen the same sort of tortoises on the Isles Tristan d'Acunha and Bourbon. Like the camel, the turpins have a stomach or reservoir in which they preserve water to the amount of several quarts for a long time. Voyagers sometimes kill them for the purpose of procuring this water to drink, which they pronounce to be cool and sweet. Commodore Porter told me he had repeatedly tasted it, and could bear witness how good and potable it was. The water the stomach contains is sufficient for cooking the flesh. The Gallapagos are stated to abound in volcanoes, and subterranean fires. They are rocky, peaked and forbidding. There are few springs or brooks of water. With great difficulty and exertion the Essex collected about half a dozen casks; and then sailed for the continent to obtain a further supply. There are no settled or stationary human inhabitants.

The seas abound in excellent fish and green turtle. Cocoa-nuts may be found in some places on shore. And the Guanos lizard may be catched for eating. But it must be remembered that this is the *Sea-Guanos*, a species of lacerta, entirely different from that of the West-Indies. The *Sea-Guanos* of the Gallapagos, swim and feed in the ocean, and go ashore to rest and breed."

The following occurs on p. 404 of the same volume:

"On the 13th of February, 1815, I examined the body of the female Gallapagos tortoise.

I found the alimentary canal to be exceedingly large and capacious. The whole length of this tube, from the throat to the anus, was about thirteen feet. Of this the gullet and stomach were twenty inches; the small guts five feet, and the large ones six feet and a half. The cæcum had no appendages; the colon had faint and weak muscular bands; and the rectum communicated with the uterus and bladder a few inches before the posterior outlet. They are all united with one common cloaca.

The bladder contained a considerable quantity of urine. It was remarkably large, and capable of holding four quarts of water, as we found by experiment. The creature, when alive, voided naturally great quantities of urine.

The animal is said to hold within it, when in health, a plenty of potable water. I found none in this individual; though the stomach, colon, and bladder could each have contained a large supply. The reason probably was, that the creature had been for a long time under artificial restraint, and had been crammed to death, through kindness, by Indian meal (meal of maize). The uterus contained two eggs almost ready for exclusion, the weight of one alone was six ounces. These had beautiful calcarious shells, that were rough, white, round, and about the size of a one pound shot. It was divided into two parts, and the ova were very numerous, and of different sizes. Near the junction of the two cornua uteri with the strait intestine, were the two kidneys of a triangular figure, and of a convoluted structure. Their extreme length was four inches, and the breadth of the widest part two and a half.

The trachea divided into two branches, one of which entered each lung. The cells of this organ were open, large, and distinct, as usual in these amphibious creatures.

There were two large muscles parallel with the back, for retracting the neck. One of them arose from each side of the cervical vertebrae; they were of extraordinary length, and were inserted in the shell towards the rump. The outer coat of the shell looked as if it was sufficiently beautiful for manufacture.

The heart consisted of two auricles and one ventricle; the auricles were separated by a septum. The pulmonary veins emptied into one, and the vena cava into the other. There was but a single ventricle; and two fleshy valves, in shape somewhat like the epiglottis, opposed the return of the blood from the ventricle into the auricles.

From the ventricle proceeded three arteries; two of which soon divided into two branches each, making five in the whole, soon after leaving the heart. The heart was oblong and kidney shaped. These arteries had appropriate valves at their origin."

MEASUREMENTS.

(*In inches*).

	Straight length	Straight width	Curved length	Curved width	Height	Sternal length
T. porteri[1]	$36\frac{1}{2}$	31	$50\frac{1}{2}$	55	$22\frac{3}{4}$	$31\frac{3}{4}$
T. darwini[2]	38	28	49	46	$20\frac{7}{8}$	$32\frac{1}{4}$
T. darwini[3]	$48\frac{1}{2}$	$34\frac{1}{2}$	$56\frac{1}{2}$	62	25.7	36
T. sp.[4]	$26\frac{3}{4}$	$22\frac{1}{2}$	$34\frac{1}{2}$	37	$16\frac{1}{4}$	$22\frac{9}{10}$
M.C.Z. 11079	$24\frac{1}{4}$	$19\frac{1}{2}$	30	32	$12\frac{1}{2}$	
11080	$21\frac{1}{2}$	$16\frac{1}{2}$	27	$27\frac{1}{2}$	$11\frac{1}{4}$	
11088	$27\frac{1}{2}$	$21\frac{1}{4}$	37	$38\frac{1}{2}$		
11091	$22\frac{1}{4}$	18	28	$30\frac{1}{2}$	$12\frac{3}{4}$	
12049	$11\frac{1}{2}$	9	15	15	$5\frac{3}{4}$	$10\frac{1}{4}$

TESTUDO MICROPHYES Günther.

Plates **11–20**, **38**, fig. 3.

Testudo elephantopus GÜNTHER, 1875, Philos. trans. Roy. soc. London, **165**, p. 261, pl. 33, fig. A, pls. 37–39, fig. A, pl. 40, fig. A, C, D., pl. 41, fig. B, pl. 42, fig. A, pl. 43, pl. 44, fig. A–A″, C, D; 1877, Gigantic land-tortoises, p. 63, pl. 30, fig. A, pl. 42–44, fig. A, pl. 46, fig. A, C, D, pl. 47, fig. B, pl. 51, fig. A, pl. 52, pl. 53, fig. A–A″, C, D; ROTHSCHILD, 1902, Nov. zool., **9**, p. 448, 618; HELLER, 1903, Proc. Wash. acad. sci., **5**, p. 53; SIEBENROCK, 1909, Zool. jahrb. Suppl., **10**, p. 532.

Testudo microphyes GÜNTHER, 1875, Philos. trans. Roy. soc. London, **165**, p. 275, pl. 36–39, fig. B; 1877, Gigantic land-tortoises, p. 78 (part), pl. 37, pl. 42–44, fig. B; ROTHSCHILD, 1915, Nov. zool., **22**, p. 406, 416.

Testudo güntheri BAUR, 1889, Amer. nat., **23**, p. 1044; VAN DENBURGH, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 335, pl. 84–92; ROTHSCHILD, 1915, Nov. zool., **22**, p. 406, 410.

Testudo galapagoensis ROTHSCHILD, 1915, Nov. zool., **22**, p. 404 (part), pl. 27, 28.

Testudo chathamensis VAN DENBURGH, 1907, Proc. Cal. acad. sci., ser. 4, **1**, p. 4; 1914, **2**, p. 323, pl. 64–69; ROTHSCHILD, 1915, Nov. zool., **22**, p. 406, 409, 416, pl. 29, 30.

The species *Testudo microphyes* was founded on a specimen twenty-two inches and a half in direct length, at the time in the possession of the Royal Institution of Liverpool. It was said to be "a fully adult male," "the smallest of the Galapagos Tortoises," and was supposed to have come from Española Island (Hood). Later this type was secured by the British Museum and in the publication on the Gigantic Land-Tortoises, 1877, after comparison with Cookson specimens it was said to be "undoubtedly a female" from the north of Isabela Island (Albemarle). The conclusions here recorded after a detailed

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[1] Rothschild, Nov. zool., 1903, **10**.

[2] Van Denburgh, Proc. Cal. acad. sci., 1907, **1**.

[3] Rothschild, Nov. zool., 1915, **22**.

[4] Van Denburgh, Proc. Cal. acad. sci., 1914, **4**.

study are that the type is abnormal, somewhat aged, probably a dwarf, and differs so much from the specimens obtained by Cookson as to prevent retention in the same species. The Tagus Cove species is considered a new one, and, being one of the largest found on the islands is named *T. macrophyes* (Plate **4**, **5**).

The type of *T. microphyes* Günther, 1875, was probably not an average individual of the species. The outlines of the original figures by Wesley, are sketched on Plate **11**. As seen from above the shape is subelliptical, slightly irregular, and slightly narrower forward. The body is depressed and has a rather low arch on the back. The outline, from the side, is broadly curved from front to rear. Anteriorly in the first and the second vertebral plates there is some descent and posteriorly from the middle of the third vertebral the curve becomes steeper and sharper. The curved width is little if any greater than the curved length, certainly not so much greater as in the nearly allied species, *T. nigra*. Compared with that species the bones of the shell are thicker and heavier, the back is not so high posteriorly. The scales are smooth, the marginals appear to be much worn, the edges of the carapace are thickened and rounded at the edges. The sternum bears more resemblance to that of *T. elephantopus* than to that of *T. macrophyes;* it is broad and broadly rounded in front of the humeral extension, and behind the femoral extension, across the anal scutes, it becomes when old nearly or quite truncate. The skull differs from that of *T. macrophyes* from Tagus Cove; it agrees with that of *T. güntheri* from Villamiel.

Young individuals of about fifteen inches in direct length, Plates **17**, **19**, purchased on Santa Maria Island (Charles) appear rather smooth, though the striae are sharper in the younger stages. The gular plates are rounded and not separated by a sharp notch. In the specimen, Plate **19**, the bone in the anal scutes is nearly truncate and the notch is shallow but the horny scales extend beyond and turn up in points behind it. Specimens of this size have the shallow early indications of the sternal concavity.

Plates **12**, **20** represent specimens of about two feet in length of carapace. In this size, with the exception of the blister-like pits, the scales are smooth, the gulars, the anals, and the scallops of the edges are much changed. The back is depressed to different degrees in different individuals and varies in curvature. The swollen flanks of the females indicate that they are fully adult. In cases the notch between the gulars, or that between the anals is obsolete; in others these scutes have suffered less. The gulars thicken upward; in some examples the anals have hardly changed.

Specimens of from thirty-one to thirty-eight inches, Plates **14**, **16**, show the edges of the shells to be more modified and the backs to be more depressed, especially in the male, in which they have become subquadrate. The sternum is nearly truncate, is deeply concave and the slight constriction at the fourth and the eighth pairs of marginals is evident in both sexes. None of the specimens show decided bosses on the areolar spaces of the dorsal scutes.

The specimen, Plate **12**, was received in exchange from Van Denburgh, from Villamiel, southeastern Isabela (Albemarle); its affinities are evident on comparisons with his Plates **66**, **68**, **83**, **84**, **90**, **92**, and others. Plates **14**, **16** of the present work are photographed from large specimens brought by Baur from the same locality. Plate **15** shows outlines of *T. elephantopus* Günther, 1875 and 1877 (not of Harlan, 1827), from drawings by Ford of a specimen the history of which was unknown. Much dependence was placed on the skull of the same specimen for distinction from other species. The differences appear to be individual rather than specific. The occipital crest affords the greatest variance; that crest, however, figured in Günther's, 1875, Plate **38**, fig. A, and 1877, Plate **43**, fig. A, had been broken or mutilated and in its repair took on a peculiar shape not occurring on other specimens. Young to medium sized specimens favor *T. microphyes* Günther, 1875; the old ones agree better with *T. elephantopus* Günther, 1875, = *T. güntheri* Baur, 1889.

On Plates **17** and **18** are figures of No. 4479 M. C. Z. and on Plate **19** is a photograph of No. 4476. These are the smallest specimens of this species in the collection; they were purchased by Prof. Louis Agassiz on Santa Maria. A description of No. 4476 will answer about as well for No. 4479, they are so nearly of the same size and appearance. No. 4476 has a rather plump appearance, being well and smoothly rounded on the sides and back. The indentation or concavity on the first to the third marginals is shallow and these scutes are but little turned upward. The indentation of the eighth marginal is not very distinct. The bosses on the vertebrals are low, the most marked being that on the first of the series; there are no bosses on the second and third, and none on the costals. Instead of a sharp ridge along the flank as on *T. vicina* this portion is rounded and smooth, the carina making its appearance far in front, in the fourth marginal, and far back, in the seventh. The declivity in the first vertebral scute, the descent to the neck, is a little steeper than on older specimens; the greatest height is attained in the third vertebral. There is a large area in the central portion of each scale on which the striae are effaced, either by sloughing or by scouring; nearer the edge there are seven or eight more distinct striae. From the fourth vertebral to the caudal there is a moderately sharp descent but the first of these scales has not a marked boss. The lines of junction between marginals and costals are moderately straight. The caudal does not extend as far backward as the marginal at either side of it, but curves downward somewhat lower.

The sternum is broad; the abdominals make a long bend from their lowest portion to meet the marginals. The anals form a shallower notch than that of *T. vicina;* their hinder angles are more rounded off. The sternal concavity is shallow, not yet reaching the depth of half an inch in the hind parts of the abdominals. A deep groove near the edges of the scutes (stria of growth) shows that the abdominals have made a greater enlargement than the other scales (Plate **19**, fig. 3).

MEASUREMENTS.

(*In inches*).

	Straight length	Straight width	Curved length	Curved width	Sternal length	Sternal width	Height
T. elephantopus [1]	31	26	37½	40	24½	23	
T. microphyes [1]	22½	15½	26	29	18	14	10
T. chathamensis [2]	35¼	24¼	39½	38	26¼		14
T. chathamensis [2]	22½	17	28¼	26	18¼		11½
M. C. Z. 11065	37¾	30¾	43½	50	28½	27½	17½
11066	31¾	24¼	36½	40	23½	22	14
11067	25½	19½	29½	32½	19¼	16¾	11¼
11071	23⅝	17½	28½	31¼	18½	16⅛	11½
11085	42	31	50½		30½	28½	17
11086	41¼	32½	51	55¾			
4476	15½	12¼	19½	19½		12¾	7½
4479	15½	11½	19¼	19½	12½	10¾	7⅜

TESTUDO CLIVOSA, sp. nov.

Plate **21**.

This tortoise (Type M. C. Z. 11075) is described from a bony carapace and plastron on which there are seven or eight entire scutes in place. Of its history nothing definite is known. It was supposed to have come from the Mascarenes. Possibly a name and date, "Narraga 1861," may yet help to

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[1] Günther, Philos. trans., 1875, **165**.

[2] Van Denburgh, Proc. Cal. acad. sci., 1907, **1**.

determine the habitat. There is nothing in its structure that would preclude an eventual determination of an origin, either indirect or direct, among the Galapagos. It has close affinities to their species though in some respects its peculiarities do not permit identification with any of which descriptions or figures have been published. Its outlines are suggestive of the wider and shorter individuals of *T. elephantina* Duméril et Bibron. It has two gulars but no nuchal plate.

Direct length	Direct width	Curved length	Curved width	Height	Circumference
25⅜ in.	20 in.	30½ in.	32¾ in.	12¼ in.	51½ in.

Height to nuchal notch 10, to middle of back 12¼, and to lower edge of caudal scale 1½ inches. The bones are thin and light, the entire weight, with attached scales, being less than five pounds. All sutures are complete and firmly joined excepting those at the inner edge of the marginals from the first vertebral to the edges of the supracaudal. The bones of the back at the lower edges of the costals are separated from those under the marginals by a space and their only connections are made by the ribs, except at the nuchals and at the supracaudals where they are rigidly united by broad anchyloses. The conditions along the flanks are like those existing on the very young of other species. The scutes are thin and fragile, the areolar spaces are small; the concentric striae are numerous, narrow, and sharp. The carapace is short and broad and is broadly arched on the back. In front from the middle of the second vertebral, through the first, the descent is about as in *T. vicina* Günther. Fourth vertebral narrow behind, hind edge about 3¾ times in front edge. Seen from above the shape approaches the subquadrangular, owing to a considerable spread and recurvature of the humeral and the femoral marginals. The anterior marginals extend forward and upward, and the posterior extend farther back than the caudal, which is narrow, convex, and curves down and forward at the lower edge. The humeral indentation, on the third marginal, is shallow but the groove from it to the middle of the first vertebral is decided, because of the recurvation of the marginals behind it similar to *T. elephantopus.* The vertebral shields are broader than the costals; each has a high convex boss on the middle, that on the fifth vertebral being especially prominent. Including the areolar space on each costal there is a similar boss. On the plastron the gulars are broad and subtruncate in front, swollen and rounded above the edge and rounded on the angles. The pectorals are short, broad and in contact.

The concavity is rather deep, deepest in the hinder halves of the abdominals. The anals are shorter and broader than the gulars; they meet in a shallow notch behind, below which the edge is swollen, thickened and bent downward.

TESTUDO TYPICA, sp. nov.

Plate **22, 34.**

This species (Type M. C. Z. 11072) is one of the nearest allies of *T. nigra*. Looking downward upon it the carapace appears subquadrangular and somewhat narrower across the humeral section than across the mid length or farther back. In the middle of the first vertebral scute there is a prominence and from it a considerable declivity forward. Behind this vertebral the dorsal arch is low and regularly curved to the areolar space on the middle of the fourth vertebral, which is prominent and from which the descent is steeper to the space on the fifth vertebral, which latter is yet more prominent, almost acuminate. From this boss the descent to the caudal is nearly vertical. The upper margin of the fifth vertebral is narrow, being less than one fourth of the width of the lower edge. The convexity of the other vertebrals and of the costals is low. The marginals are comparatively large; the anterior three pairs and the posterior four pairs are reverted and form scallops along the margins. Marked grooves occur from the humeral and the femoral notches along the inward edges of the marginals. Along the flanks the costals and the marginals are sufficiently convex to give a full and plump appearance to the body. The lower edge of the caudal is not bent forward; it inclines straight back and downward. Axillary and inguinal scales are single. In the femoral section the marginals are somewhat wide and pass back and upward; the lower edge of the caudal descends sharply below the marginals. This form is distinguished from all its nearest allies by the prominent subacuminate boss of the fifth vertebral.

Sternum subtruncate in the gulars with the angles rounded off. On the lower surface the concavity is deepest at the junction of the femorals with abdominals; it shallows gradually forward and more rapidly outward and backward. The anal scales are hardly swollen at all; between them the notch is of moderate depth. In front the gulars are swollen upward. Solidity of bones and anchylosis of sutures are probably the effects of a considerable age. The color was nearly a uniform black.

MEASUREMENTS.

(In inches).

M. C. Z.	Direct length	Width	Curved length	Width	Height	Sternal length	Width	Gulars	Anals
11072 Type	24	17½	33	30	11¾	19	16¼	4	3
5260	29	22¼	34	36½	13⅝	23	20		

The type, Plate **22**, differs from specimens of *T. nigra*, equal in size, in being less convex on the back, the arch from the first to the fifth vertebral scale being lower, as also that across the back; the marginals above the legs are entire, not worn and thickened, and form greater arches, the eighth marginal is wider on its upper edge; the bones of the sternum above the gulars and the anals are not swollen downward; the anal notch is a little more than 90°; and the fifth vertebral scale is narrow on its upper edge and bears in its upper half a steep and sharp prominence. On similar comparison with *T. microphyes* it is seen that nearly all of these differences are pertinent.

Specimen described is from the Boston Society of Natural History. Dr. C. F. Winslow collection (See Proc. Boston Society Natural History, 1861, **10** p. 59).

TESTUDO NIGRA Quoy et Gaimard.

Plates **23–33**, **35**, **36**.

Testudo nigra Quoy et Gaimard, 1824, Voyage Uranie et Physicienne zool., p. 172, pl. 40; Cuvier, 1829, Regne anim., **2**, p. 10; Voigt, 1832, Thierreich., **2**, p. 9; Duméril et Bibron, 1835, Erpétol. génér., **2**, p. 115; Wiegmann, 1835, Nov. act. Leop.-Carol., **17**, p. 118, pl. 13; Strauch, 1862, Mem. Acad. St. Petersb., ser. 7, **5**, p. 85; 1865, Verth. schildkr., p. 29; Boulenger, Cat. Chelon., p. 170; Strauch, 1890, Bemerk. schildkr., p. 53.

Testudo californiana Quoy et Gaimard, 1824, Bull. sci. nat., **1**, p. 90, pl. 11.

Testudo elephantopus Jackson, Boston journ. nat. hist., **1**, p. 443, pl. 10, 11; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 245, 316, pl. 55, fig. 2, pl. 56, fig. 1.

Testudo galapagoensis Baur, 1889, Amer. nat., **23**, p. 1044; Günther, 1902, Nov. zool., **9**, p. 184, pl. 16–21; Heller, 1903, Proc. Wash. Acad. sci., **5**, p. 53; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 553; Rothschild, 1915, Nov. zool., **22**, p. 404, pl. 23–26.

Testudo wallacei Rothschild, 1902, Nov. zool., **9**, p. 619; Heller, 1903, Proc. Wash. acad. sci., **5**, p. 54; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 533; Rothschild, 1915, Nov. zool., **22**, p. 407, pl. 31, 32.

The type described and figured by Quoy and Gaimard was said to be twelve inches long and eight inches wide. It was obtained by Freycinet at the Sandwich Islands (Hawaiian) from the Captain of a vessel that had recently (about 1818) arrived from California. There is no mention of the original habitat. The figures published by the describers are sketched in outline on Plate **23**, fig. 2, 3. Plate **23**, fig. 1, is from a drawing published by Wiegmann of a specimen weighing a hundred and twenty-five pounds, after losing forty pounds of its weight in a year's voyaging, before being bought by Meyen from a Galapagos Whaler at Honolulu.

The more important items in the description are in the words of the authors: — "Testudo, toto corpore nigro; testa gibba, scutellis dorsalibus priori posteriorique altius in medio elevatis, cunctis loricae margine striatis, lateribus subcarinatis. Les enveloppes de cette tortue ont douze pouces de longueur et huit de largeur. La carapace est très bombée, arrondie, et le disque composé de treize ecailles; des cinq qui forment la rangée du milieu, deux ont un diametre transversal plus considérable que les autres; plusieurs sont protubérantes à leur centre, mais surtout l'antérieur et la postérieur. . . . Le plastron se compose de seize pièces, dont huit en avant, une paire beaucoup plus large au milieu, et six en arrière: les deux premières sont arrondies et courbées en bas; les postérieurs assez profondément echancrées. Toutes offrent des stries concentriques et parallèles entre elles."

Duméril et Bibron, Erpétol. Génér., 1835, **2**, p. 118, give the length of the type as 34″, and those of a larger carapace as "Long. (en dessus) 71″; haut. 28″; larg. (en dessus) 86″."

In a description taken from a specimen of about eleven inches in length (Plate **24**, probably an average individual), the form of the species is approximately a short oval in which the ends do not converge enough to render them at all pointed. In fact the shape would not be badly described as subtruncate with the front a little the more rounded and the opposite extremity, across the caudal scale somewhat more truncate. The proportions of an individual of about this length have a width of nearly three fourths and a height of about one half of the straight length. A flattening on the back is usually most apparent across the third and the fourth of the vertebral plates. The descent from this portion is more gradual forward in the first and the second vertebrals and more rapid backward through the fourth and the fifth vertebrals and the caudal. The arch across the middle of the back is low and broad. The entire series of the marginal plates forms scallops the more prominent of which are the first to the fourth and the eighth to the hindmost, inclusive, at each side of the median line. The areolar spaces on the costal scales, and on the vertebrals are a low convex, those of the first and the fifth vertebrals being most prominent. The general outline is rather smooth or even. The concentric striae are strongly marked on the scales of all the young. At the fourth and at the eighth of the marginals, on each side, the notches at the outer angles of the bridge are apparent, shallow, but distinct. The second, third, and the fourth marginals, toward their outward ends, are slightly curved upward; the first pair above the neck incline downward slightly; the hindmost one, the caudal, extends down abruptly and curves forward at the lower edge; and on the fourth to the eighth marginals, along the flanks, there is a low blunt keel.

The width of the plastron is about nine elevenths of its length; the concavities on its lower surface are so shallow at this age they may be overlooked. The gular extremity is subtruncate, rounded, and a trifle swollen upward at the end in front. There is a weak notch between the gulars; they turn downward slightly at the front edge. The lateral outline of each humeral scale is convex in its hinder half and a very little concave anteriorly, forming a feeble sigmoid; and in the femoral section the lateral outline of each femoral scale is strongly convex. The anal scutes are separated by a deep notch, and each scale is longer than wide. In the young as in the old there is a considerable amount of individual variation, in outlines, prominence of areolar spaces, smoothness, and in measurements. The specimens in Plates **24**, **25**, **26** are a little larger than the type to which the name *T. nigra* was originally applied; they are part of the lot secured by the Hassler Expedition on Santa Maria Island (Charles).

Plates **32** and **33** represent a group of medium sized specimens, about twice the length of the type. They exhibit considerable changes worthy of note in a specific description. There has been an increase in direct length as compared with the direct width and height, and an increase in the width across the curvature beyond that of the curved length as the width and bulging roundness of the body increases, posteriorly there is a comparative increase in the height near the middle of the fourth vertebral scale and, in males especially a widening or flattening of the arches of the back without corresponding increase in height. The nuchal height has become greater, the humeral and the femoral arches have become higher and wider proportionally, and some of the marginal plates are curved and thicker at the free outer edges. The caudal plate has acquired a greater prominence as the marginals at its sides have worn away. The notches on the sides at the fourth and the eighth marginals, near the angles of the bridge, and the grooves above them are deepened; compression of the flanks anteriorly has steepened the sides and the saddle-shape, so called, has been increased thereby. From the scales the striae have disappeared in great measure, as also has the low ridges from the fourth to eighth marginals.

In both sexes the plastron has become deeply concave; its ends are wider and more rounded. Between the anal plates the notch is more shallow; gulars and anals are widened, the former have thickened upward, the latter are swollen downwards. Along each side of the medial concavity there is a great rounded prominence. An extreme form of the female in medium size is that shown on Plate **33**, a more common form on Plate **32**.

Specimens of about three times the length of the types are figured in Plates **29**, **30**, **31**, **35**. They emphasize the tendencies prominent on those of the medium sizes besides indicating others acquired on approach of maturity or depending on age, together with those dependent wholly or partly on sex. In the majority these features will be sufficiently evident from the illustrations. The large females on Plates **31**, **35** as compared with those of the smaller group, Plate **32**, have more fullness or roundness in the vertebral and in the costal plates and have much greater concavity in the sternum. They are even more concave than in the male, Plates **29**, **30**, fig. 3; the latter is more elongate and more depressed on the back and a trifle narrower across the humeral region. Being less deep in the sternal concavity may be a peculiarity of this specimen as the difference is not great. Plate **28**, fig. 1 and Plate **31** pertain to the female described in Dr. Jackson's article, The anatomical description of the Galapagos tortoise, Boston Journal of Natural History, 1837, **1**, p. 443. Plate **29** is the male discussed in the same article; it is outlined on Plate **30**, from Günther's figures in the Nov. Zool., 1902, **9**, Pl. 16 and 17.

These specimens were secured by the U. S. S. Potomac. Santa Maria (Charles) was the only island of the group visited. In the latter part of May, 1834, the vessel was at Boston, and in June the donation of "two gigantic Galapagos tortoises (living) weighing near three hundred and twenty pounds each, by *Capt. John Downes* (*U. S. Navy*) is recorded by the Boston Society of Natural History. The Potomac was at Santa Maria from August 31 to September 10, according to Reynolds's account, p. 547, "a large number of the crew were daily on shore after terrapin, and frequently exposed throughout the day to a hot sun, with these immense animals on their backs, travelling over the broken lava." The male of the Downes and Jackson specimens was examined by Baur and became the type of his *T. galapagoensis*. Afterward it crossed the Atlantic and was described and figured by Günther, 1902. The photograph, Plate **35**, a fine specimen inscribed with the legend "SHIP ABIGAIL 1835 Bj. CLARK MASTER," is probably from a native of the same island, Santa Maria. The ABIGAIL was a whaling vessel from New Bedford, Mass. The specimen is No. 11064 M. C. Z., received from the Boston Society of Natural History in exchange.

MEASUREMENTS.

(*In inches*).

M. C. Z.	Straight length	Straight width	Curved length	Curved width	Height	Length of sternum	Width of sternum
4477	$10\frac{3}{4}$	8	$13\frac{1}{4}$	$13\frac{1}{2}$	$4\frac{7}{8}$	$9\frac{3}{8}$	$7\frac{3}{4}$
4480	$12\frac{7}{8}$	$10\frac{1}{8}$	$16\frac{1}{2}$	$17\frac{1}{4}$	$6\frac{1}{2}$	$11\frac{1}{4}$	$9\frac{1}{4}$
4478	$15\frac{1}{4}$	$11\frac{1}{2}$	$19\frac{1}{4}$	$19\frac{1}{2}$	$7\frac{1}{2}$	$12\frac{1}{2}$	$10\frac{1}{2}$
11074	$24\frac{3}{4}$	$15\frac{1}{2}$	$30\frac{1}{2}$	32	$12\frac{1}{4}$	$19\frac{1}{2}$	18
11070	$38\frac{1}{4}$	28	45	$46\frac{1}{2}$	$17\frac{1}{2}$	$28\frac{1}{2}$	26
11069	$42\frac{1}{2}$	$32\frac{1}{4}$	$52\frac{1}{2}$	56	$20\frac{3}{4}$	33	30
1905	28	$21\frac{1}{2}$	$32\frac{1}{2}$	$36\frac{1}{2}$	$13\frac{1}{4}$	$21\frac{1}{4}$	$19\frac{1}{4}$
1904	$27\frac{1}{2}$	$21\frac{5}{8}$	35	38	$14\frac{1}{4}$	$21\frac{1}{8}$	20
11064	$41\frac{1}{4}$	33	52	59	$22\frac{7}{8}$	$31\frac{1}{2}$	29
4668	26	$20\frac{5}{8}$	33	34	13	20	18

For the type of *Testudo wallacei* these measurements are given by Rothschild, 1915:

Straight length	Straight width	Curved length	Curved width	Height	Sternal length
31.25	23.50	39	37.50	15.65	24.25

The straight length in the original description was 32.25 inches.

TESTUDO ELEPHANTOPUS Harlan.

Plates **37**, **38**, fig. 1, 2, **39–42**.

Testudo elephantopus Harlan, 1827, Journ. Acad. nat. sci. Phil., **5**, p. 284, pl. 11.

Testudo ephippium Günther, 1875, Philos. Trans. Roy. soc. London, **165**, p. 271, pl. 34, 35, fig. B, pl. 37, fig. C, pl. 38, fig. C, pl. 39, fig. C, pl. 42, fig. B, pl. 44, fig. B, pl. 45, fig. A, B; 1877, Gigantic land-tortoises, p. 81, pl. 31, 32, fig. B, pl. 39, 42–44, fig. C, pl. 51, 53, fig. B, pl. 54, fig. A, B; Baur, Amer. nat., **23**, p. 1040; Günther, 1896, Nov. zool., **3**, p. 329, pl. 20–22; Lidth, 1898, Notes Leyden mus., **20**, p. 126, pl. 3, 4; Gadow, 1901, Cambridge nat. hist., **8**, p. 378; Heller, 1901, Proc. Wash. acad. sci., **5**, p. 57; Beck, 1903, 7th Ann. rept. N. Y. zoöl. soc., p. 172; Siebenrock 1909, Zool. jahrb. Suppl. **10**, p. 534; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 306 pl. 39–52; Rothschild, 1915, Nov. zool., **22**, p. 404.

Testudo abingdonii Günther, 1877, Proc. Zool. soc. London, p. 66; Gigantic land-tortoises, p. 85, pl. 40, 41, 45, fig. D, F, pl. 48–50; Heller, 1903, Proc. Wash. acad. sci., **5**, p. 57; Van Denburgh, 1914, Proc. Cal. Acad. sci., ser. 4, **2**, p. 296, pl. 24–29; Rothschild, 1915, Nov. zool., **22**, p. 403, pl. 21, 22.

Testudo becki Rothschild, 1901, Nov. zool., **8**, p. 372; Heller, 1903, Proc. Wash. acad. sci., **5**, p. 59; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 530; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 303, pl. 31–38; Rothschild, 1915, Nov. zool., **22**, p. 404.

Testudo bedsi Heller, 1903, Proc. Wash. acad. sci., **5**, p. 59.

Testudo hoodensis Van Denburgh, 1907, Proc. Cat. acad. sci., ser. 4, **1**, p. 3; 1914, ser. 4, **2**, p. 313, pl. 52–55; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 535.

Testudo phantastica Van Denburgh, 1907, Proc. Cal. acad. sci., ser. 4, **1**, p. 4; Siebenrock, 1909, Zool. jahrb. Suppl., **10**, p. 535; Van Denburgh, 1914, Proc. Cal. acad. sci., ser. 4, **2**, p. 299, pl. 30.

What vessel carried Harlan's tortoises to Philadelphia may not be known. They may have been brought by the same expedition bringing those to New York, under Capt. David Porter, U. S. N., though no doubt there were numerous opportunities for transportation in the ten years or more elapsing after the visit of Porter and before Harlan's date of publication. The references in the latter, mainly to Porter's narrative, do not fix upon the donor, the time of arrival, or the island from which specimens were brought. Harlan's description applies to such forms as are compressed and narrowed above and in front of the shoulders, rather than to any of the others. The dimensions given correspond somewhat closely with those of the specimen figured below on Plates **37, 38.** The yellow blotches on the "under jaw and upper part of the throat" do not distinguish from the form described as *Testudo ephippium* Günther, 1875, and its closest allies.

Harlan's measurements in inches, are:

Length of the back-plate, following the curvature	21.6
Breadth of the back-plate, following the curvature	22.6
Vertical diameter, or height of the animal	9
Lateral diameter	14
Circumference of the body	36

Evidently Dr. Harlan had specimens other than his type under examination. For he says, p. 287, "The animal which is the subject of the present observations, is no doubt young, although larger than a similar species which lately lived for several months in the Philadelphia Museum. If we are permitted to judge from the shortness of the tail, and still less certain sign, the planeness of the sternum, our specimen is a female. Its weight is forty pounds." On page 292 he remarks "The present specimen is living in the possession of Mr. Whitton Evans. For the drawings which accompany the description we are indebted to Dr. S. G. Morton." February 27, 1827, some months after the reading of his paper, September 5, 1826, the Museum recorded mention of the gift of a *Testudo elephantopus* from Richard Harlan, M. D., but did not state whether it was the type specimen, whether it was the one that had been in the possession of Mr. Evans, or whether it had been drawn by Dr. Morton. After the efforts of Günther, Baur, Rothschild, Van Denburgh, and the authorities of the Philadelphia Academy there are few grounds remaining for hope of tracing the type from recorded history. The only attempt in this article is made in comparisons of a specimen, probably of the same species, as nearly as may be of the size of the type with the description and the drawings. The specimen selected is

No. 11063, M. C. Z., an exchange from the Boston Society of Natural History of which nothing more of the history is now known. It is suggested that it may have served as Harlan's type for description or Morton's for drawing.

The direct length of the type would be somewhat near seventeen inches. As for the drawings Dr. Morton drew them from a living individual which probably made accurate measurements difficult. The outlines on Plate **37**, fig. 2, 3, are from the original illustration. The vertebral series of plates was about twice as wide as it should be; only half the width could be seen from the artist's point of view. The scales nearest the feet also bore evidence of much uncertainty. On the same Plate **37**, fig. 1, are the outlines of a carapace making the nearest approach of those in the collection to what Harlan's type may have been. Plate **38**, fig. 1, 2 show this carapace, with a sternum, fig. 3, that was fastened to it, by mistake no doubt as it belongs to a different species. In direct length this carapace is more than sixteen inches. Compared with *T. vicina* it lacks the dome-shape, is more elongate, is less broadly curved on the back and is narrower and higher in front. Placing this figure side by side with that of Plate **39**, from a specimen of thirty-three inches, of the same species, brings out the close correspondence of the two. Seen from above the main difference in outline is due to wear of the reverted marginals on the older individuals. On the smaller one the small areolar spaces are yet indicated and the striae are yet present, but have begun to show signs of wear.

In connection with Harlan's paper another series of measurements is given on page 292 of the Journal of the Philadelphia Academy of Natural Science, and on page 196 of the Med. Phys. Researches, in a note by DeKay: these are:

Length	25	inches
Breadth	19.5	inches
Height	13	inches

These dimensions may have been taken from specimens of either of several species; they were not taken from Harlan's type and have no importance in the history of the species. Evidently the length and the width were taken directly instead of over the curvature.

As seen from above, the carapace of a specimen of about two feet in length, Plate **41**, has an outline that is oblong with rounded ends. It has a width of about three fourths of the length; in front of the mid length the shape is narrower, and more rounded; behind the middle it widens somewhat and above the tail it becomes subtruncate. The greatest height is nearly one half of the length and the outline curves with some regularity from the third vertebral scute back and downward to the lower edge of the supracaudal, which last extends back about as far as the marginal at each side of it. In the forward half of the body the back retains its height, even rises in males or some old females, or curves down toward the nuchal notch in most females and the young. Across the first pair of costal scutes the body is compressed into a blunt angle with its apex in the foremost vertebral; from this scale a groove descends along the hinder edges of the reverted marginals of the foremost three pairs and ends at or in the fourth marginal at each side. In front the opening into the carapace is nearly two thirds as high as it is wide, narrowing upward. The marginals form scallops along the edges. Similar to that at the fourth there is another indentation in the eighth marginal of each side, from which on the upper sides each of the posterior three pairs of marginals forms a groove to the caudal scale, by the recurvature of the scales. The concentric striae are present except on some old individuals; the areolar spaces are moderately larger and more or less convex and prominent; they are smooth except perhaps on scales of the very young.

On the sternum the gulars are broad, about five sevenths of the width of the anals; they are rounded in front and have a slight notch between them. The outer edges of the humerals are concave, in large specimens; they are longer than the femoral scutes. The pectorals are short, but meet on the median line. The anal extremity of the sternum is short, broad and subtruncate behind. The anal scutes are broader than long, are thickened and swollen downward, and are partly separated by a notch below, much like that on specimens of *T. vicina.* The sternum is concave from the anals to the gulars; the concavity is greatest from the femorals through the hinder halves of the abdominals, farther forward it becomes shallow and disappears; it is less marked in females and is absent in young. The specimen to which particular reference is made, Plate **41**, was secured by Dr. Baur on Pinzon (Duncan) Island. The lateral ridges on the marginals of the flank are low; they become weaker with age.

Females of twenty-one inches from the same island are higher and more arched on the back, less broadened posteriorly, more declivous in the first vertebral shield and are less concave in the sternum. With age the length becomes greater as compared with the width; this with the worn and broken scales of the second and the third pairs of the anterior marginals induces individual differences which might lead to selection as types of new species. The color of *T. elephantopus* in general is a black or blackish brown, marked with yellow in places on the lower surface. This species, including its varieties, is one of the most distinct of the Galapagos tortoises. The variations of individuals at different ages, or in different sexes, are such that measurements taken of specimens and reduced to percentages of the direct length parallel those from the other localities to so great an extent that they are of no real assistance in determining varieties or species.

Testudo elephantopus Harlan has under various names been reported from five of the islands: — Española (Hood), Pinzon (Duncan), North Isabela (Albemarle), Fernandina (Narborough), and Pinta (Abingdon). As will be seen by reference to the chart, Plate 1, this distribution might have been effected entirely by the currents after the species had secured a location on Española or it may in part have been brought about by the intervention of man. The agency of the currents, from the directions indicated by the arrows on the chart, is entitled to much favor. For it is sheer assumption that denies the possibility of drift and establishment by its agency on either of these localities to an animal of such buoyancy, as also that denying ability to swim or otherwise exert itself in the water to a creature possessed of so much muscular ability, endurance, and persistence in walking and climbing. While the buccaneers, the whalers, and the explorers have had something to do with distributing the tortoises since the discovery of the islands by the whites there is a possibility that earlier introductions perhaps including the earliest of all were due to aboriginal navigators of the times of the Incas or farther back. Considering the possible means of distribution, the amount of differentiation from such a species as *T. tabulata*, Plate 2, the rapidity of growth the variability of the individual it appears unnecessary to go back to the Tertiary or perhaps more than a few generations for the first appearance of the tortoises in the Archipelago.

Among five so-called species placed under *T. elephantopus* there may be one or more entitled to varietal rank. All of them have been styled races, whatever that may have meant, but the individual descriptions given do not supply the details necessary for characterization.

The original measurements in inches, of several so-called species are: —

	Straight length	Straight width	Curved length	Curved width	Sternal length	Sternal width	Height
T. ephippium Günther, 1875	33	23½	40	40	24	21½	17
	7	5	9½	8½	4¾	6¾	3½
T. abingdonii Günther, 1877	38	22½	40½	38	26	21½	19½
T. becki Rothschild, 1901	31¼	21½	40¾	36	25¼		$16\frac{3}{10}$
T. hoodensis van Denburgh, 1907	22⅕	17½	27	$24\frac{8}{10}$	$19\frac{7}{10}$		11⅕
T. phantasticus van Denburgh, 1907	34½	24	42	41	24		18

Measurements.

(*In inches*).

M. C. Z.	Straight length	Straight width	Curved length	Curved width	Height
11063	16¼	11⅜	19½	19¾	7⅜
11068	25	18½	29	30	12½
11083	22	15½	24	25½	
11084	16	11¾	18½	18¾	
11081	21	15	25	24¾	10½
11082	21	15	25	25½	11
11089	28¾	21	35½	33	

Number 11063, Plate **38**, fig. 1, 2, was received in exchange from the Bost. Soc. Nat. Hist. Numbers 11081–11084, and 11089 were purchased of F. B. Webster.

Plate **37**, fig. 2, 3, are outlines from Harlan and fig. 1 is a lateral sketch from No. 11063. Plate **38**, fig. 3, is a view of the sternum of *T. microphyes*. Plate **39** gives the outlines of Günther's figures of the type of his *Testudo ephippium*. Plate **40** the outlines of Günther's figures of *Testudo abingdoni* from Pinta (Abingdon), Plate **41** represents a 25 inch specimen (M. C. Z. 11068) brought by Baur from Pinzon (Duncan). Plate **42**, fig. 2, 3, presents outlines of a cast by Webster of a specimen from Pinzon, and figure 1, a dorsal view of another cast by Webster from Isabela (Albemarle) said to be from *T. becki*.

The type of *T. ephippium* Günther, 1875, was a specimen in the Museum of Science and Art, Edinburgh. Nothing was said to be known of its history, but Porter's, 1822, description of the tortoises of Charles Island (Santa Maria) applied so well the author had no doubt the type came from that island. In 1877 in the Gigantic Tortoises this is repeated on p. 81, but on p. 11 and on Plate **39** it is ascribed without question to Indefatigable (Santa Cruz). It appears to have been the only tortoise from the Archipelago in the Edinburgh Museum; had there been another it would not have escaped mention. Baur, 1889, found that Captain Basil Hall had visited Abingdon (Pinta) (the only island of the group landed upon) in January, 1822, and remarked, in his Journal, concerning the tortoises "we took some on board, which lived for many months, but none of them survived the cold weather off Cape Horn. I preserved one in a cask of spirits, and it may now be seen in the Museum of the College at Edinburgh: it is about medium size." The measurements given are those of a specimen of about the same size as the type of *T. ephippium*. Baur took the matter up with Dr. Traquair who replied "I have to say that I have had the records of the old College Museum searched for information as to the specimen of *Testudo ephippium* figured and described by Dr. Günther, and the only entry which we can find which can possibly have any reference to that specimen is one in the year 1822–23 of a 'Large Turtle from South Sea — Captain Basil Hall.'" From this Baur reached a most logical conclusion that the type of *T. ephippium*, 1875, and that of *T. abingdonii*, 1877, were both from Abingdon island. By comparisons of other specimens with the descriptions and figures he decided that they belonged to a single species. Revision of the matter tends to confirm this, adding both names to the synonymy of *T. elephantopus* Harlan, 1827, and including as synonyms of the same species *T. becki*, *T. hoodensis*, and *T. phantastica*. The types of *T. elephantopus*, *T. ephippium*, *T. becki* and *T. hoodensis* represent young to medium ages; *T. abingdonii* and *T. phantastica* the old and very old.

EXPLANATION OF THE PLATES.

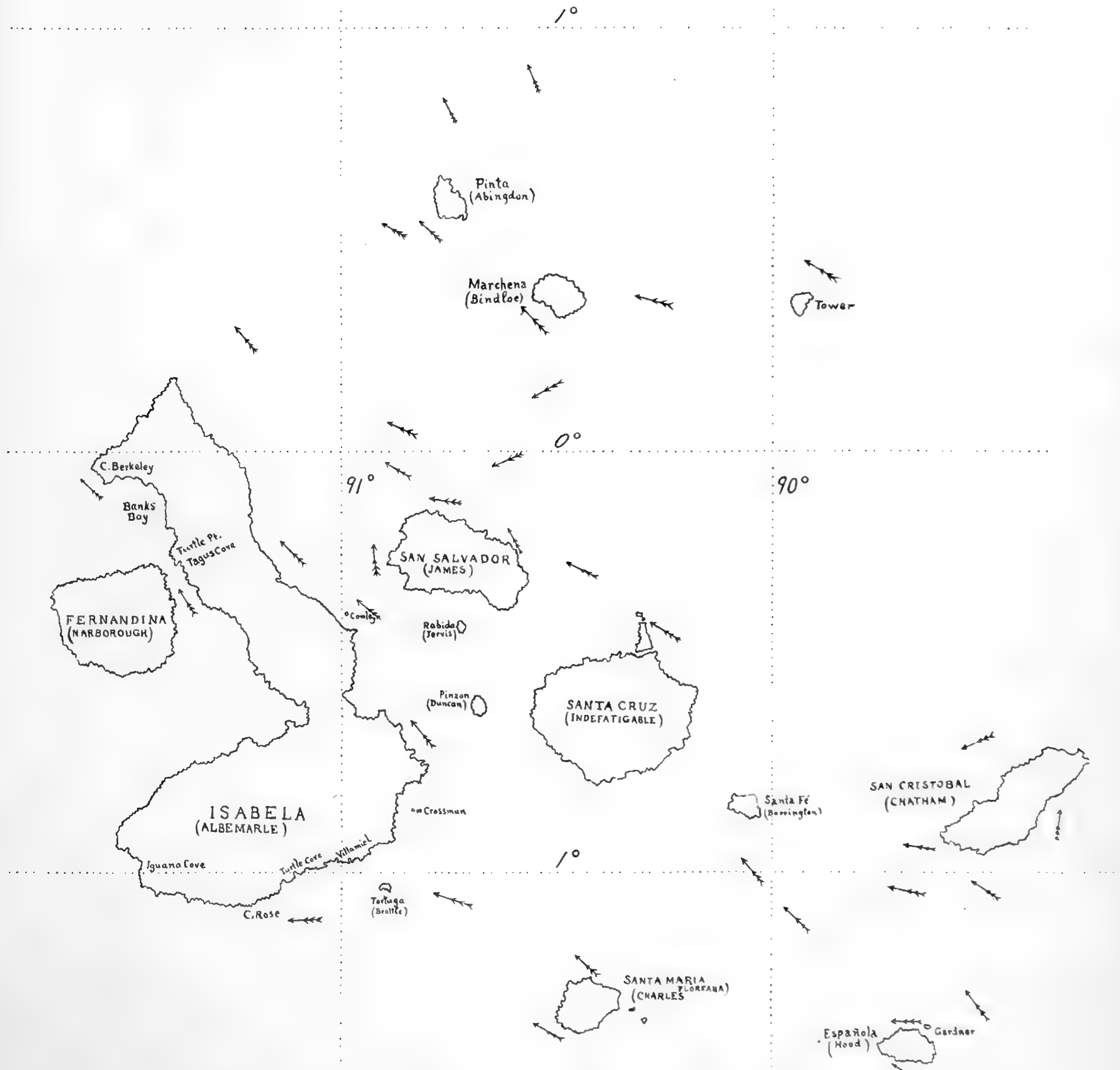
The outlines are from drawings of Samuel Garman. The photographs are from the negatives of George Nelson.

PLATE 1.

PLATE 1.

THE GALAPAGOS ISLANDS.

Reduced from chart 1798 U. S. Hydrographic Office, 1915. The arrows indicate the direction of the currents.



GALAPAGOS ISLANDS

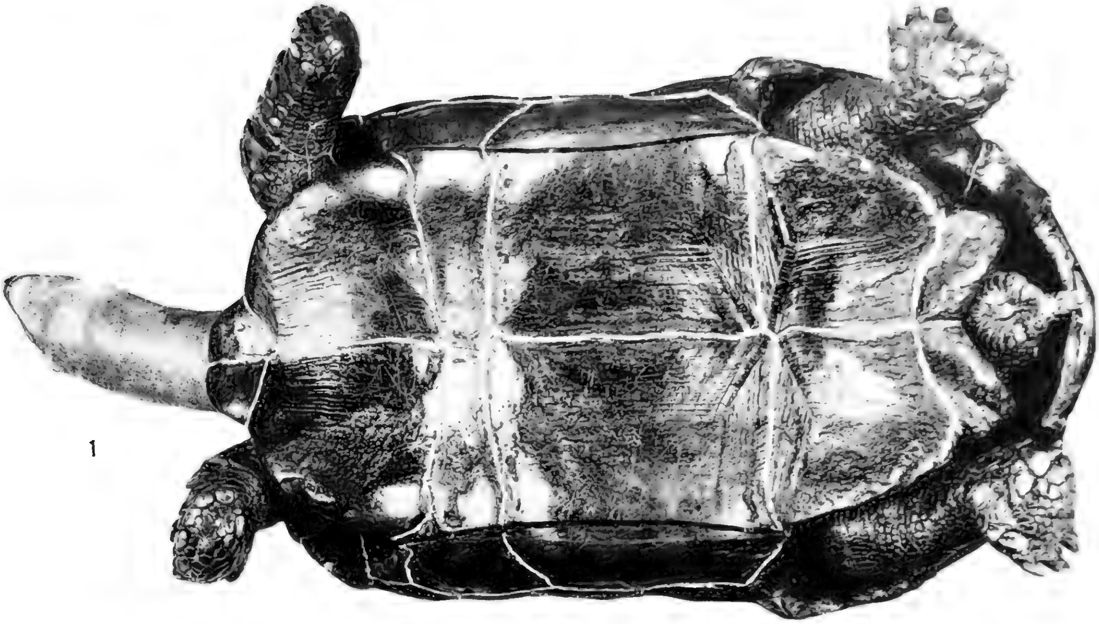
PLATE 2.

PLATE **2**.

Testudo tabulata Walbaum, 1782. Page 270

1 ventral, 2 dorsal, 3 lateral.

M. C. Z. 12050. Porto Rico. Length 22½ inches.



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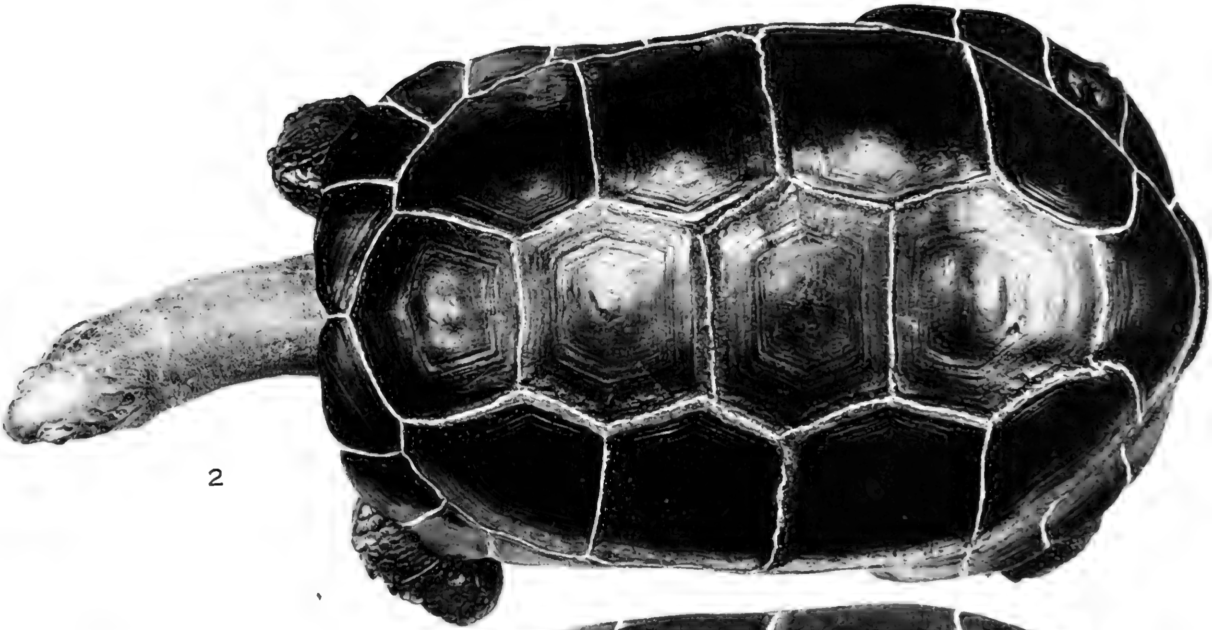

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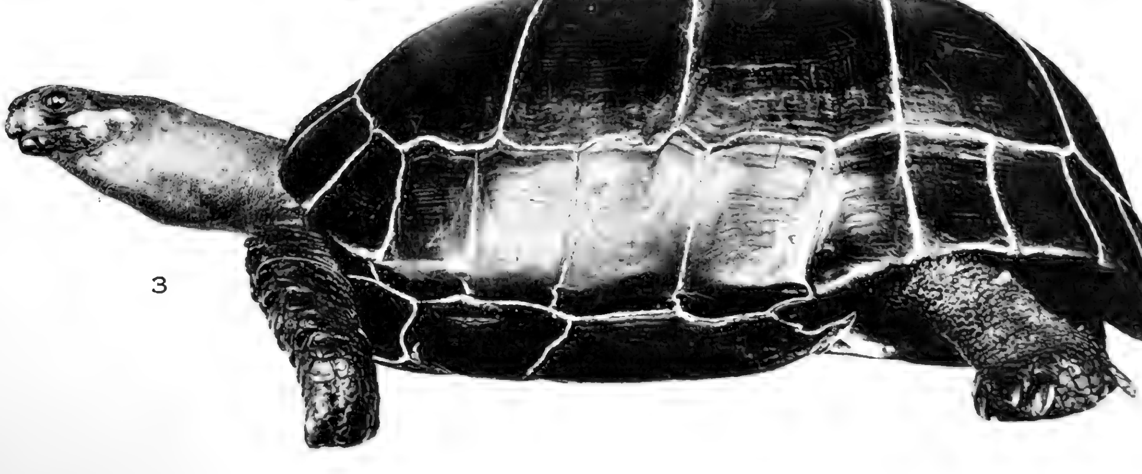

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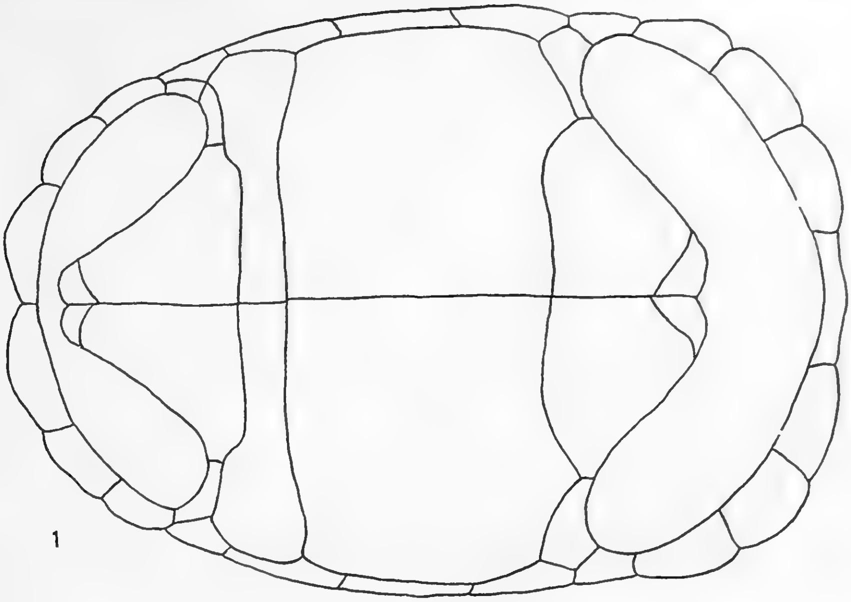
PLATE 3.

PLATE **3**.

TESTUDO MACROPHYES Garman, 1917. Page 273

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1877, Gigantic tortoises, Plate **38**. (*T. microphyes* Günther, 1877, *nec* 1875).
British Museum, COTYPE. North Isabela (Albemarle). Length 25 inches.



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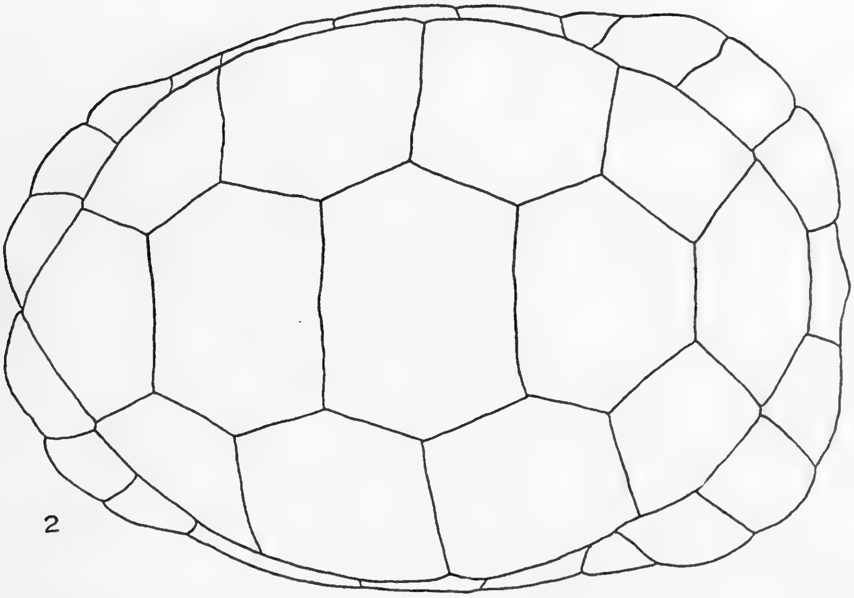

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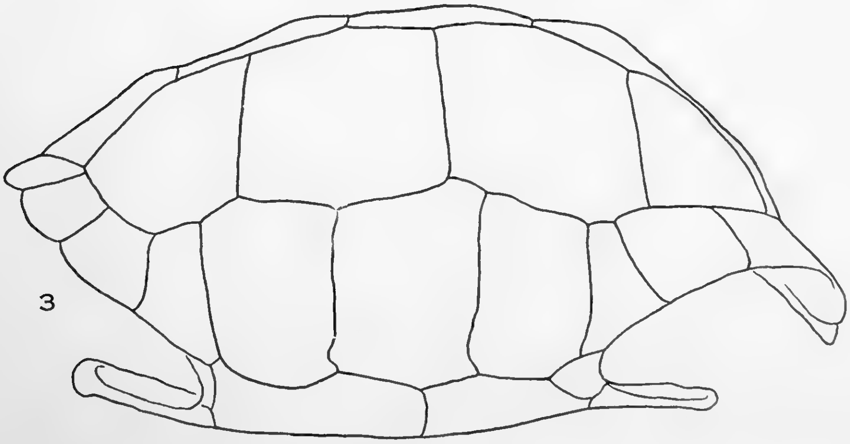

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PLATE 4.

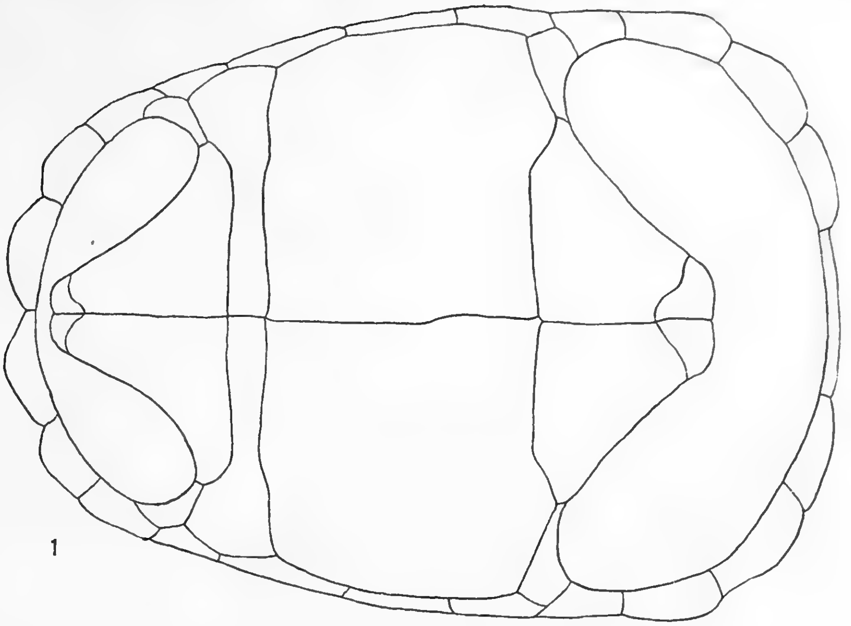
PLATE **4**.

TESTUDO MACROPHYES Garman, 1917. Page 273

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1877, Gigantic tortoises, Plate **34**, **35**, fig. A. (*T. microphyes* Günther, 1877, *nec* 1875).

British Museum, COTYPE. North Isabela (Albemarle). Adult male. Length 33½ inches. Weight 240 pounds.



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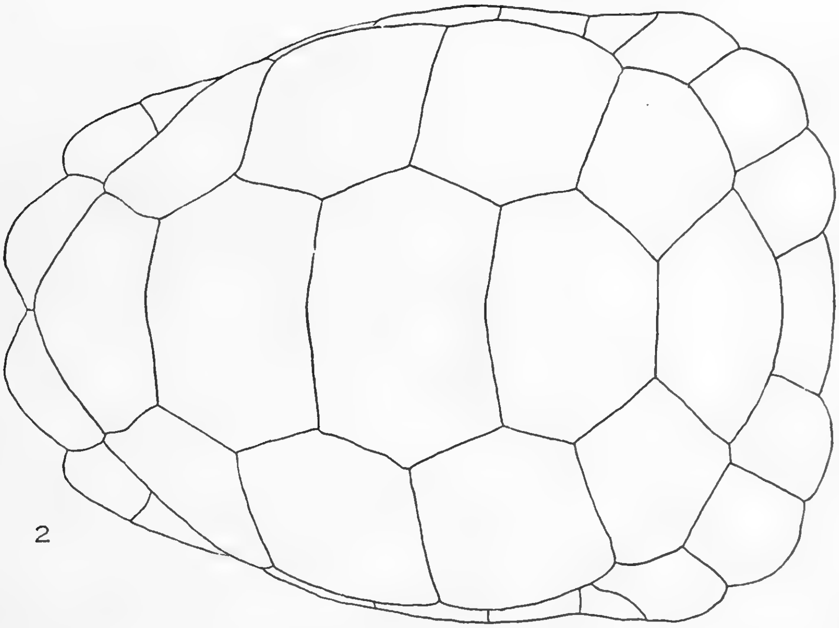

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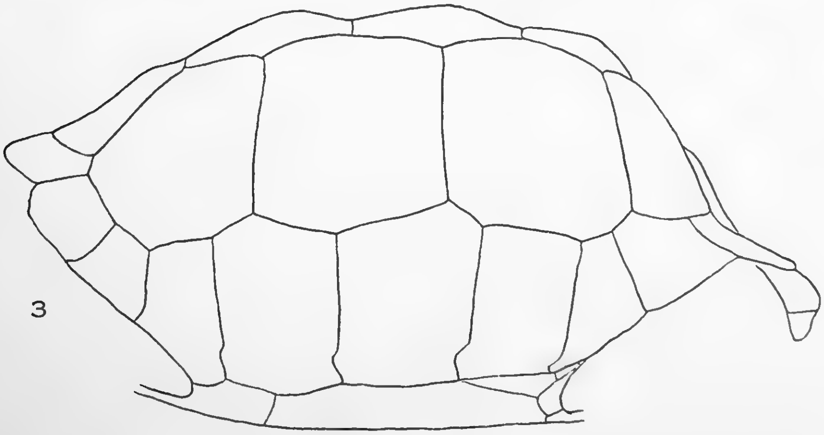

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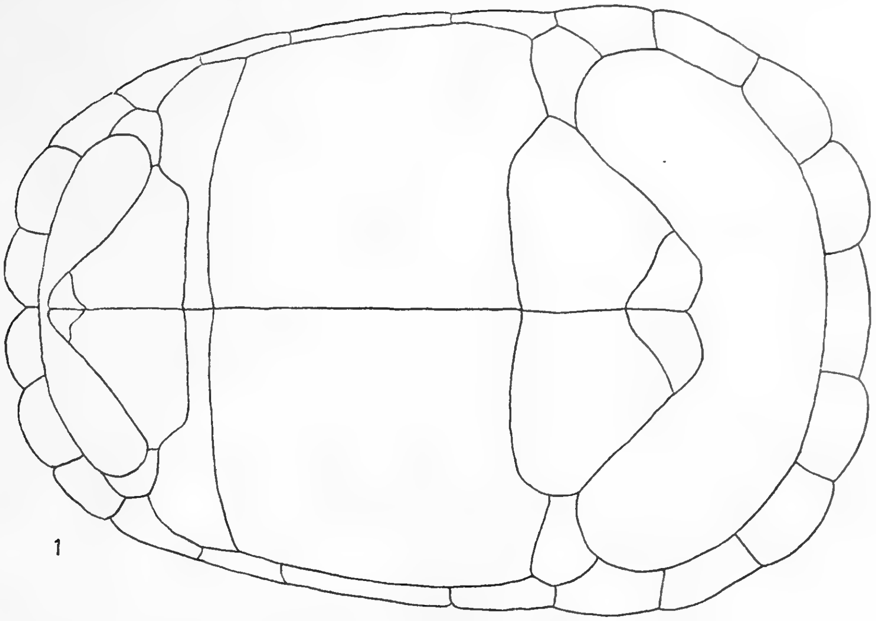
PLATE 5.

PLATE 5.

TESTUDO MACROPHYES Garman, 1917. Page 273

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1877, Gigantic tortoises, Plate **36**, **35**, fig. B. (*T. microphyes* Günther 1877, *nec* 1875).
British Museum, COTYPE. North Isabela (Albemarle). Adult female. Length 27 inches.



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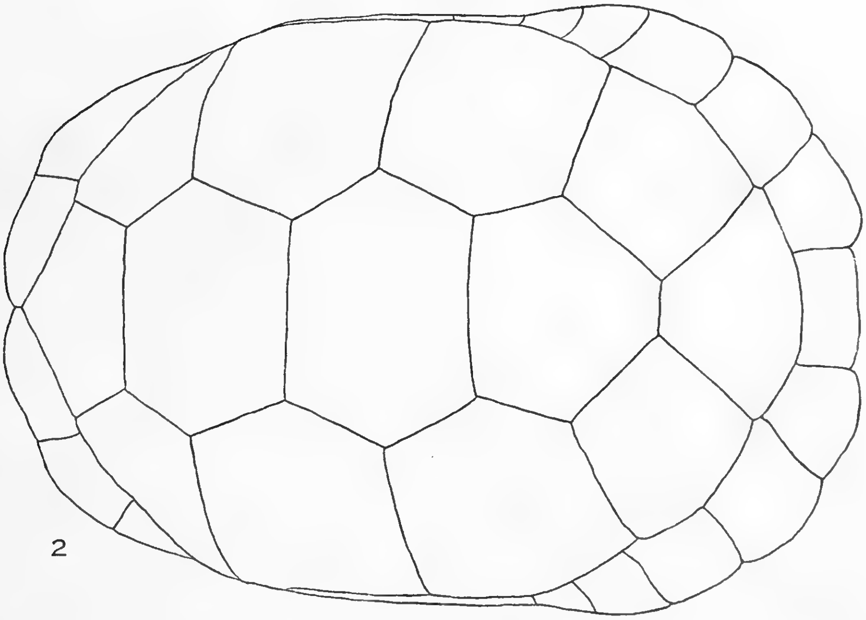

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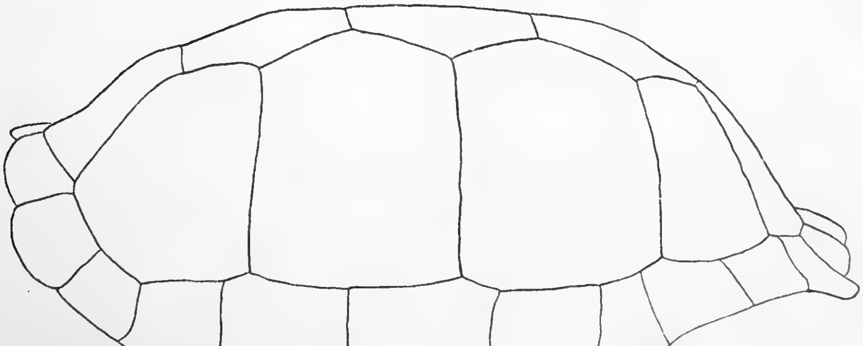


3

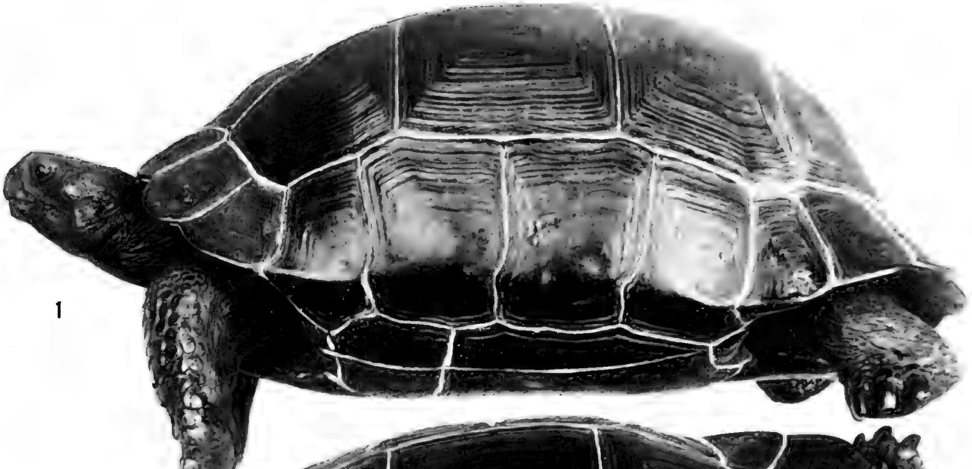
PLATE 6.

PLATE **6**.

Testudo vicina Günther, 1875. Page 274

1 lateral, 2 dorsal, 3 ventral.

M. C. Z. 4482. Santa Maria (Charles) Hassler Exped. Length 14½ inches.



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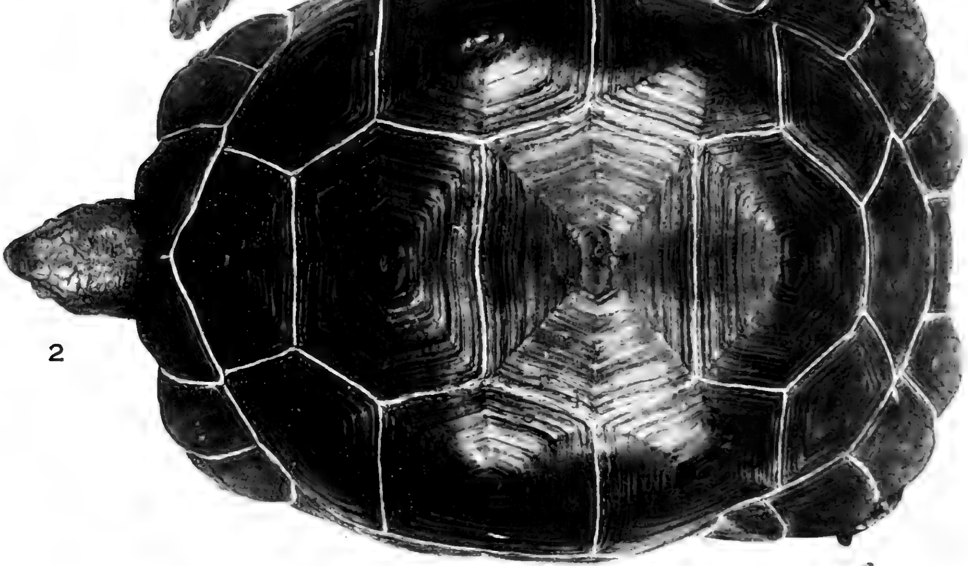

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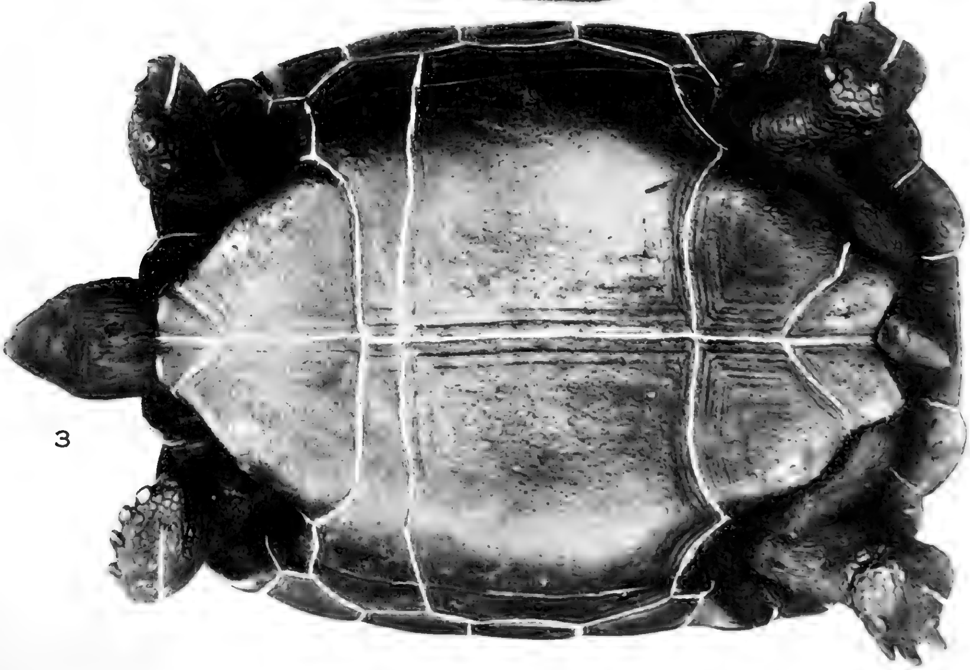


3

PLATE 7.

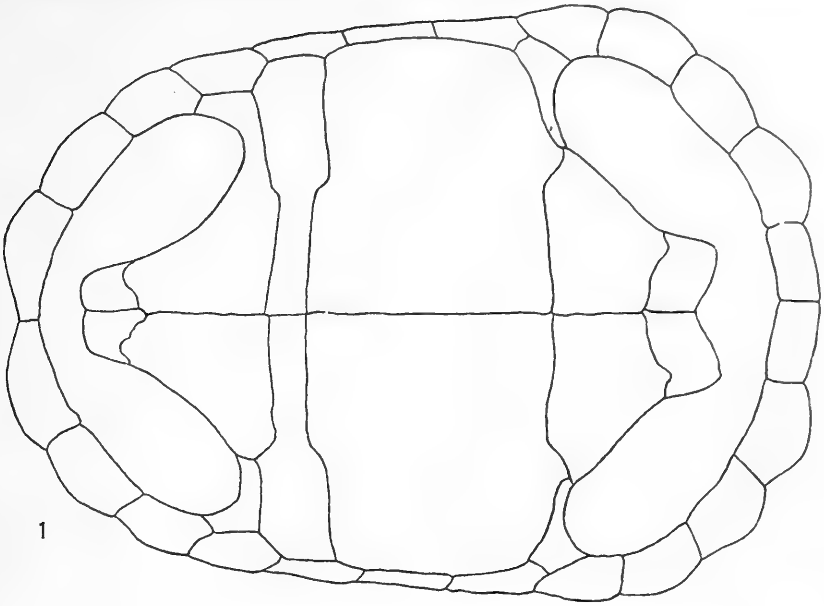
PLATE **7**.

TESTUDO VICINA Günther, 1875. Page 274

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate **35**, fig. A.

British Museum. TYPE. Male. Length 33 inches.



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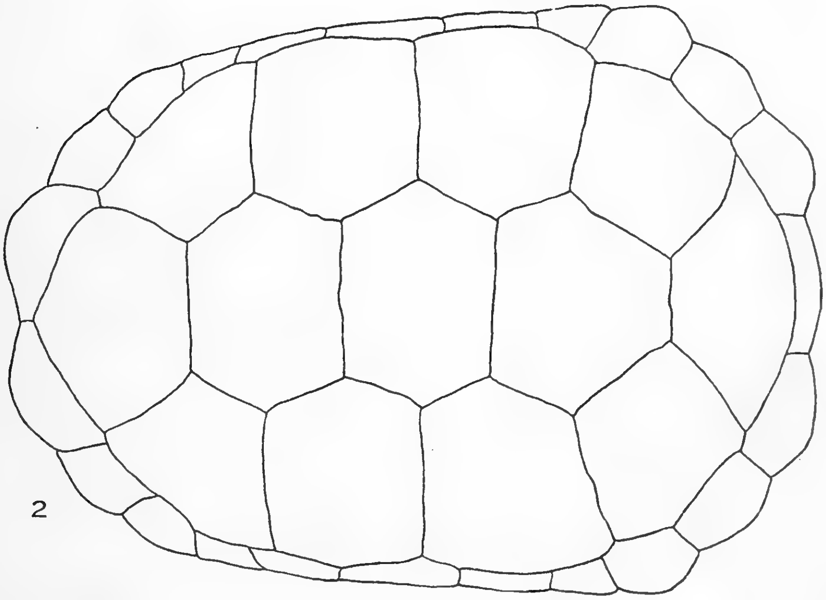

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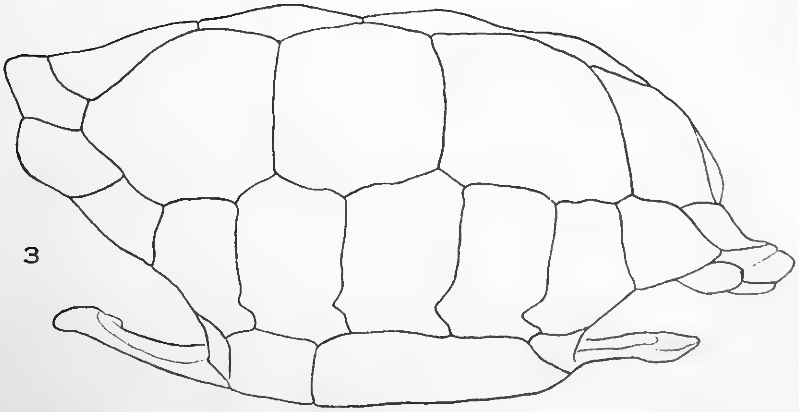

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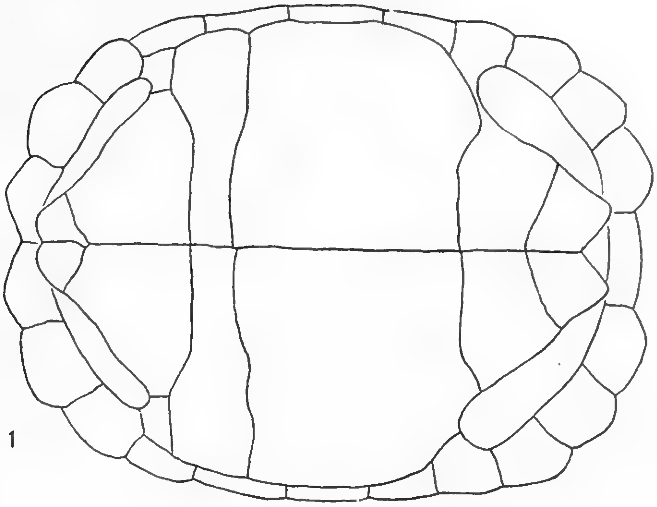
PLATE 8.

PLATE 8.

TESTUDO NIGRITA Duméril et Bibron, 1835. Page 276

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate **35**, fig. C.
Royal College of Surgeons, London. Length, 22 inches.



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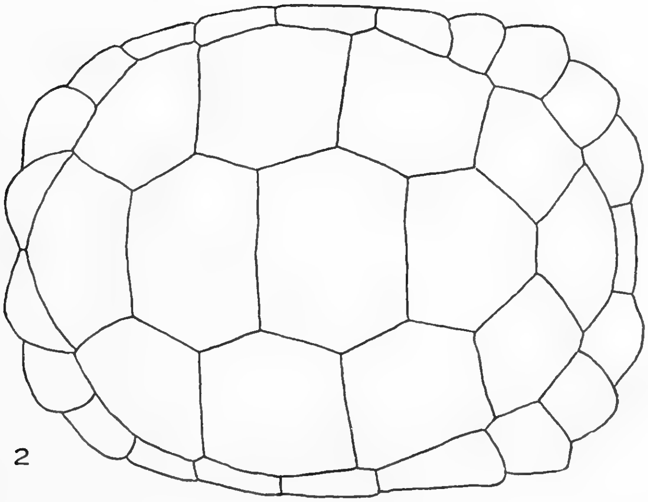

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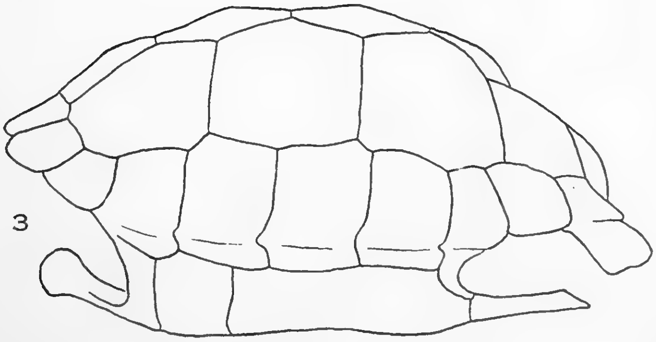


3

PLATE 9.

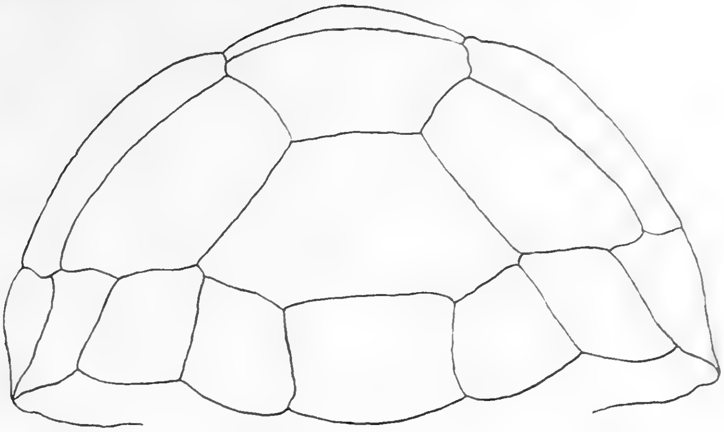
PLATE **9**.

TESTUDO NIGRITA Duméril et Bibron, 1835. Page 276

1 posterior, 2 lateral, 3 dorsal.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate **33**, fig. B.

Royal College of Surgeons, London. Length 41 inches.



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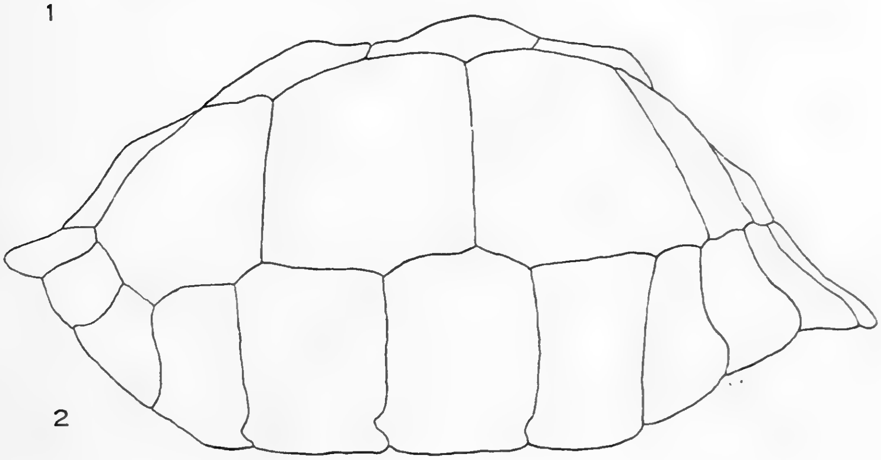

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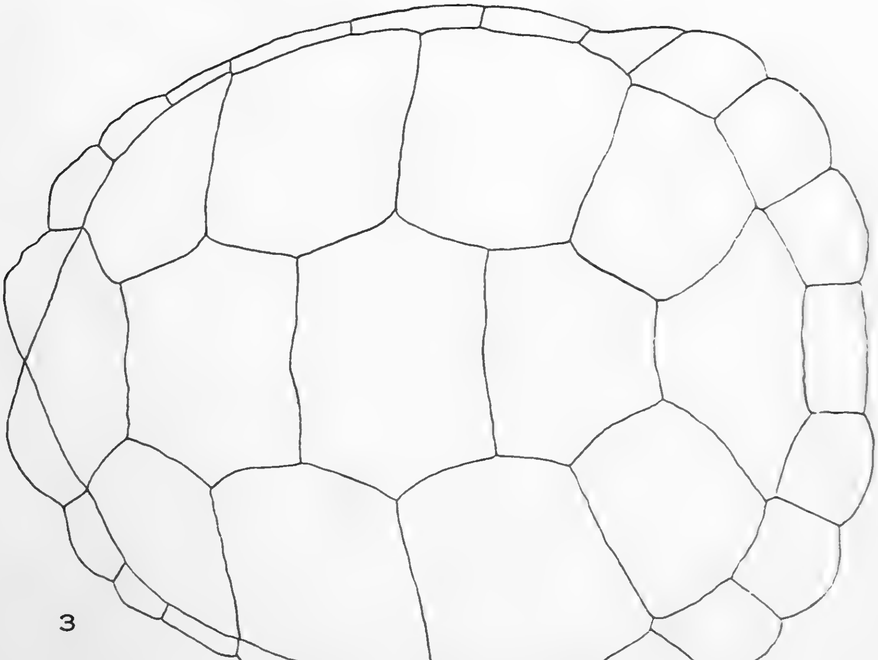

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PLATE 10.

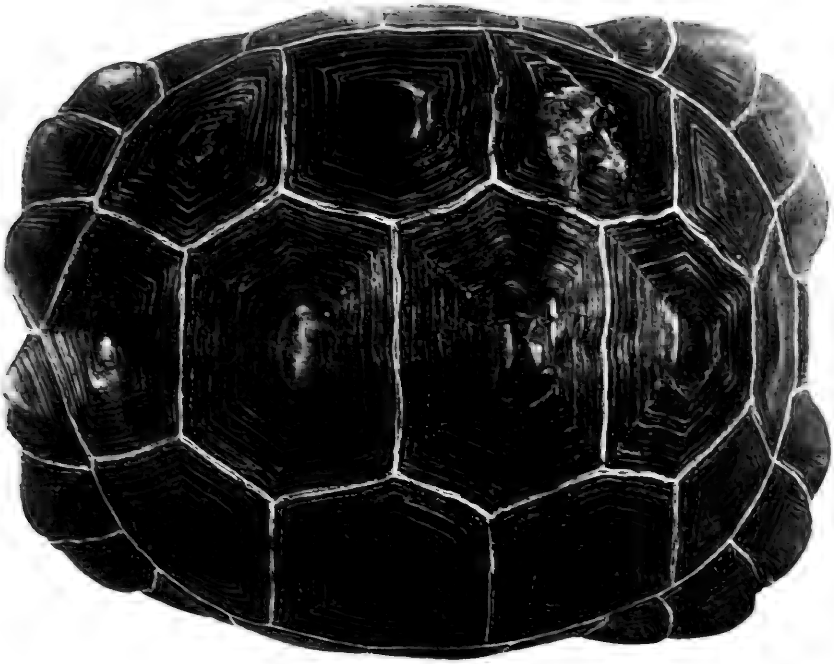
PLATE 10.

Testudo nigrita Duméril et Bibron, 1835. Page 276

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 12049. Santa Maria (Charles). Hassler Exped. Length 11 inches.

1



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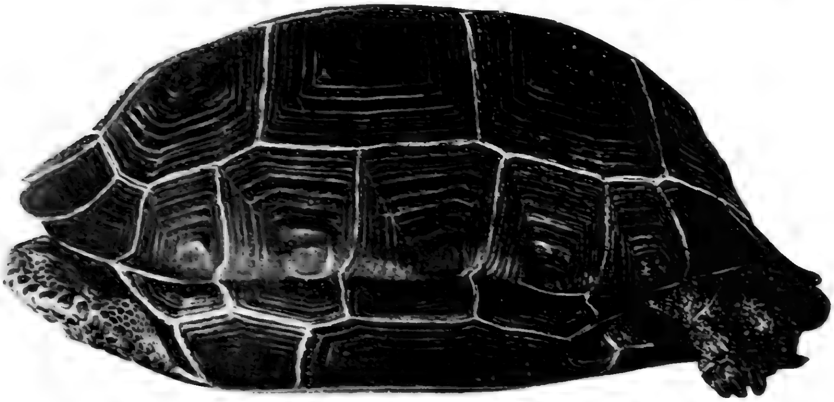

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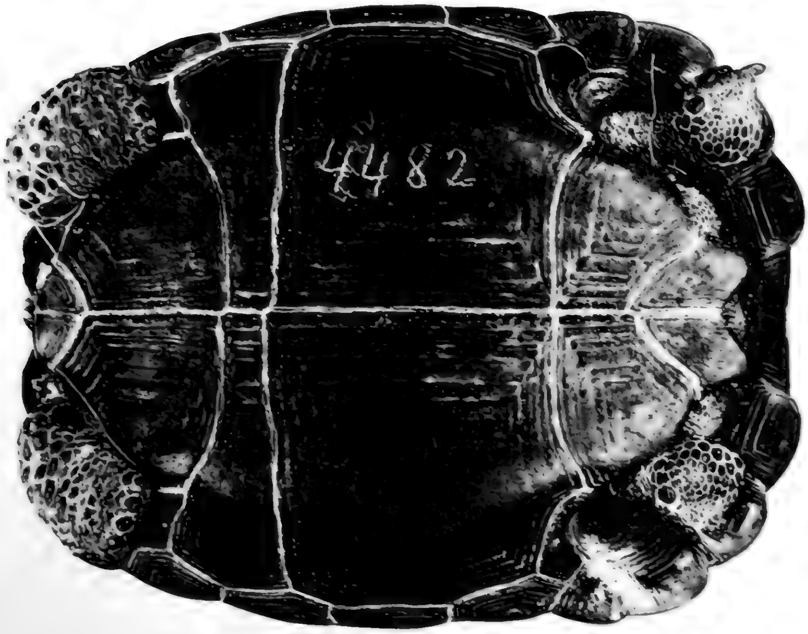


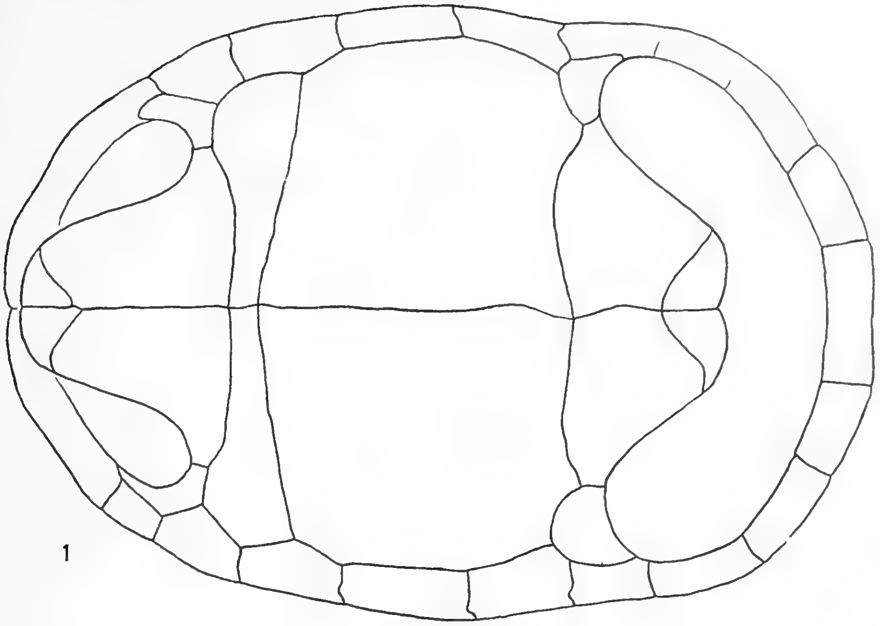
PLATE 11.

PLATE **11**.

TESTUDO MICROPHYES Günther, 1875. Page 280

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate **36**.
Royal Inst. Liverpool. TYPE. Española (Hood). Length, 22½ inches.



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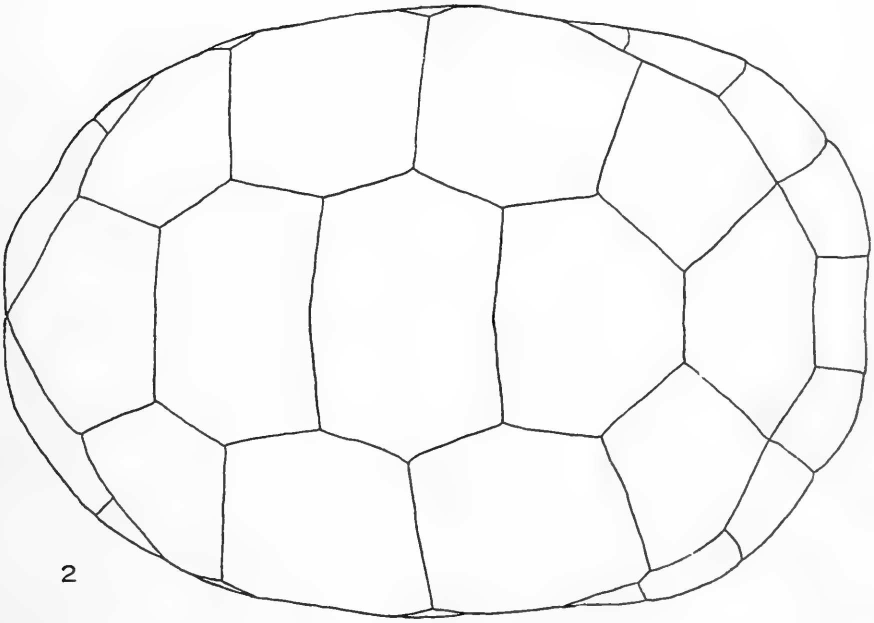

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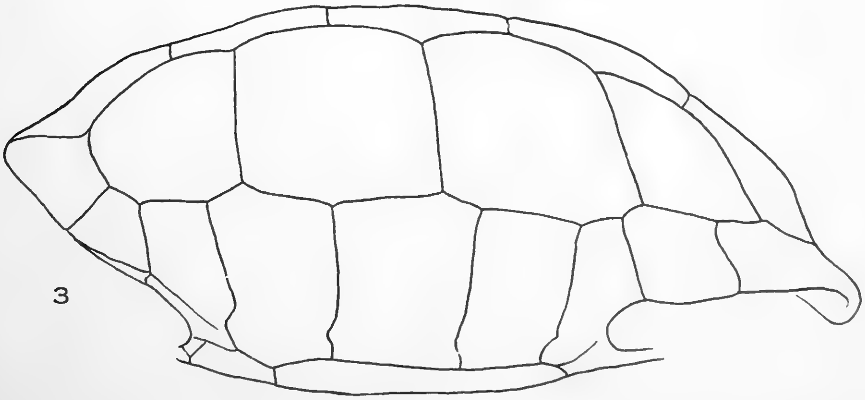

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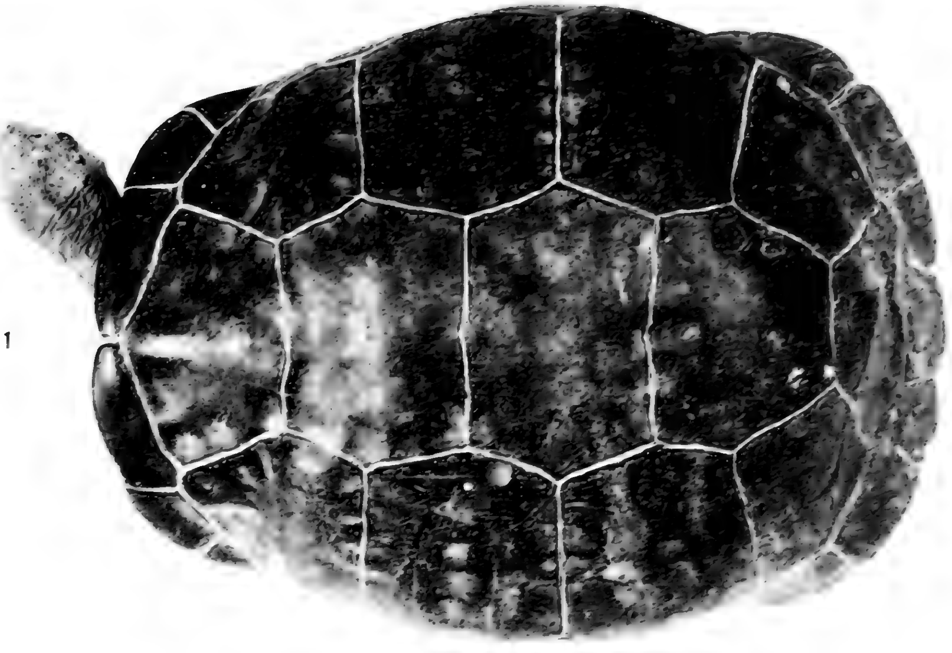
PLATE **12**.

PLATE 12.

Testudo microphyes Günther, 1875. Page 280

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11067. Villamiel, Southern Isabela (Albemarle). California Academy of Sciences. Length 25⅛ inches.



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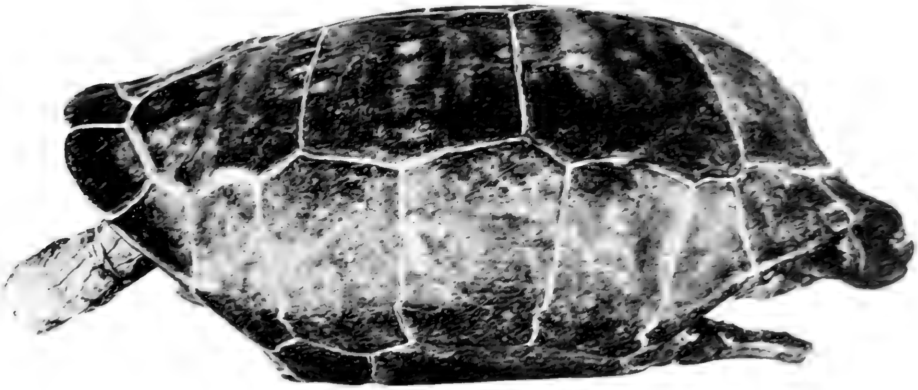


2

3

PLATE **13**.

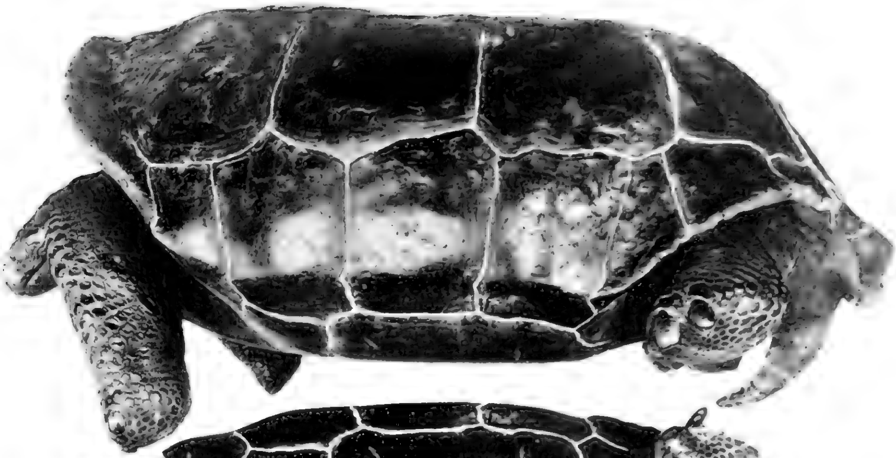
PLATE **13**.

TESTUDO MICROPHYES Günther, 1875. Page 280

1 lateral, 2 ventral, 3 dorsal.

M. C. Z. 11085. Southern Isabela (Albemarle). F. B. Webster. Length 42 inches.

1



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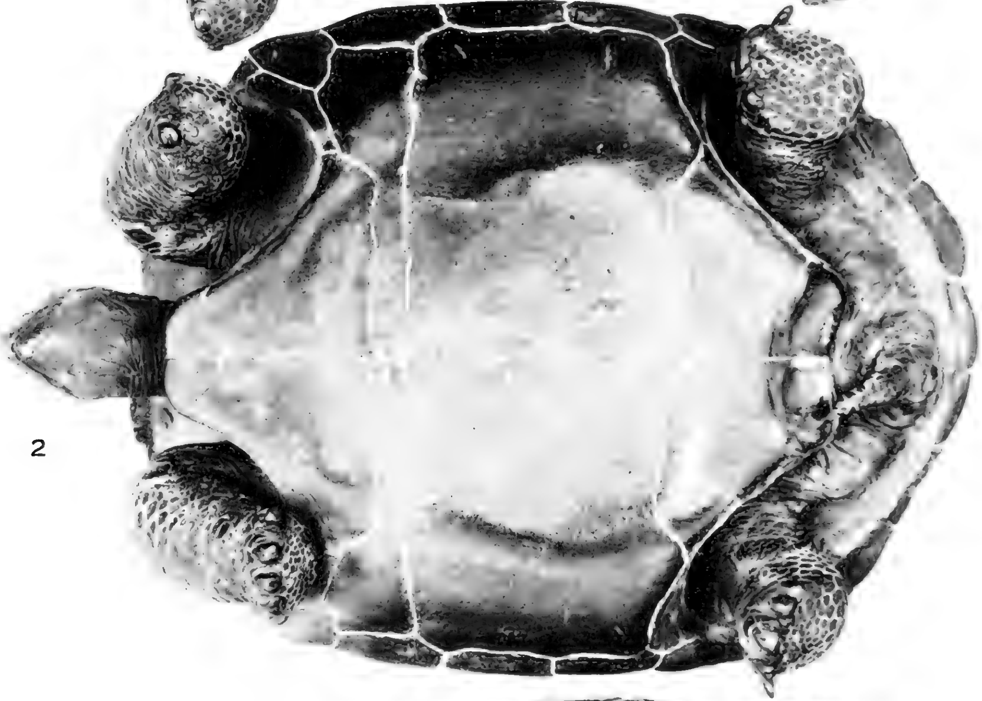

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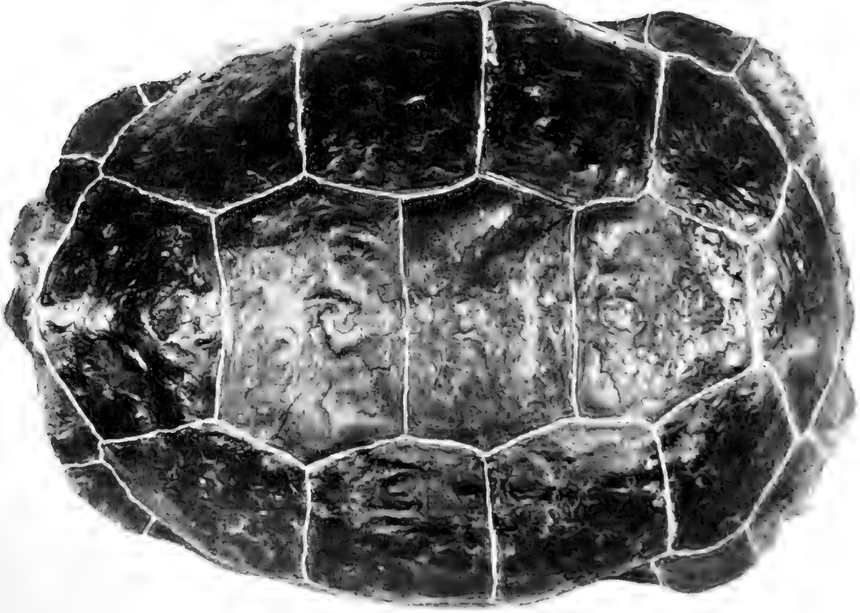


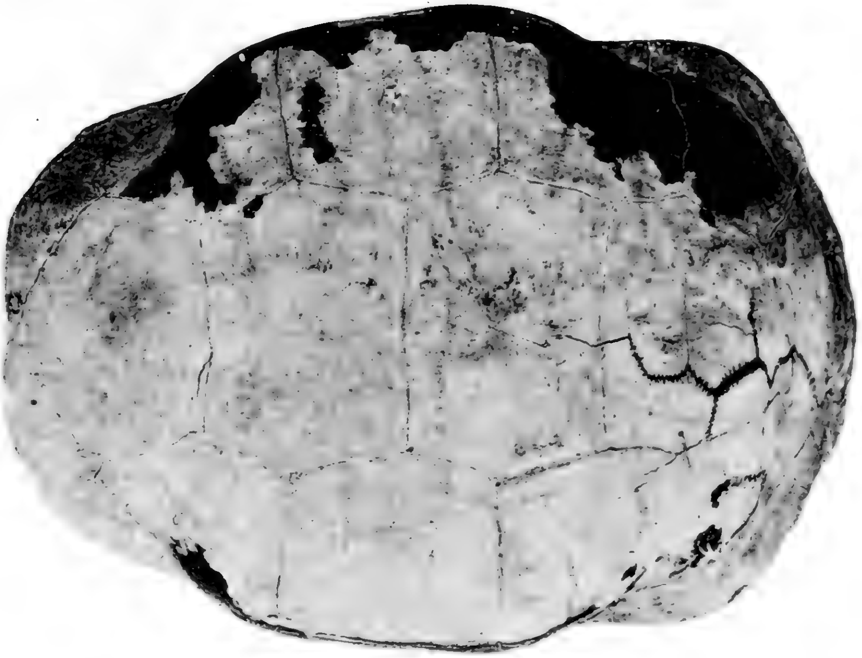
PLATE 14.

PLATE **14**.

TESTUDO MICROPHYES Günther, 1875. Page 280

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11066. Villamiel, Southern Isabela (Albemarle). George Baur. Length 31¾ inches.



1

2

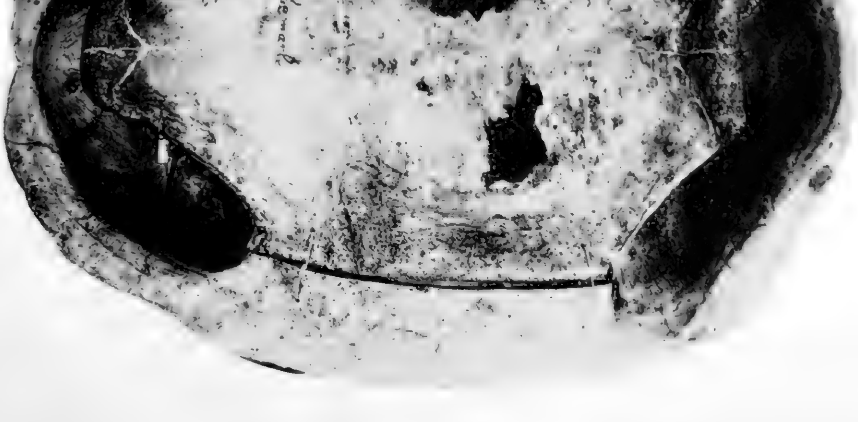


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PLATE **15**.

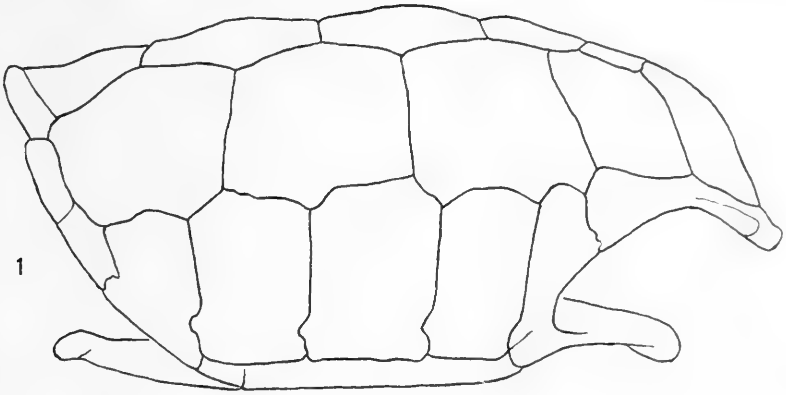
PLATE **15**.

Testudo microphyes Günther, 1875. Page 280

1 lateral, 2 dorsal, 3 ventral.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate **33**, fig. A (*T. elephantopus* Günther *nec* Harlan).

University Oxford Museum. Length 31 inches.



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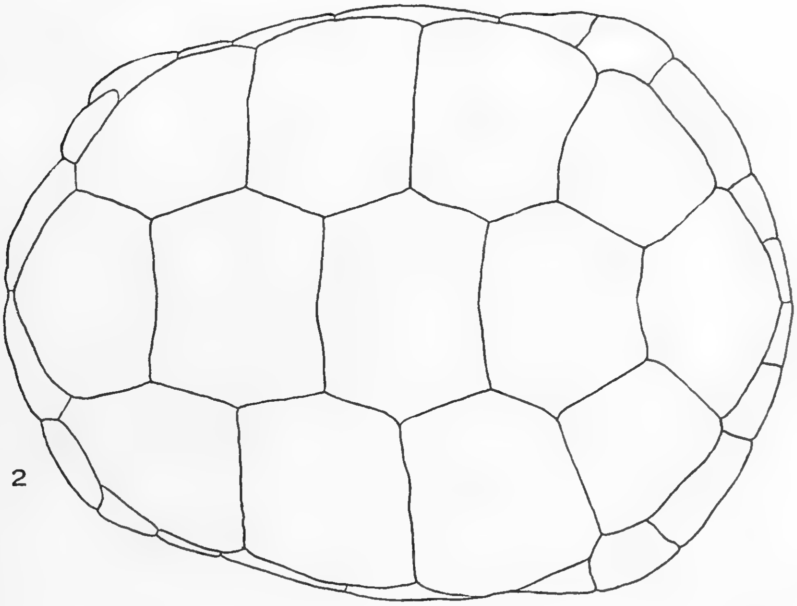

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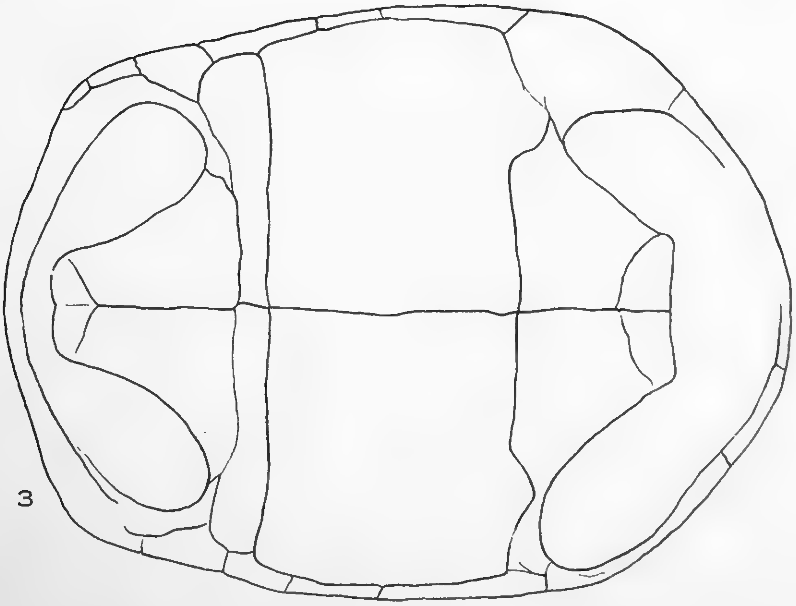


3

PLATE **16.**

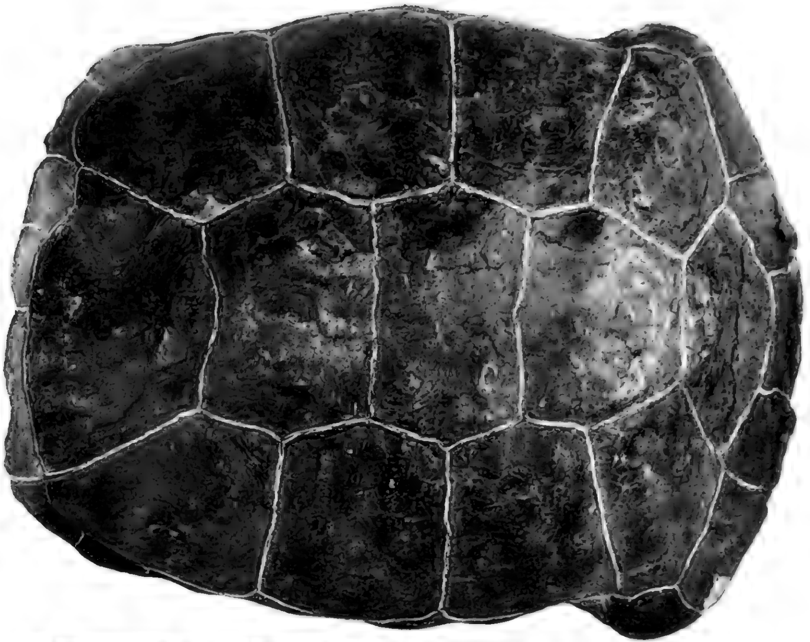
PLATE **16**.

Testudo microphyes Günther, 1875. Page 280

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11065. Villamiel, Southern Isabela (Albemarle) George Baur. Length 37½ inches.

1



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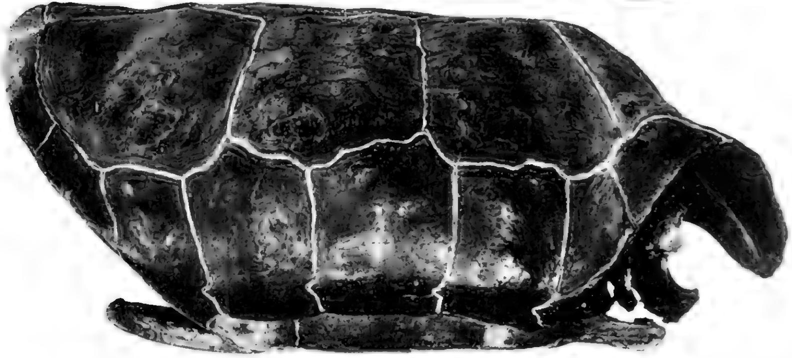

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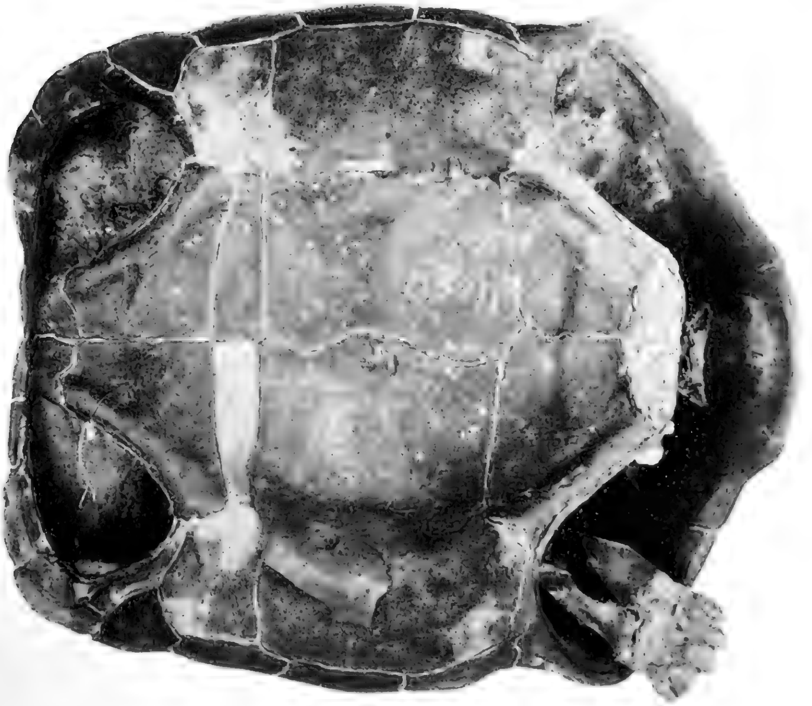


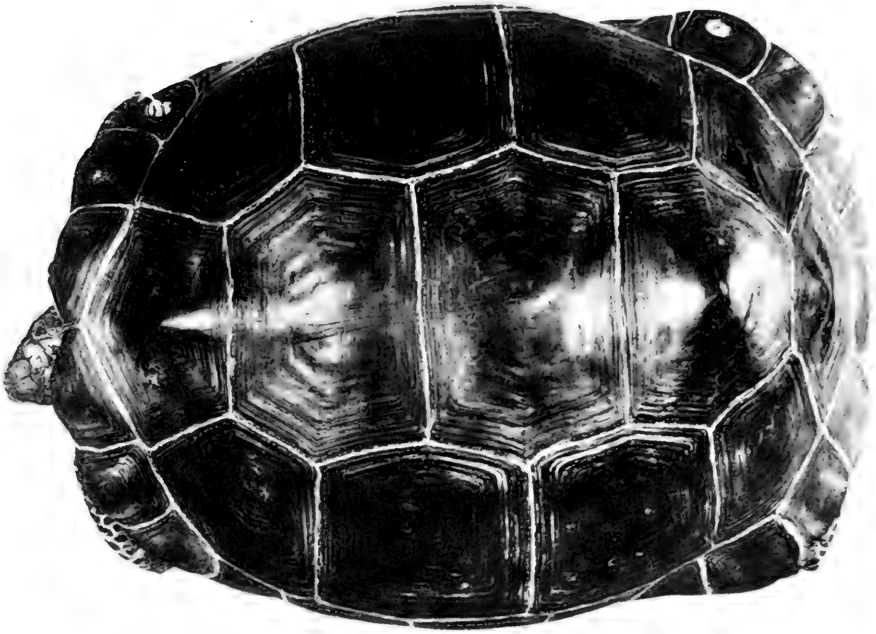
PLATE **17**.

PLATE **17.**

Testudo microphyes Günther, 1875. Page 280

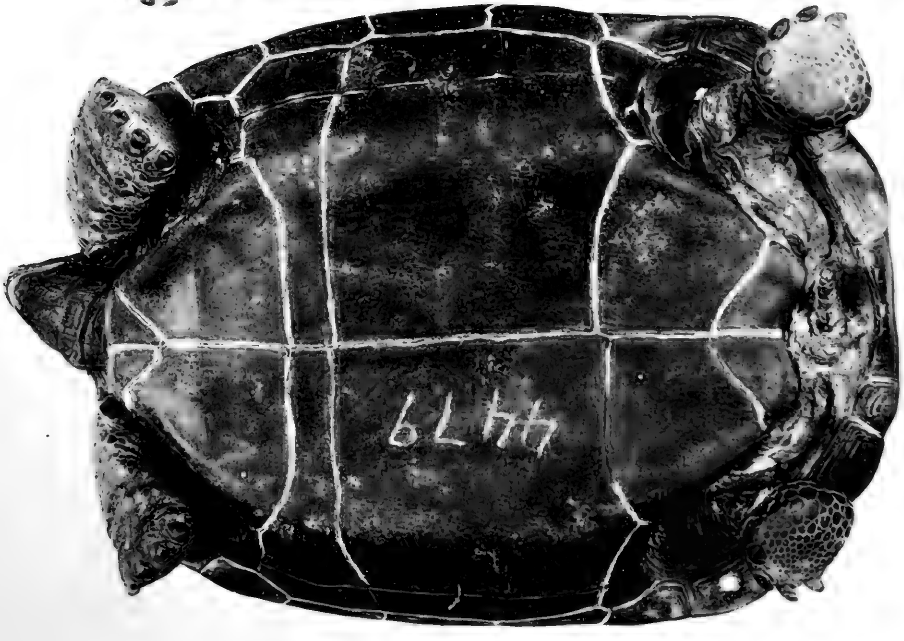
1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4479. Santa Maria (Charles). Hassler Exped. Length $15\frac{1}{4}$ inches.



1

2



3

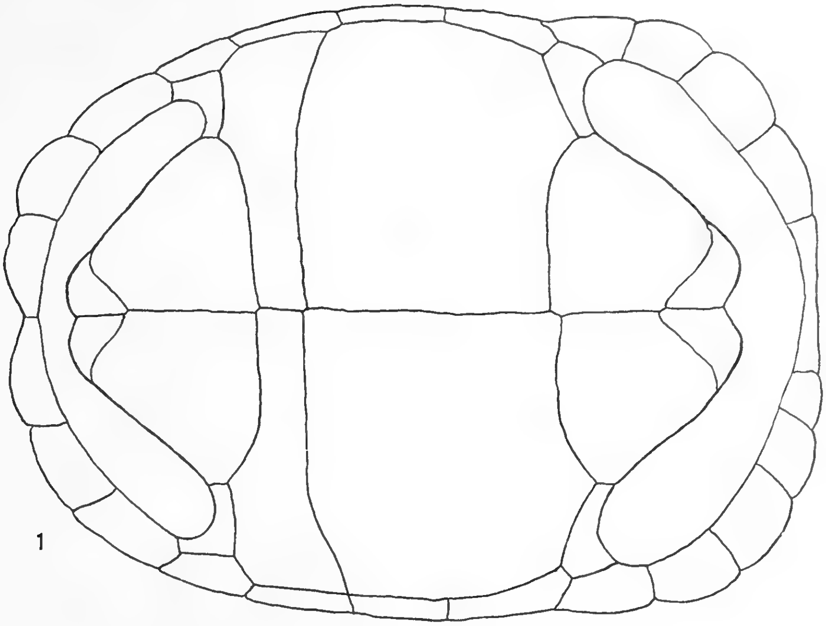
PLATE 18.

PLATE 18.

Testudo microphyes Günther, 1875. Page 280

1 ventral, 2 dorsal, 3 lateral.

M. C. Z. 4479. Santa Maria (Charles). Hassler Exped. Length 15¼ inches.



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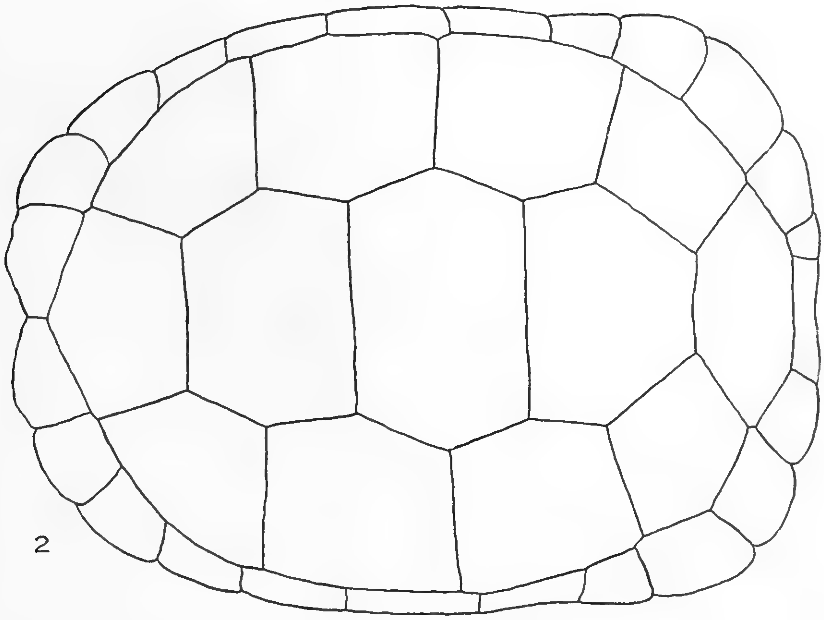

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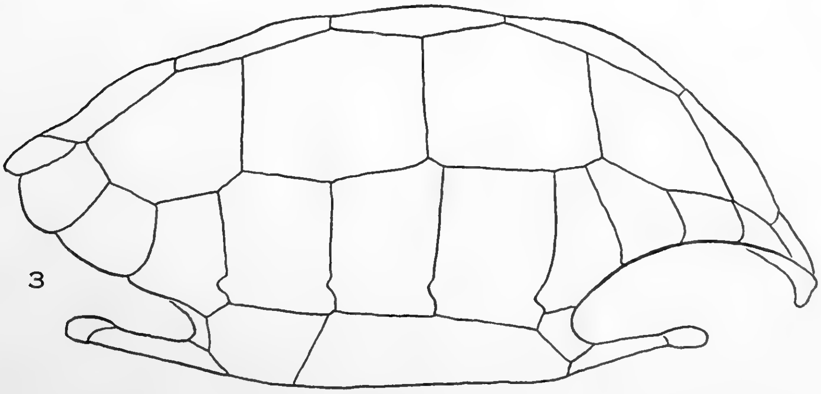


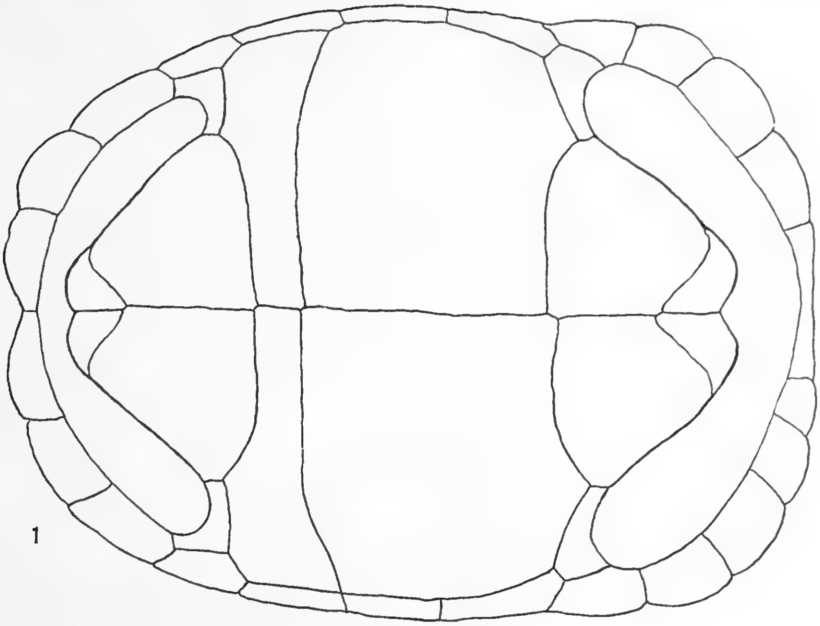
3

PLATE **18.**

TESTUDO MICROPHYES Günther, 1875. Page 280

1 ventral, 2 dorsal, 3 lateral.

M. C. Z. 4479. Santa Maria (Charles). Hassler Exped. Length 15¼ inches.



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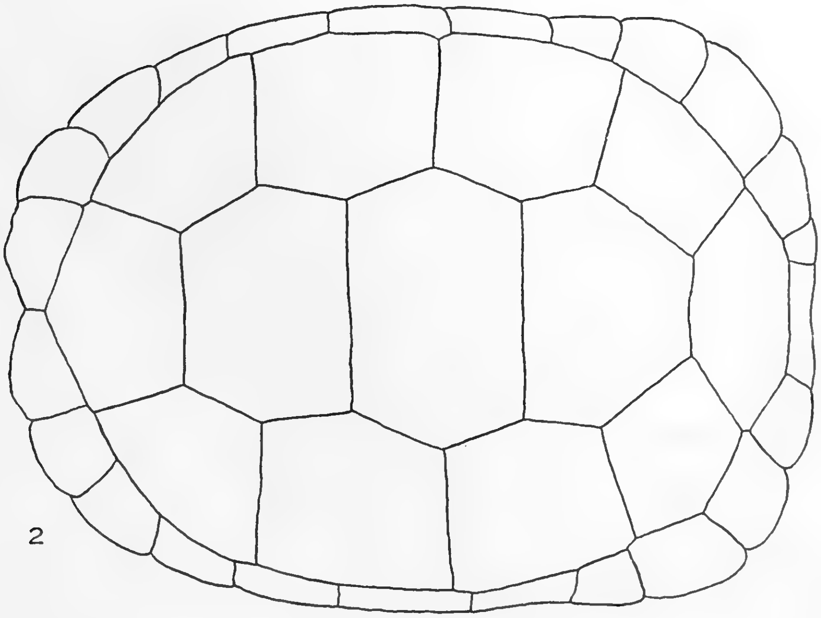

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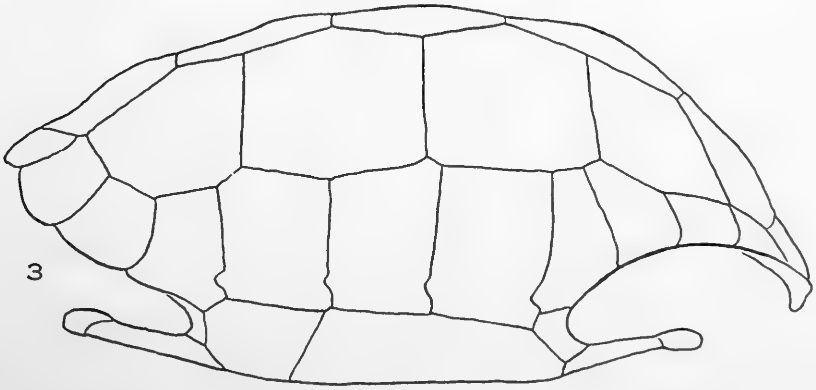


3

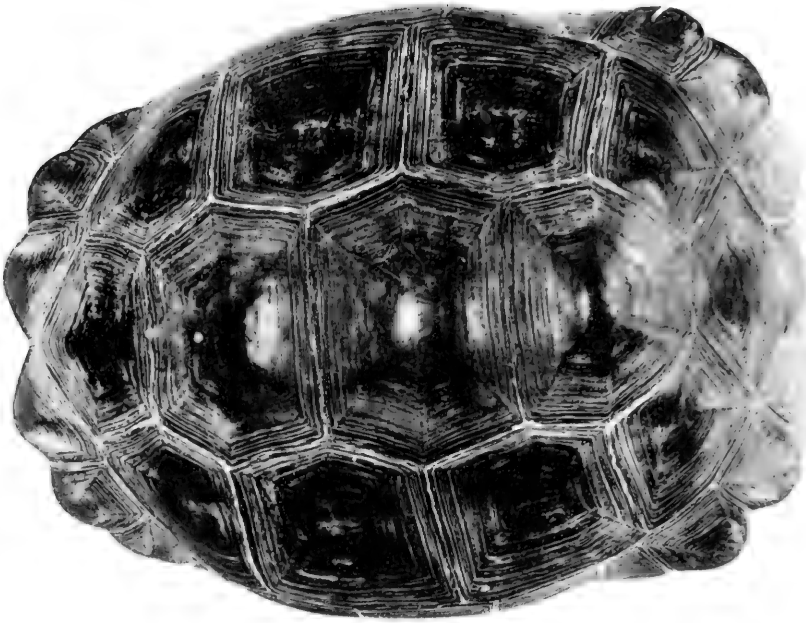
PLATE **19**.

TESTUDO MICROPHYES Günther, 1875. Page 280

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4476. Santa Maria (Charles). Louis Agassiz. Length 15½ inches.

1



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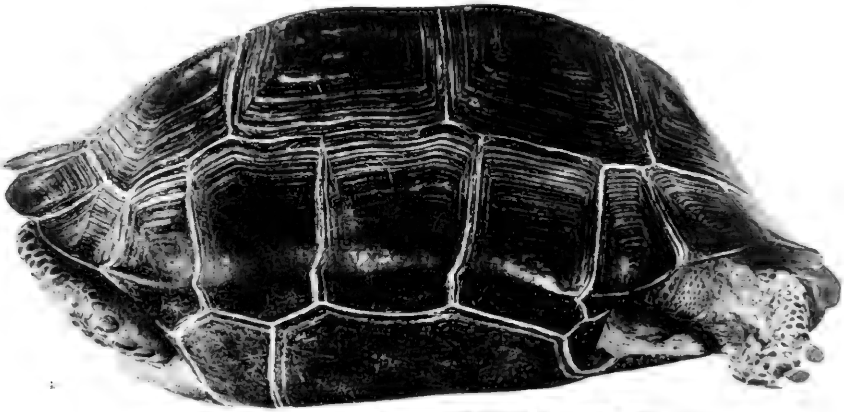

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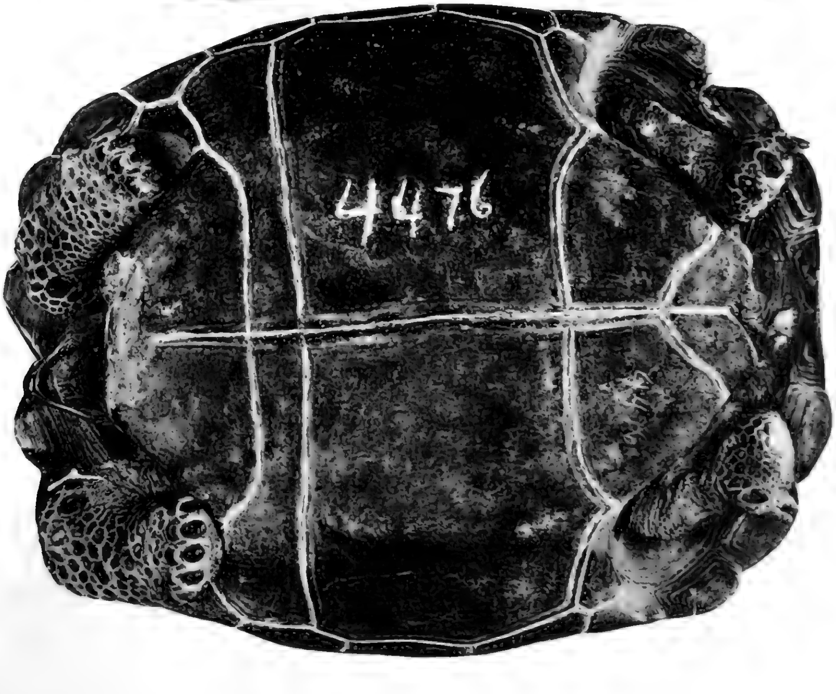

PLATE 20.

Page 280

TESTUDO MICROPHYES Günther, 1875.

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11071. C. F. Winslow. Length 23⅝ inches.

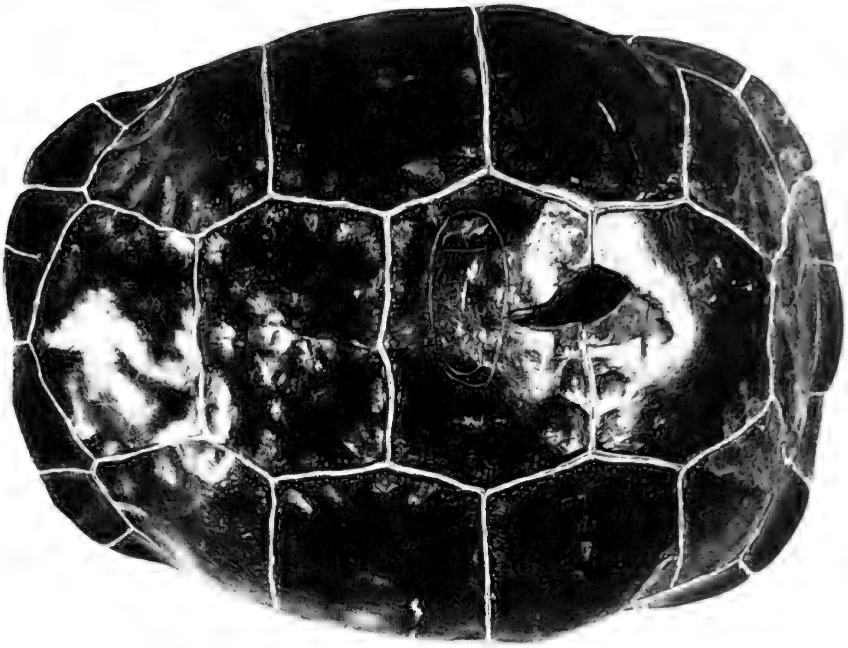

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PLATE 21.

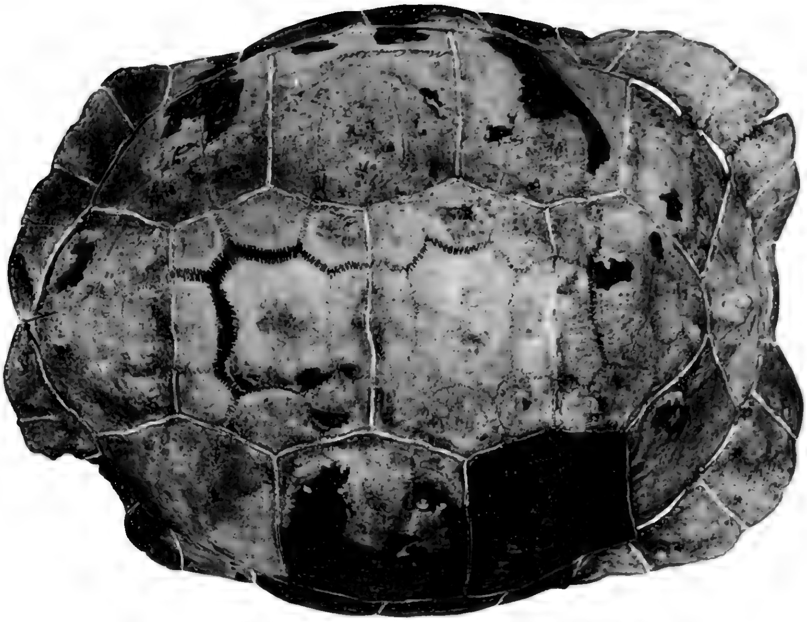
PLATE **21**.

Testudo clivosa Garman, 1916. Page 283

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11075. Type. Boston Society of Natural History. **Length $25\frac{3}{8}$ inches.**

1



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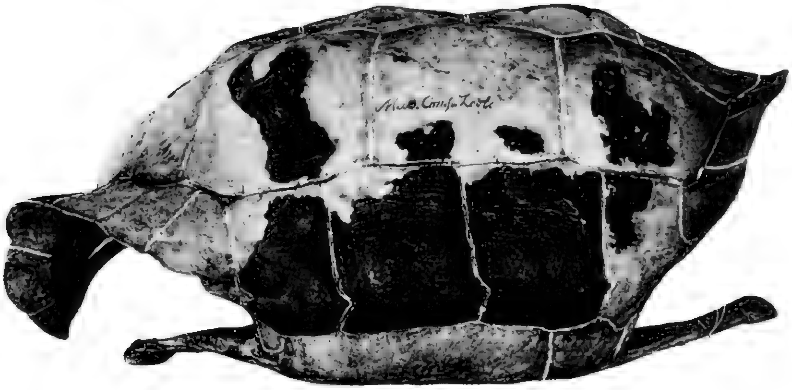

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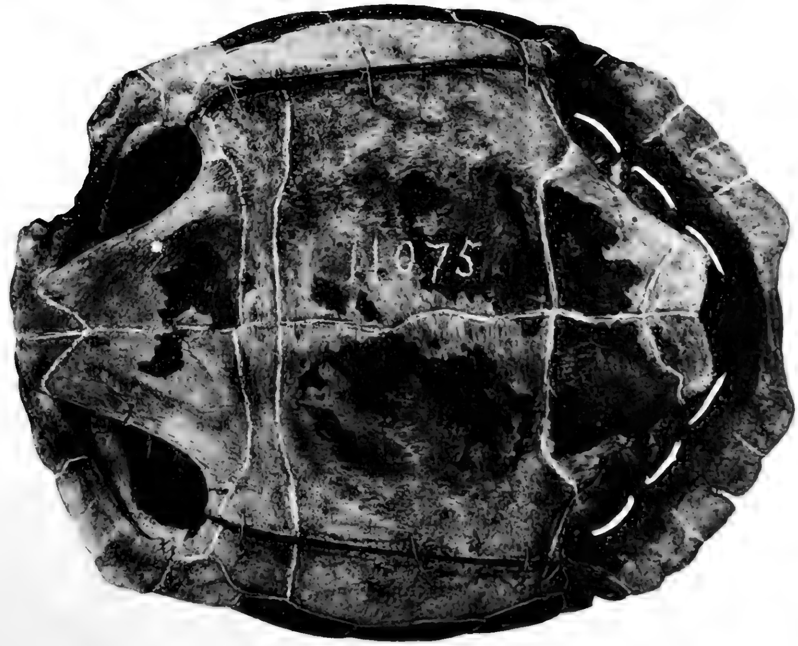


PLATE 22.

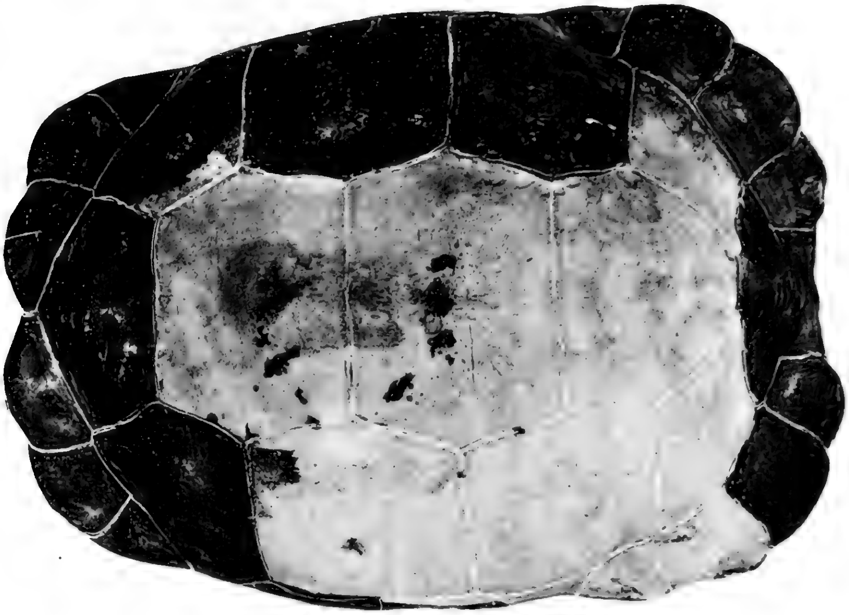
PLATE **22**.

Testudo typica Garman, 1916. Page 285

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11072. Type. Boston Society of Natural History. Length 24 inches.

1



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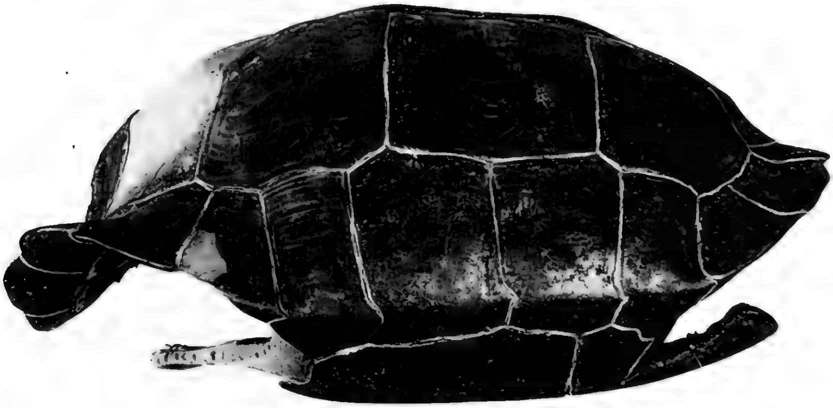

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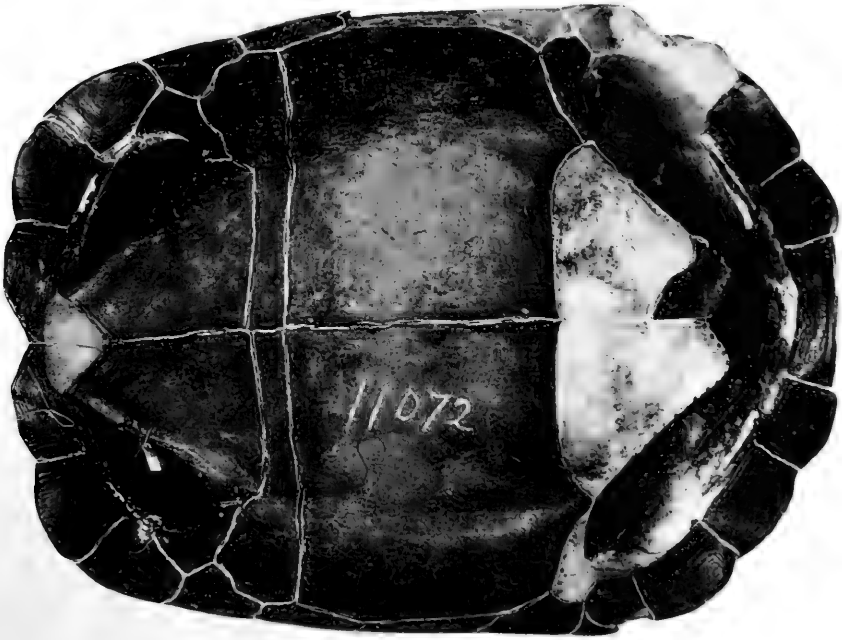


PLATE **23**.

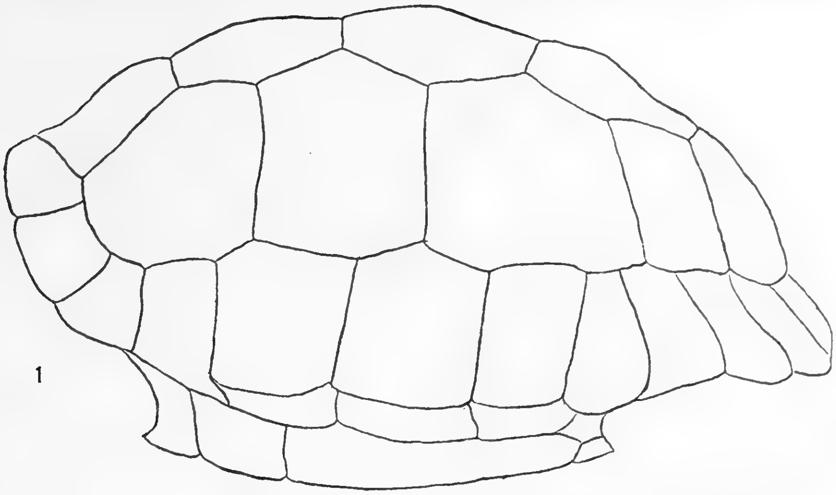
PLATE **23**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 lateral, 2 ventral, 3 lateral.

1 from Wiegmann, 1835, Nov. Acta Acad. Leop.-Carol., **17**, Plate **13**. Weight 125 pounds.

2, 3 from Quoy et Gaimard, 1824, Voyage Uranie et Physicienne. Zool., Plate **40**. Length 12 inches.



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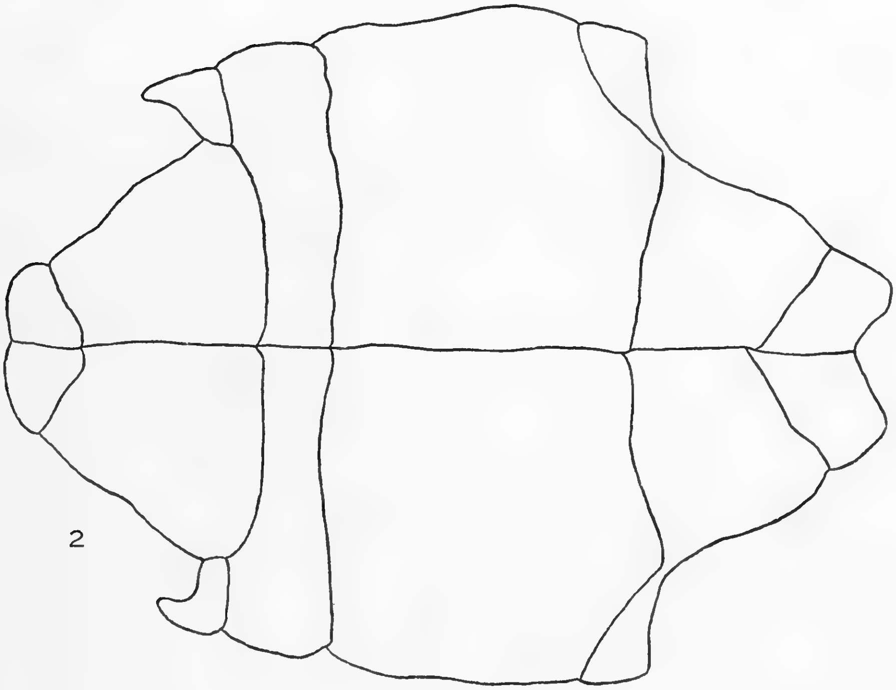

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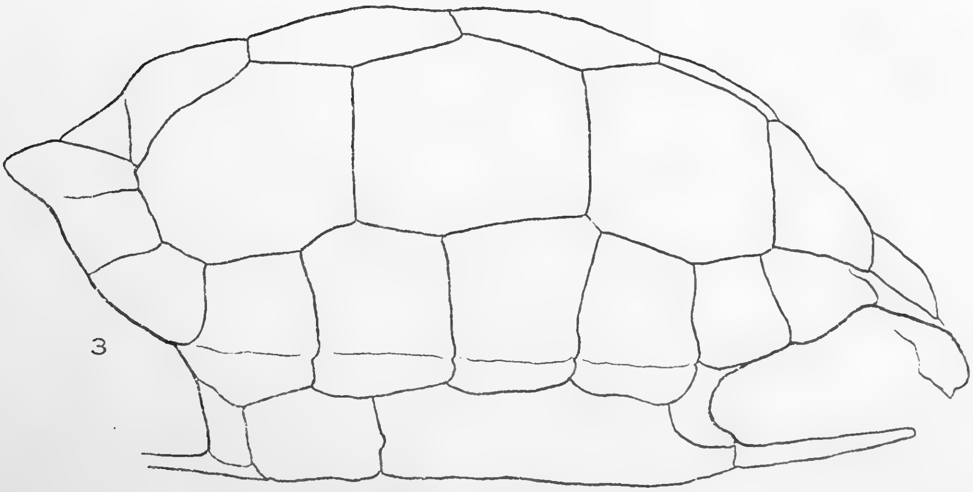


3

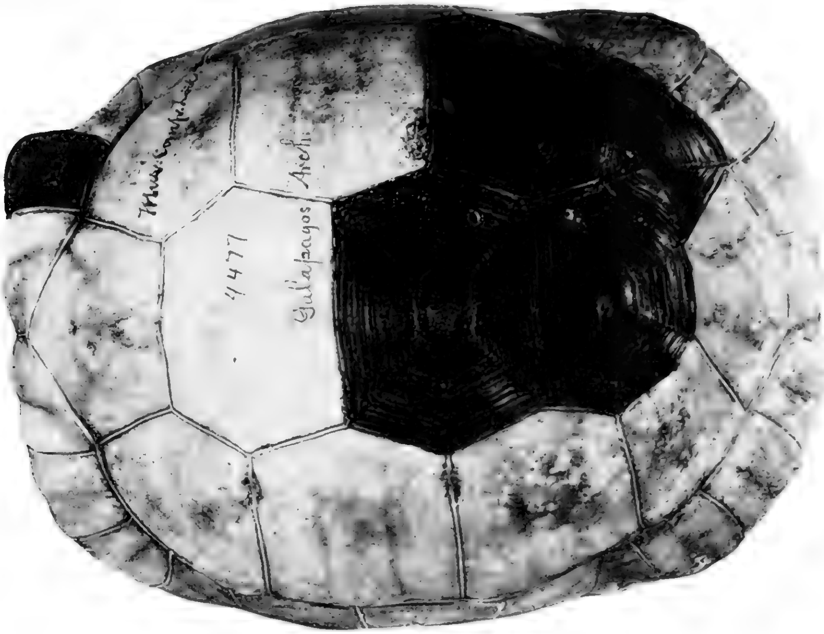
PLATE 24.

PLATE **24**.

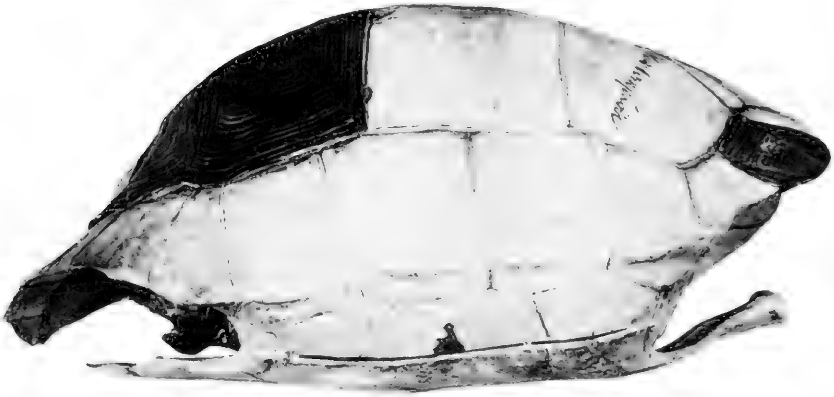
TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4477. Santa Maria (Charles). Hassler Exped. Length $10\frac{3}{4}$ inches.


Mus. Comp. Zool.
Galapagos Archi.
4477

1



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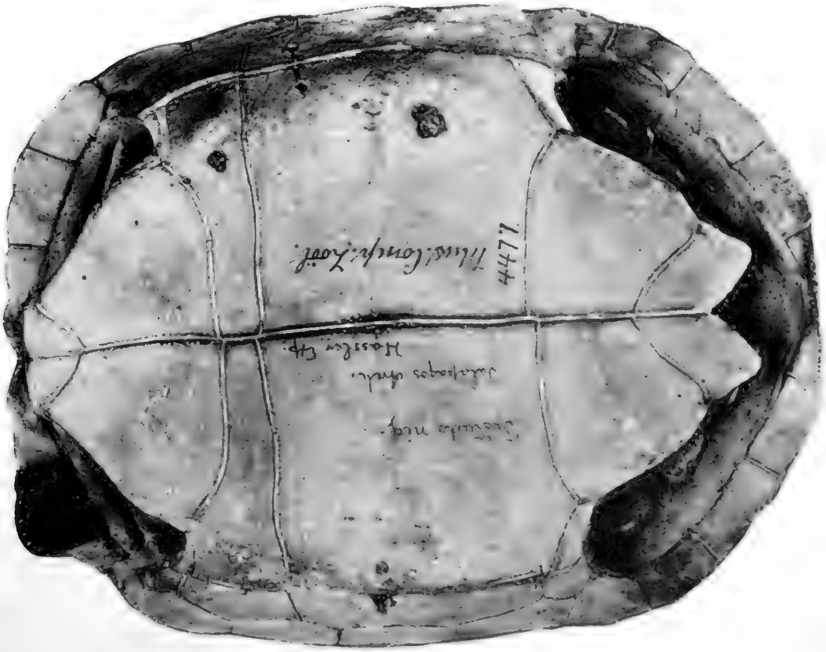

Mus. Comp. Zool.
4477
Hassler Exp.
Galapagos Archi.
Testudo nig.

3

PLATE 25.

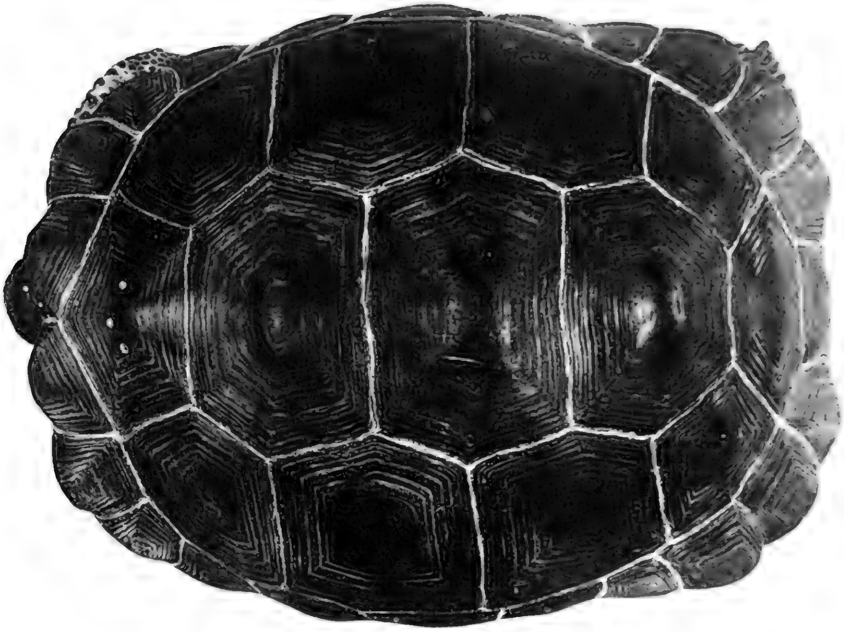
PLATE **25**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4480. Santa Maria (Charles). Hassler Exped. Length 13 inches.

1



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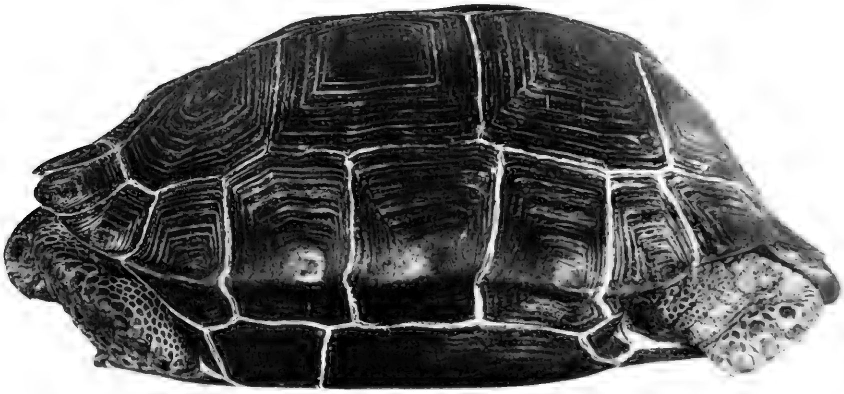

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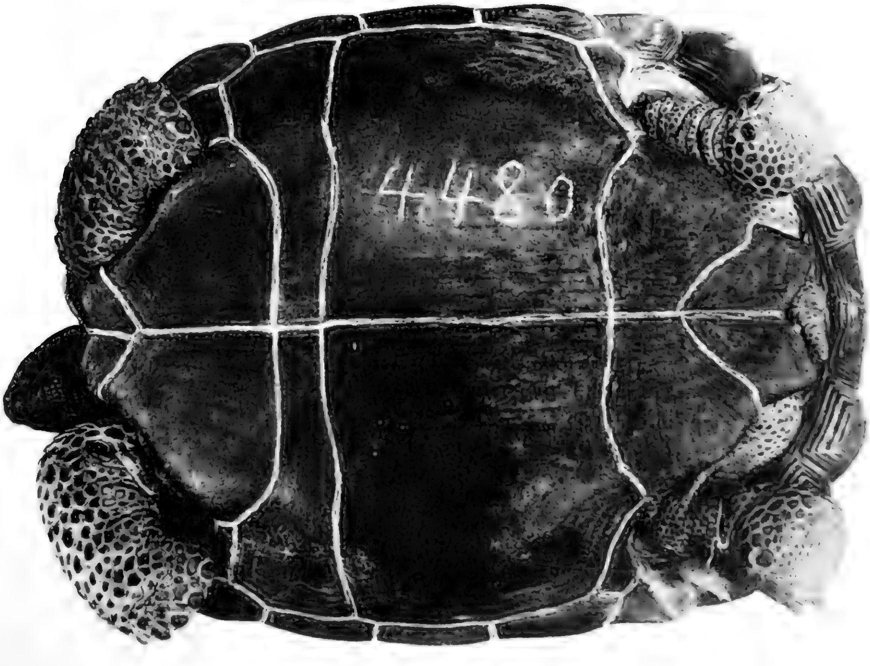


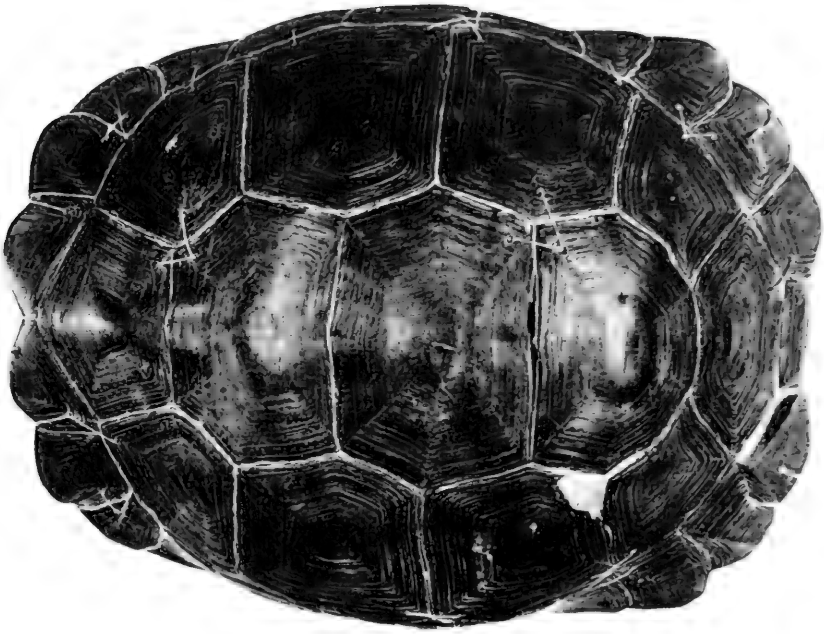
PLATE 26.

PLATE **26**.

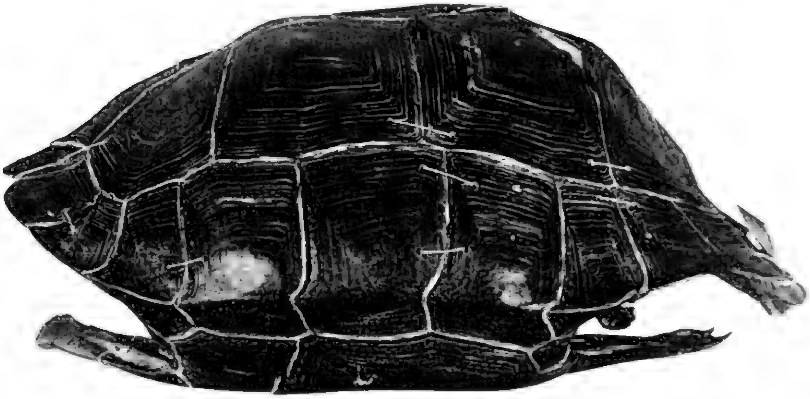
Testudo nigra Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4478. Santa Maria (Charles). Hassler Exped. Length 15 inches.



1



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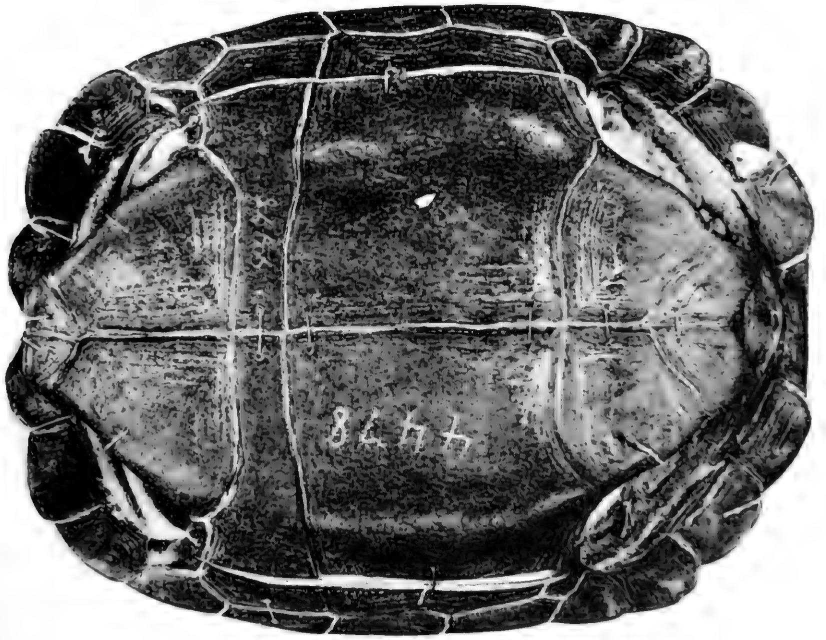


3

PLATE **27**.

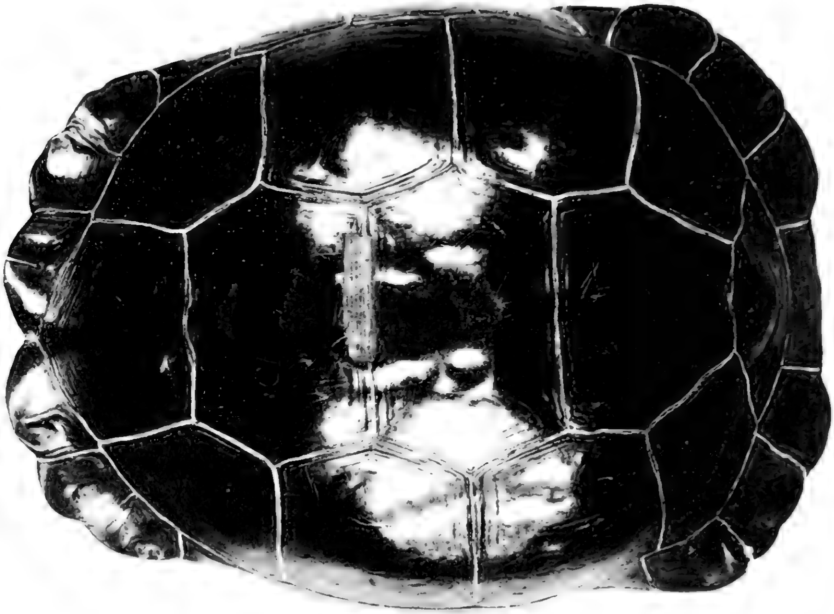
PLATE **27**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11074. Boston Society of Natural History. Length 24$\frac{3}{4}$ inches.

1



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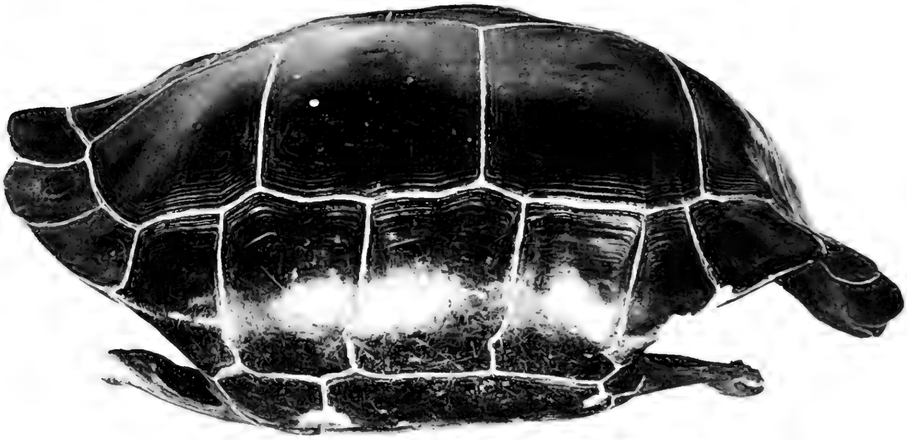

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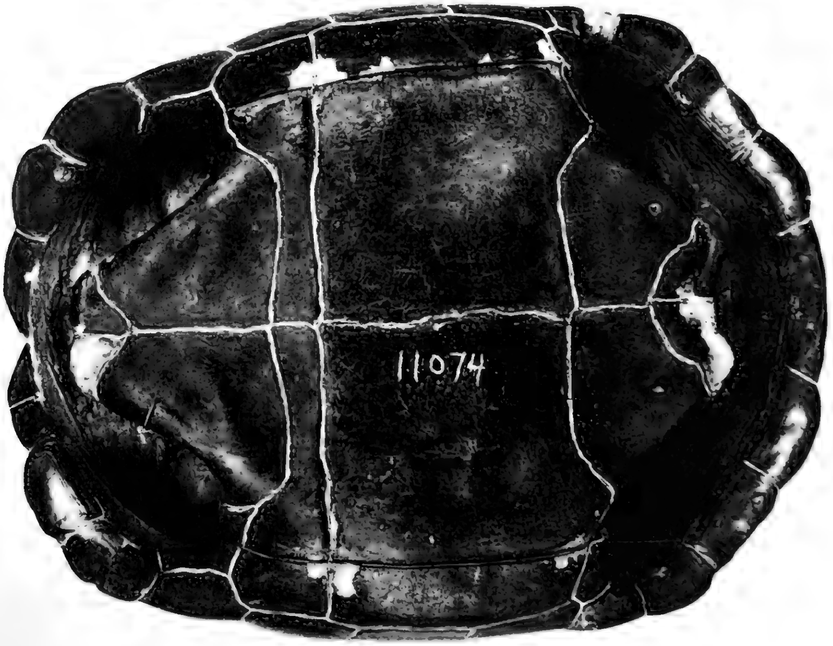


PLATE 28.

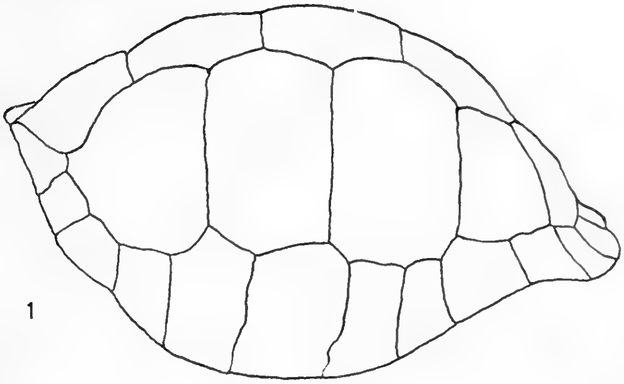
PLATE **28**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 ♀ lateral, 2 ♂ ventral, 3 ♂ lateral.

1 from Jackson, 1837, Boston Journ. Nat. Hist., **1**, Plate **10**. (*T. elephantopus* Jackson *nec* Harlan). M. C. Z. 11069 ♀ Santa Maria (Charles). Boston Society of Natural History. Length 42½ inches.

2, 3 from Jackson, 1837, Boston Journ. Nat. Hist., **1**, Plate **11** (*T. elephantopus* Jackson *nec* Harlan). M. C. Z. 11070 ♂. Santa Maria (Charles). Boston Society of Natural History. Length 38¼ inches.



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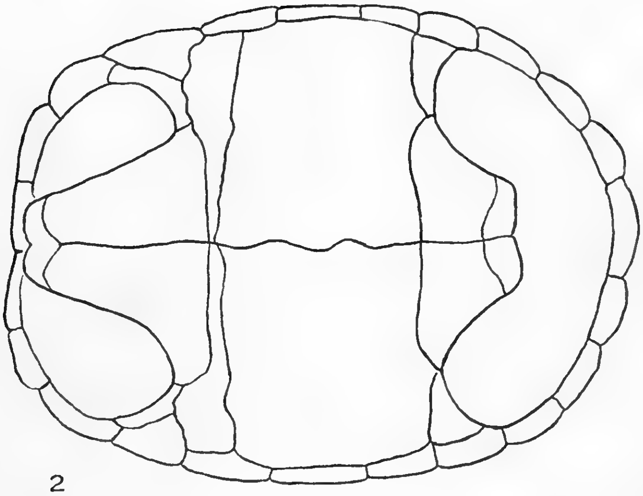
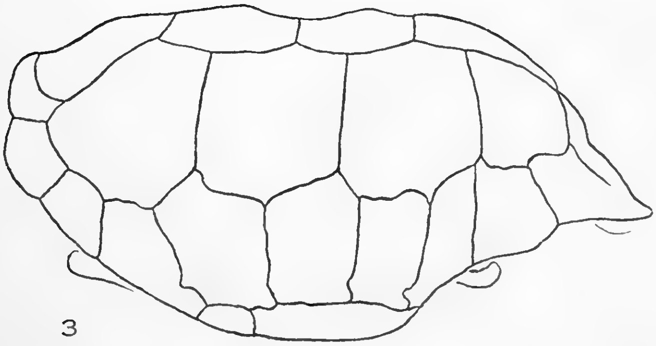


2



3

PLATE **29**.

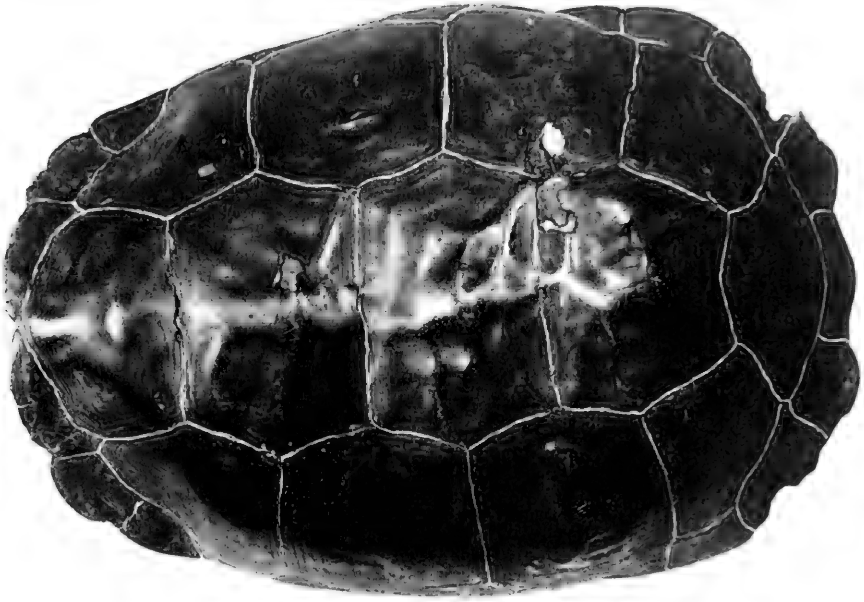
PLATE **29**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11070 ♂. Santa Maria (Charles). Boston Society of Natural History. Length 38¼ inches.

1



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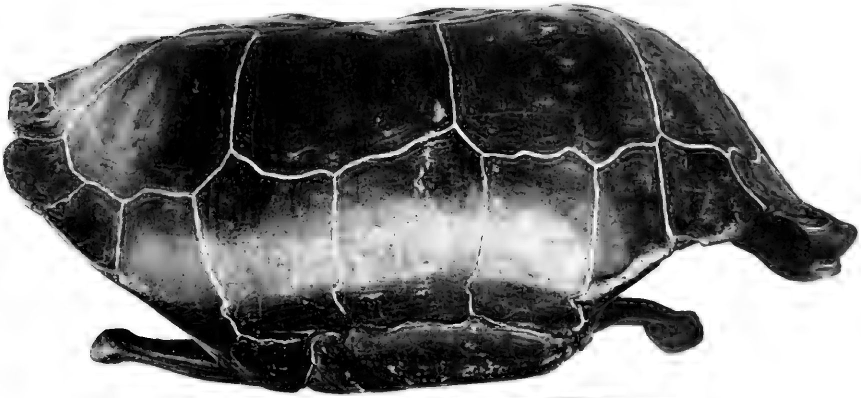


3

PLATE 30.

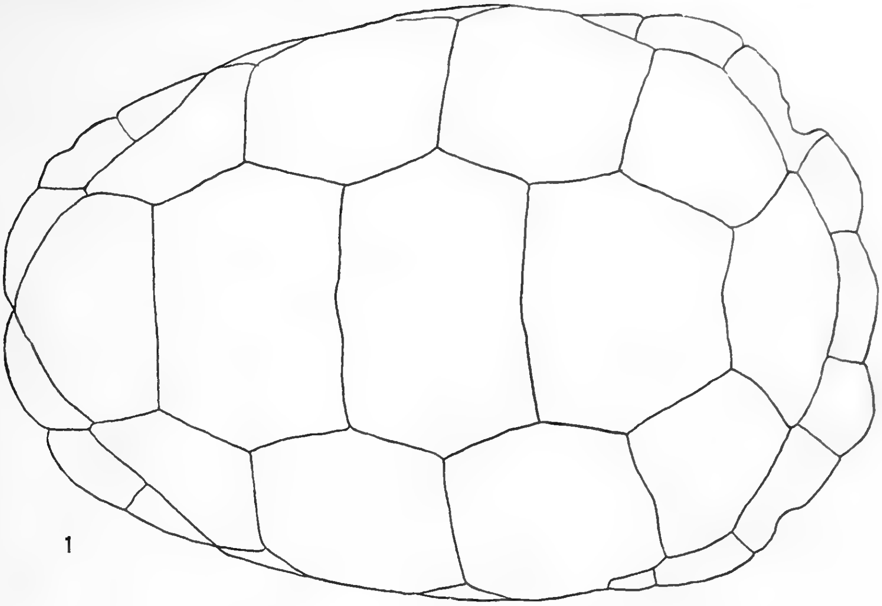
PLATE **30**.

Testudo nigra Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 ventral, 3 lateral.

From Günther, 1902, Nov. Zool., **9**, Plate 16, 17 (*T. galapagoensis* Baur).

M. C. Z. 11070 ♂. Santa Maria (Charles). Boston Society of Natural History. Length 38¼ inches.



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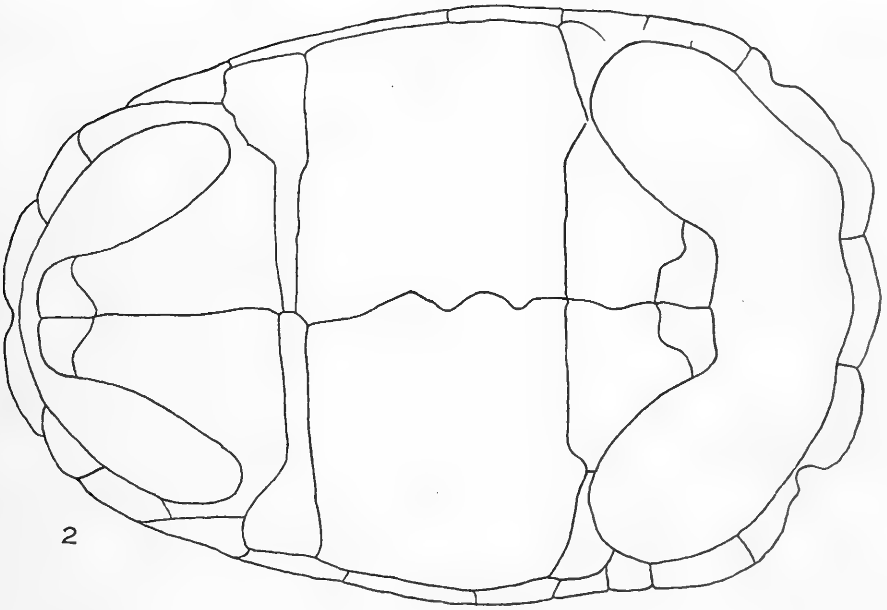

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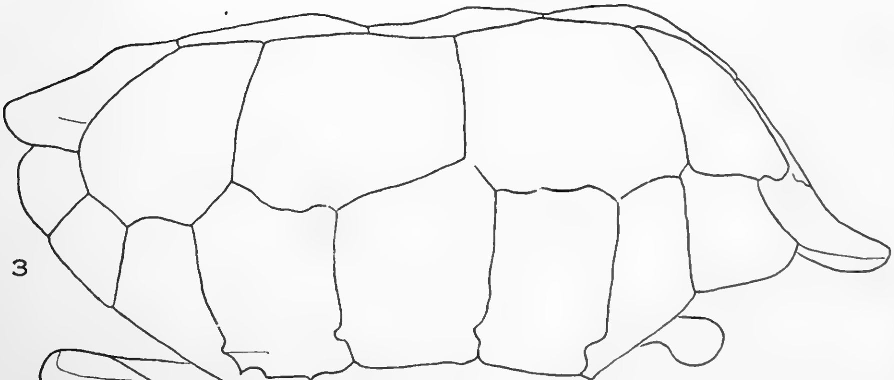


3

PLATE **31**.

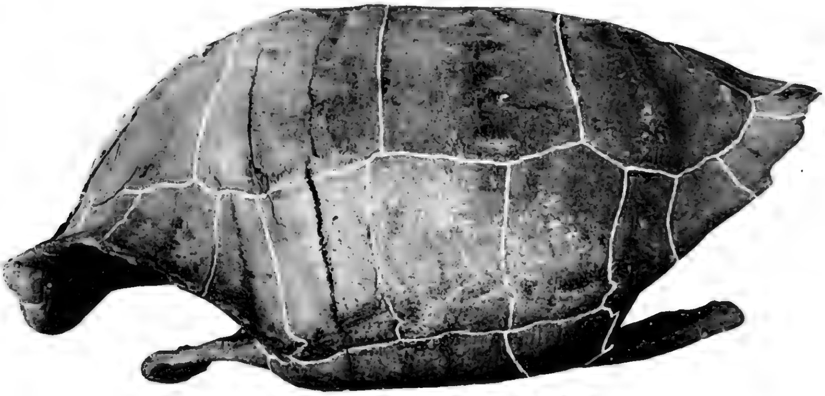
PLATE **31**.

Testudo nigra Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11069 ♀. Santa Maria (Charles). Boston Society of Natural History. Length 42½ inches.

1



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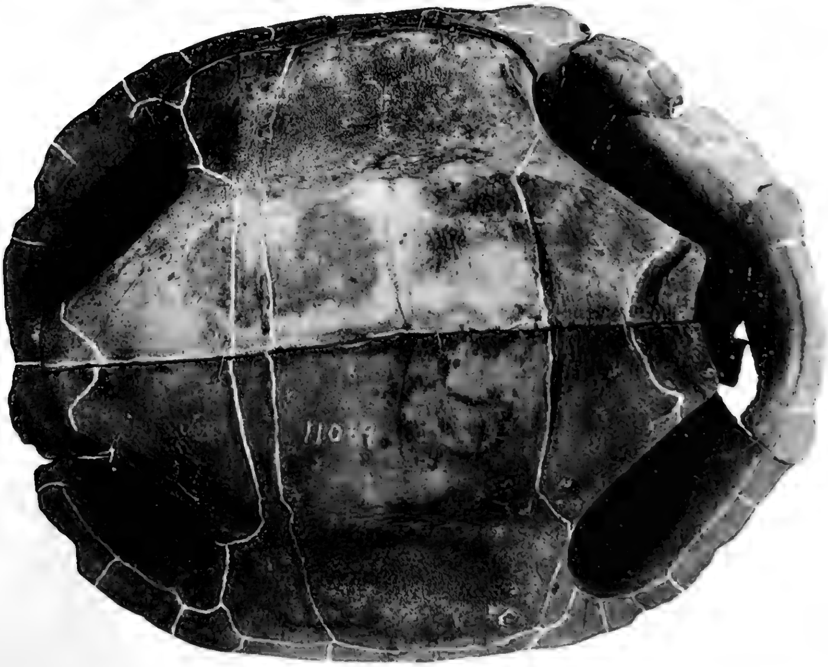


3

PLATE 32.

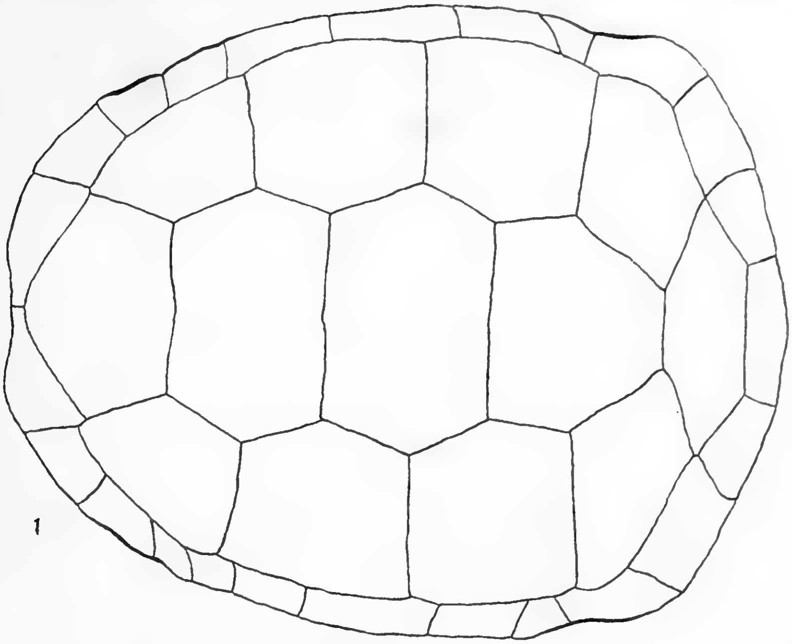
PLATE **32**.

TESTUDO NIGRA Quoy et Gaimard, 1824. **Page 286**

1 dorsal, 2 lateral, 3 ventral.

1, M. C. Z. 1905 ♀. Santa Maria (Charles). Hassler Exped. Length 27½ inches.

2, 3 from Günther, 1902, Nov. Zool., **9**, Plate **17**, fig. B (*T. galapagoensis* Baur).



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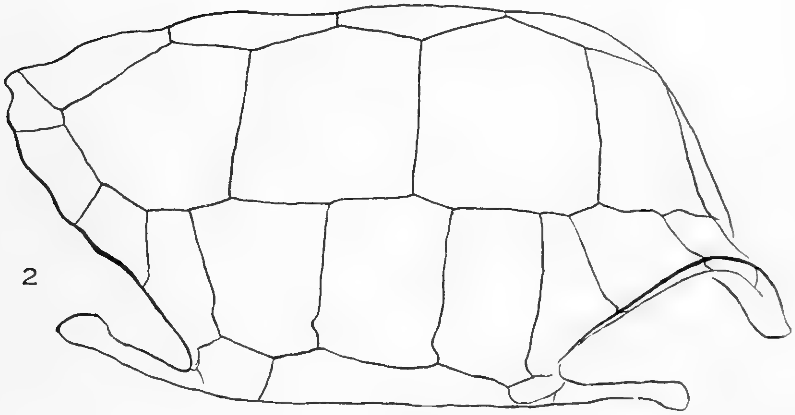

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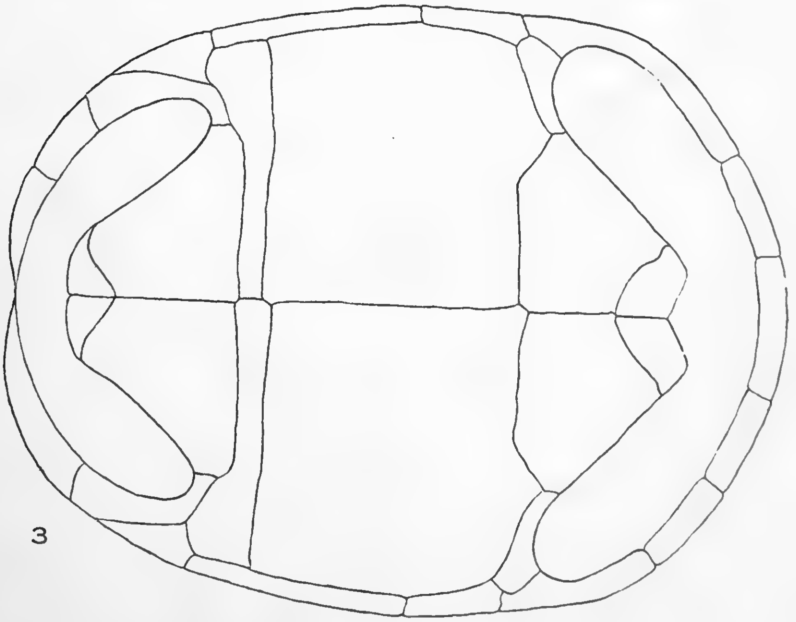


3

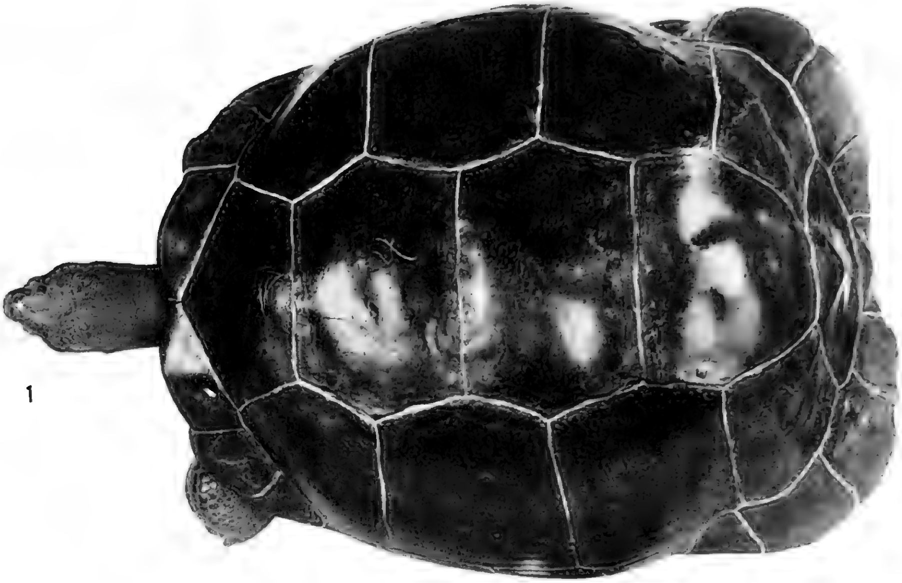
PLATE **33**.

PLATE **33**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 1904 ♀. Length 27½ inches.



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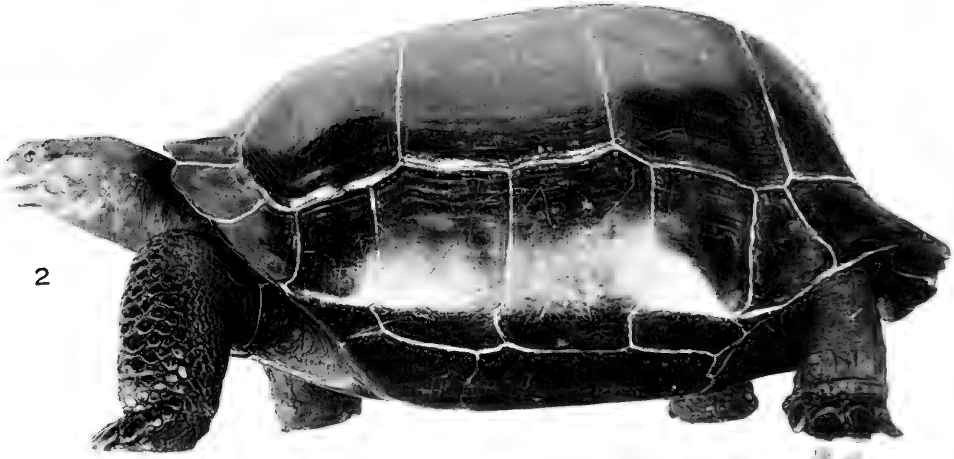

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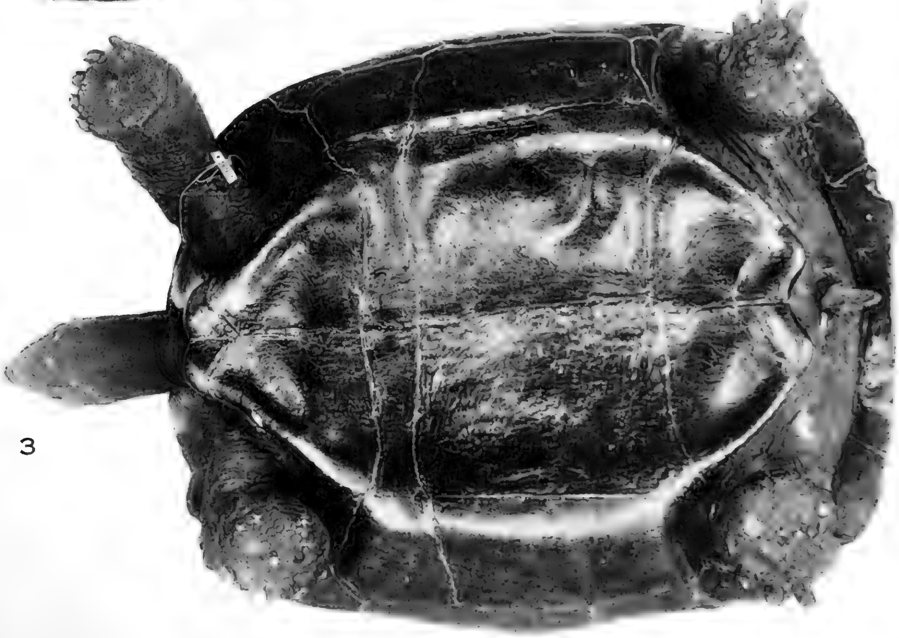


3

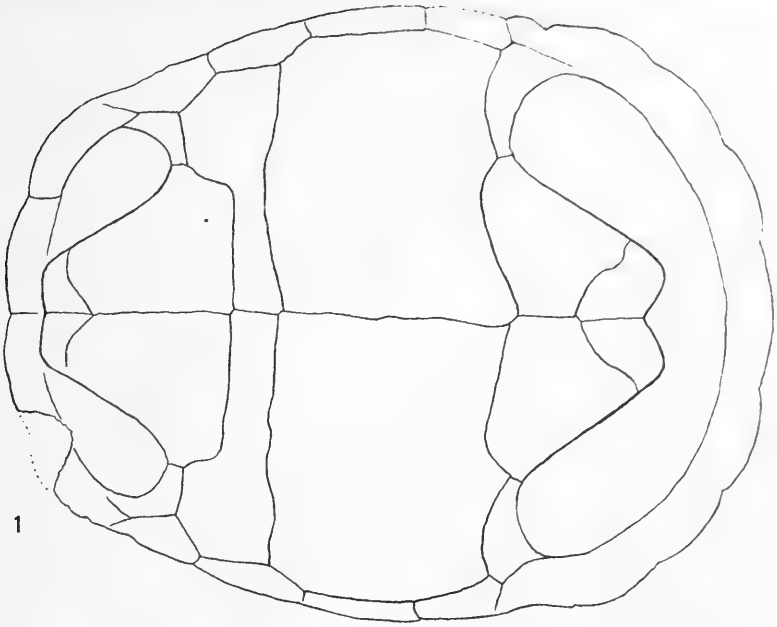
PLATE **34**.

PLATE **34**.

TESTUDO TYPICA Garman, 1917. Page 285

1 ventral, 2 dorsal, 3 lateral.

M. C. Z. 5260. H. A. Ward Coll. Length 28½ inches.



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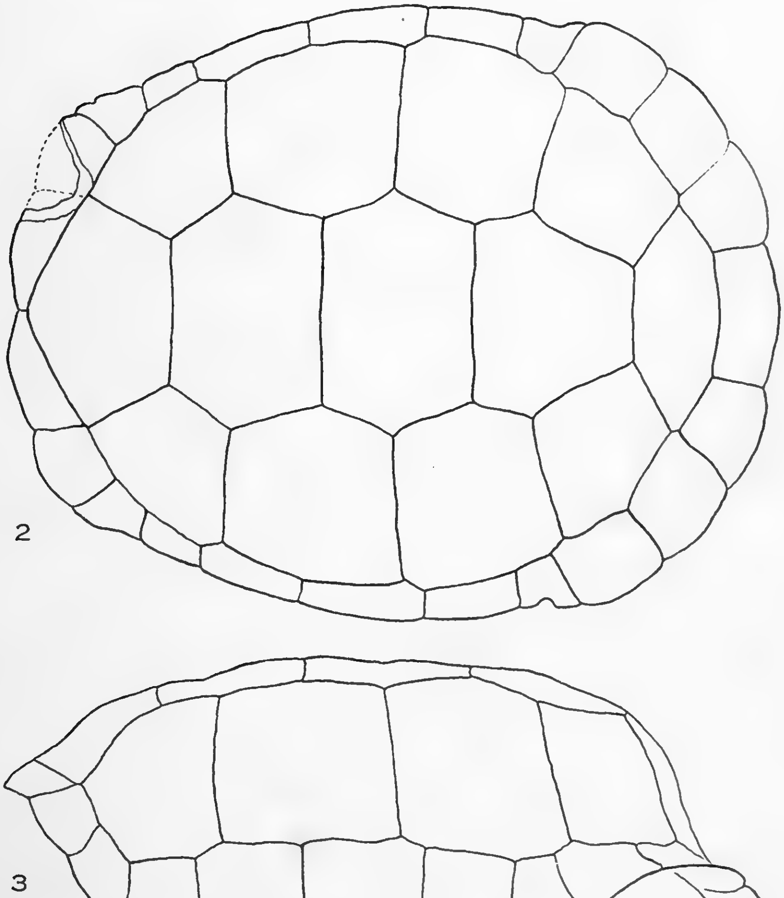


2

3

PLATE **35**.

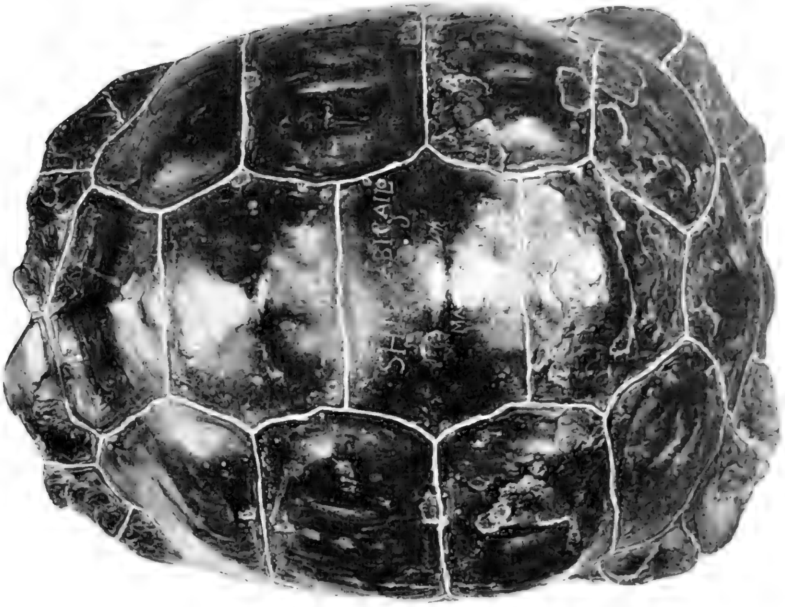
PLATE **35**.

TESTUDO NIGRA Quoy et Gaimard, 1824. Page 286

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11064. Boston Society of Natural History. Length 41½ inches.

1



2

3

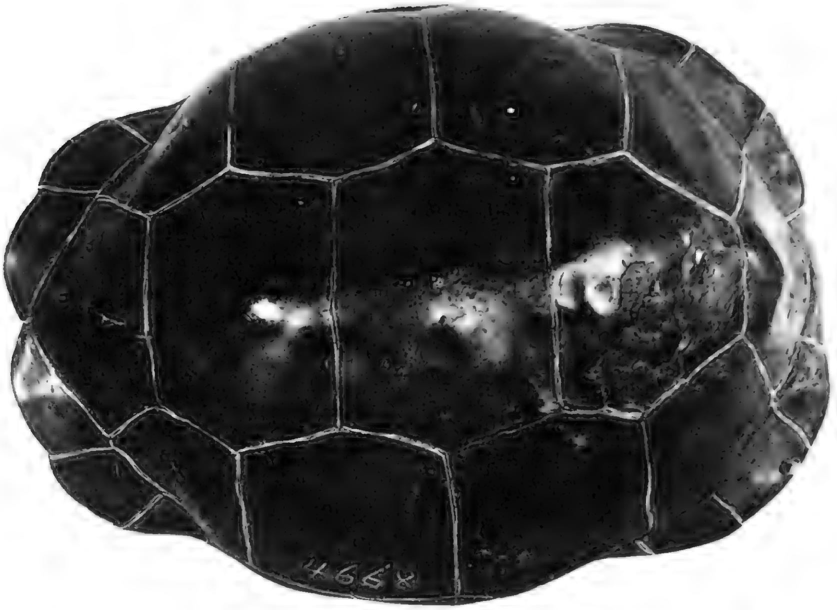
PLATE 36.

PLATE **36**.

Testudo nigra Quoy et Gaimard, 1824. Page 286

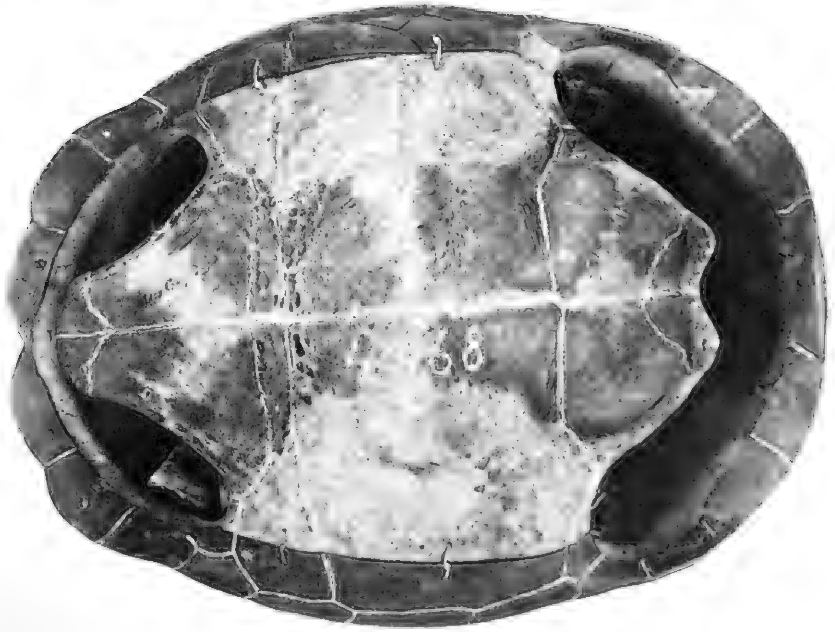
1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 4668. Charles Island. Hassler Exped. Length 26 inches.



1

2



3

PLATE **37**.

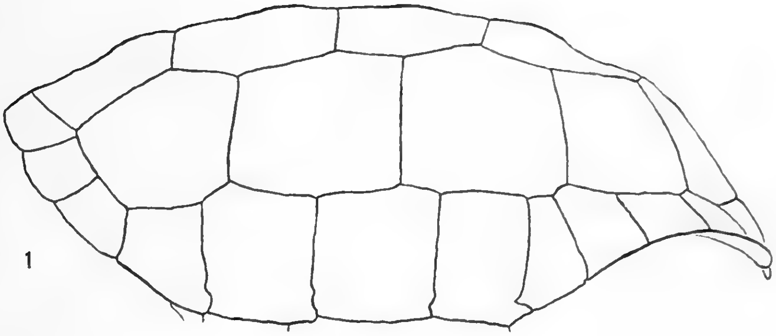
PLATE **37**.

TESTUDO ELEPHANTOPUS Harlan, 1827. Page 290

1, 3 lateral, 2 ventral.

1 M. C. Z. 11063. Boston Society of Natural History. Length 16¼ inches.

2, 3 from Harlan, 1827, Journ. Acad. Nat. Sci. Philadelphia, **5**, Plate **11**. Med. and Phys. Researches, 1835, p. 190.



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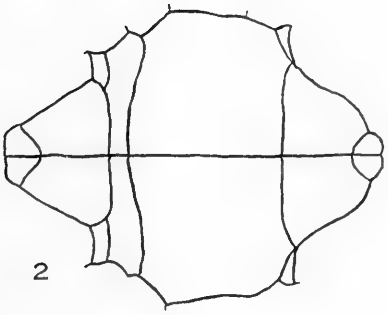

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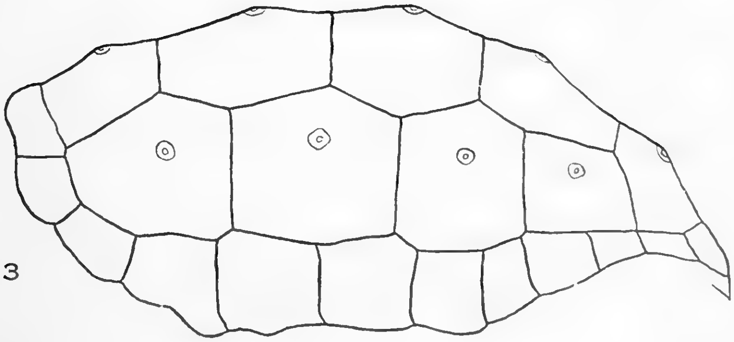


3

PLATE **38**.

PLATE **38**.

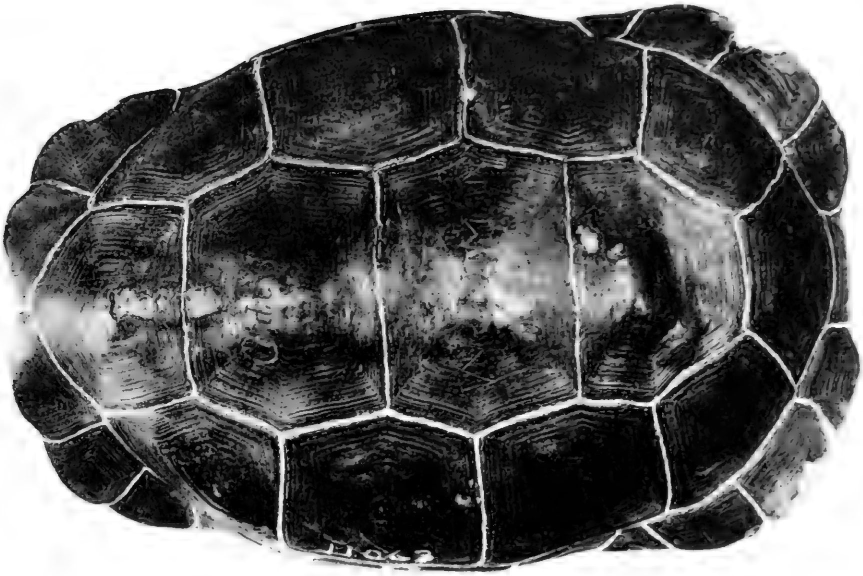
Testudo elephantopus Harlan 1827. Page 290

1 dorsal, 2 lateral, 3 ventral.

1, 2 M. C. Z. 11063. Boston Society of Natural History. Length 16¼ inches.

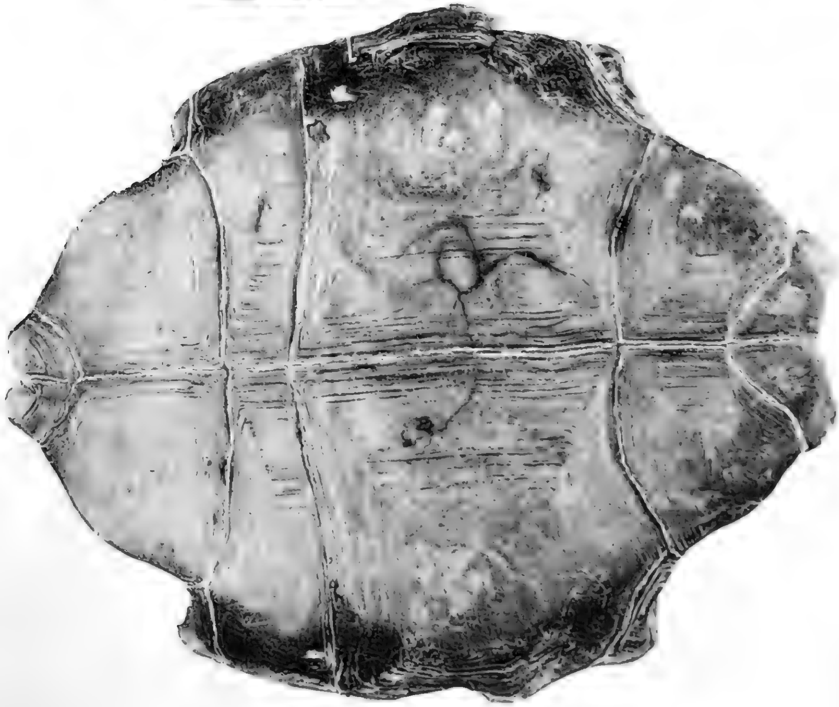
Testudo microphyes Günther, 1875. Page 280

3 M. C. Z. 11073. Boston Society of Natural History. Length 12 inches.



1

2



3

PLATE **39**.

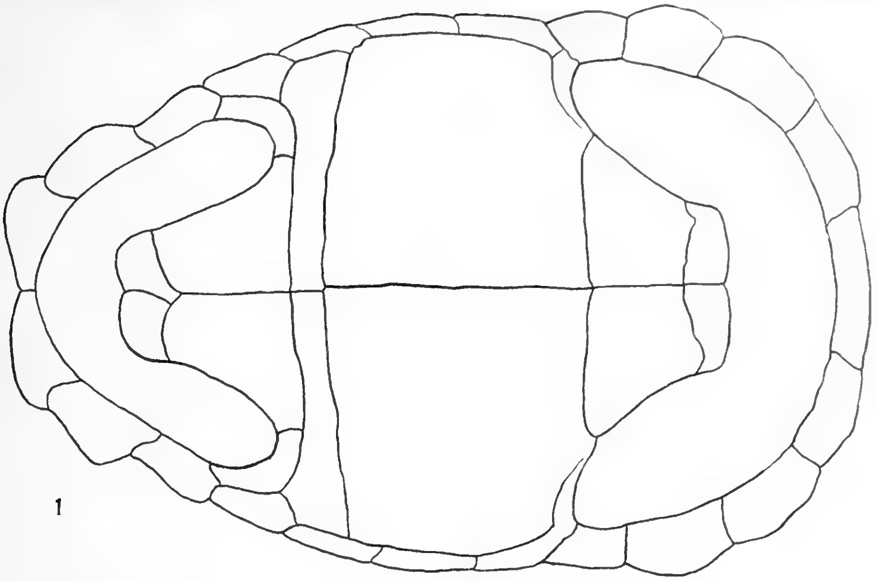
PLATE **39**.

TESTUDO ELEPHANTOPUS Harlan, 1827. Page 290

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1875, Philos. Trans. Royal Soc. London, **165**, Plate 34, 35, fig. B (*T. ephippium* Günther).

Mus. Science and Arts Edinburgh. ♂ TYPE (*T. ephippium* Günther). Pinta (Abingdon)? Length 33 inches.



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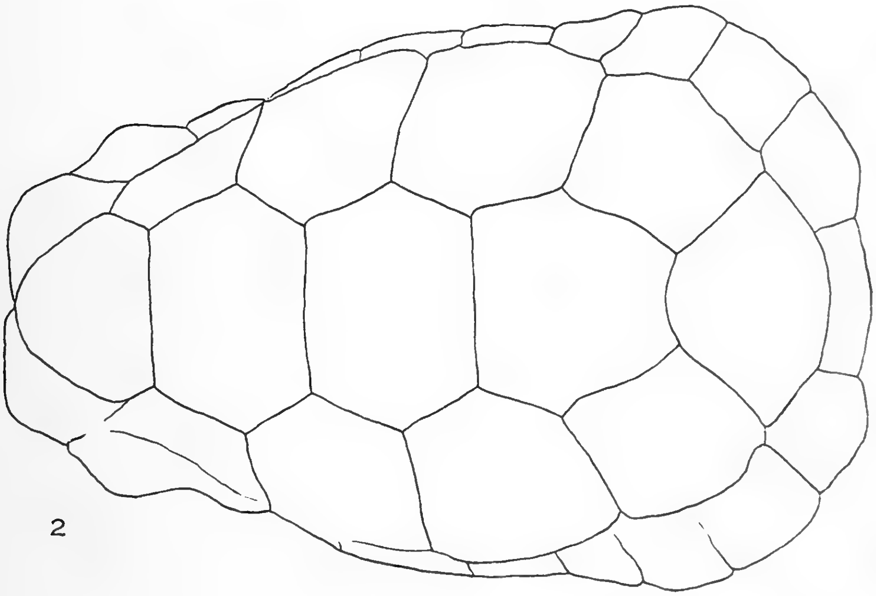

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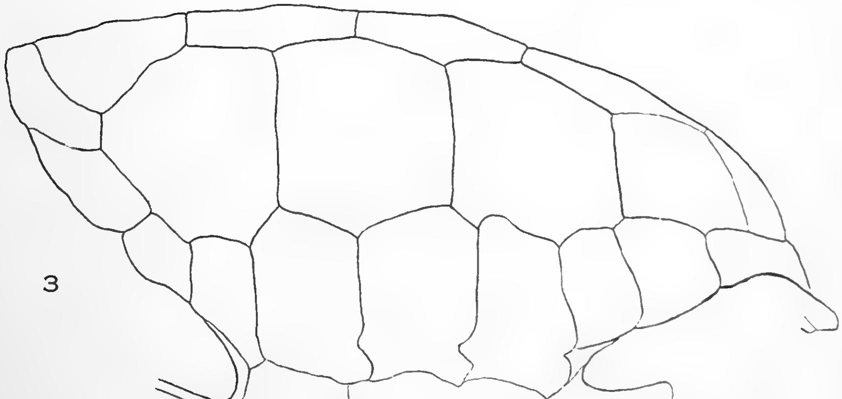


3

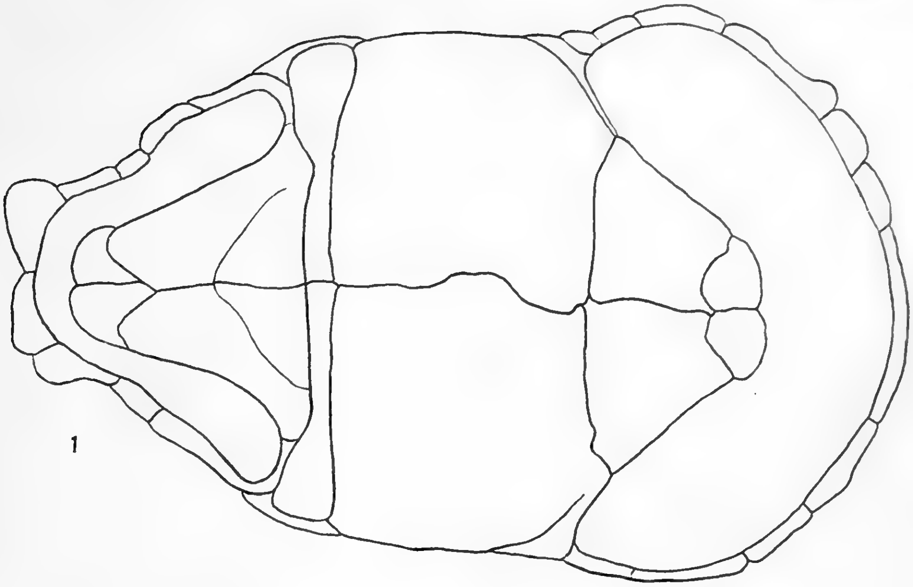
PLATE 40.

PLATE **40**.

TESTUDO ELEPHANTOPUS Harlan, 1827. Page 290

1 ventral, 2 dorsal, 3 lateral.

From Günther, 1877, Gigantic tortoises, Plate **40, 41** (*T. abingdoni* Günther).
British Museum TYPE. (*T. abingdoni* Günther). Length 38 inches.



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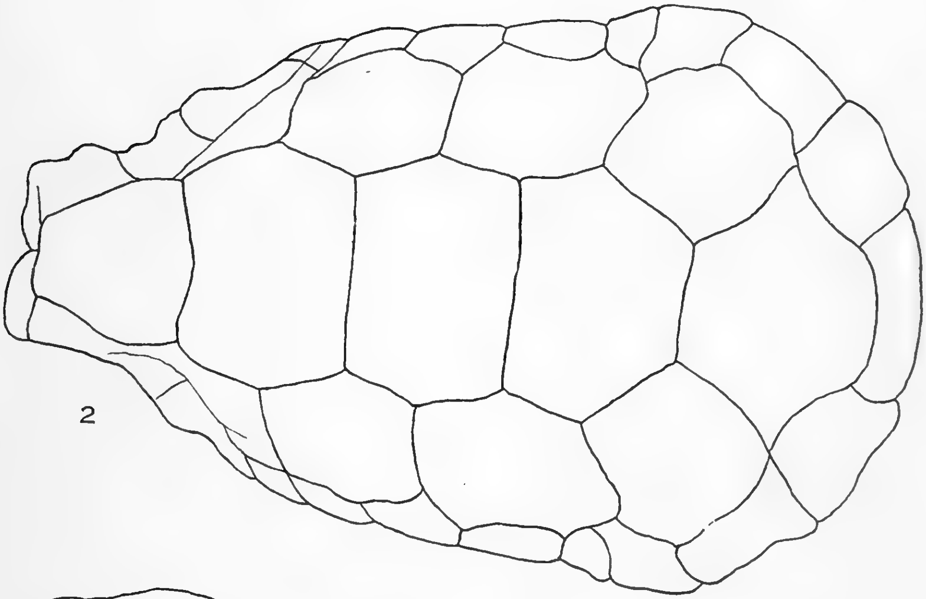

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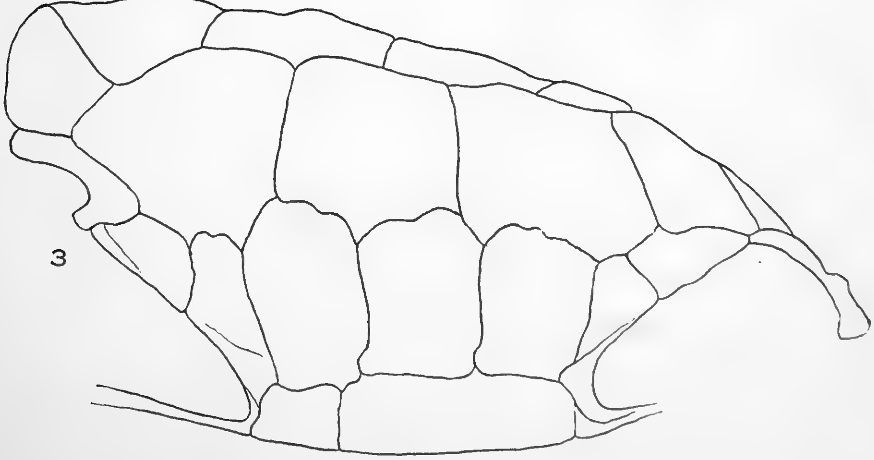

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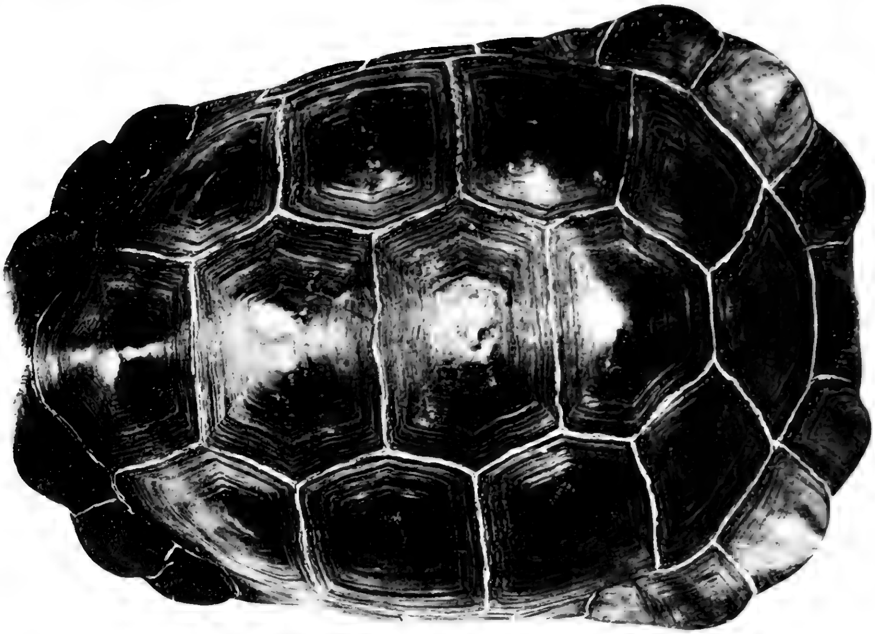
PLATE 41.

PLATE **41**.

TESTUDO ELEPHANTOPUS Harlan, 1827. Page 290

1 dorsal, 2 lateral, 3 ventral.

M. C. Z. 11068. Pinzon (Duncan). George Baur. Length 25 inches.



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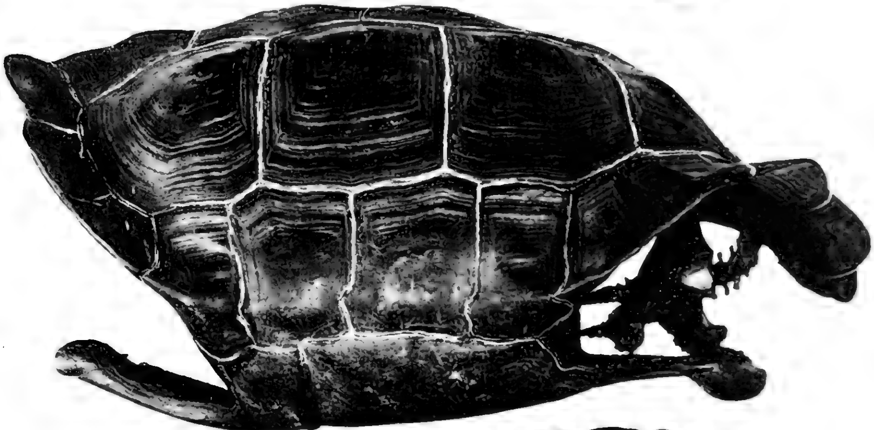

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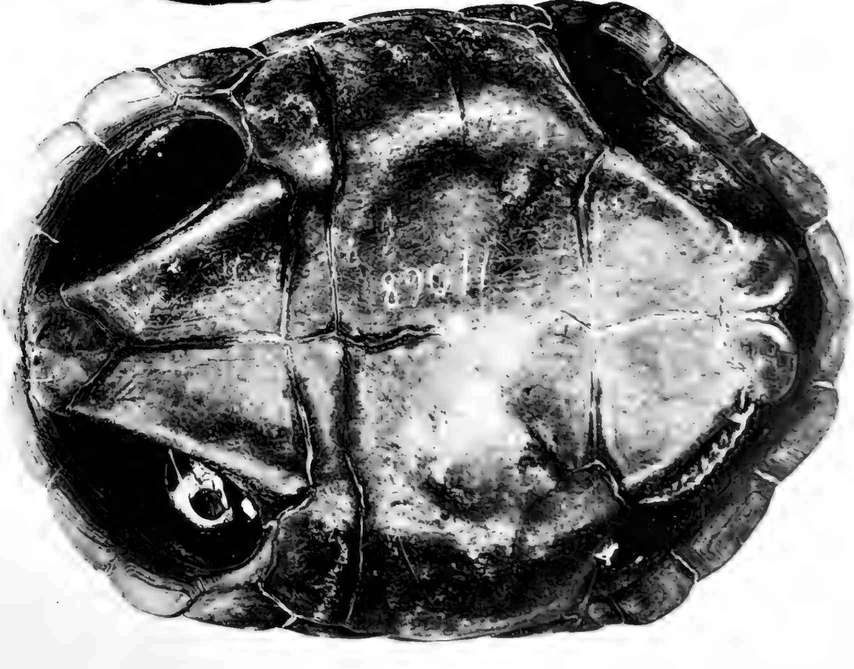

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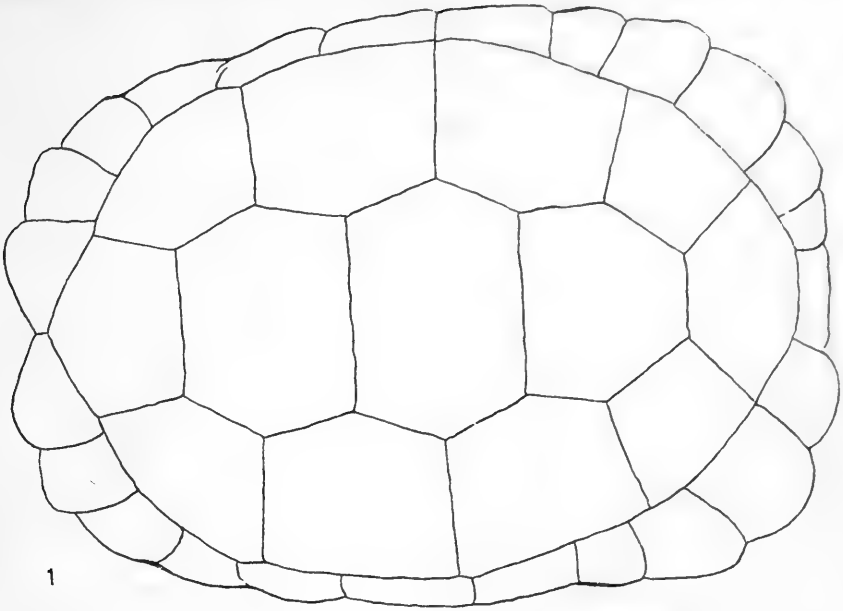
PLATE 42.

PLATE **42.**

Testudo elephantopus Harlan, 1827. Page 290

1, 2 dorsal, 3 lateral.

1 M. C. Z. 11084. Cast (*T. becki* Rothschild). F. B. Webster. Length, 16 inches.
2, 3 M. C. Z. 11083. Cast. F. B. Webster. Length 21½ inches.



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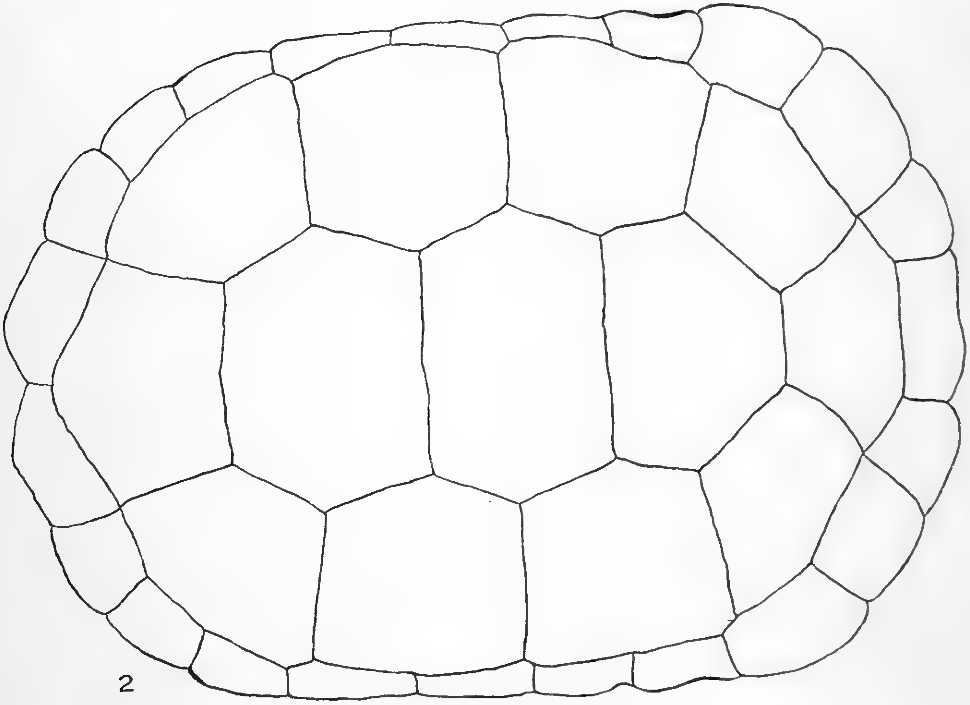

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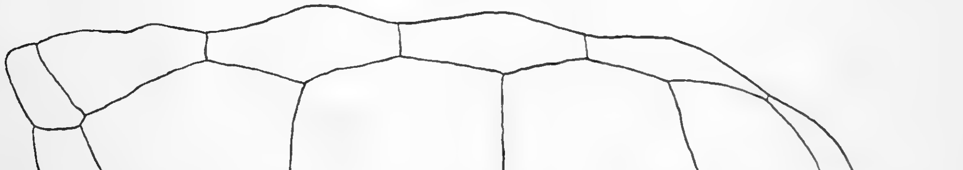

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