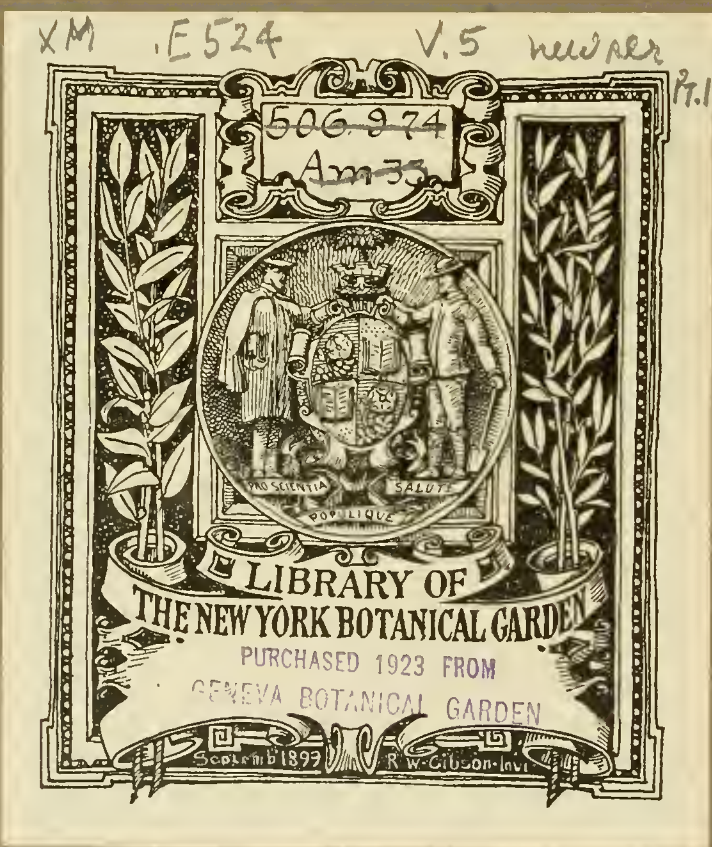
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CONTENTS OF PART I.

MEMOIRS

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I.

Astronomical, Magnetical, and Meteorological Observations, made at Panama, New Grenada.

BY W. H. EMORY,

BREVET MAJOR CORPS TOPOGRAPHICAL ENGINEERS, CHIEF ASTRONOMER AND SURVEYOR OF THE MEXICAN BOUNDARY COMMISSION.

(*Communicated by W. C. Bond, Director of Harvard Observatory, Aug. 8th*, 1849.)

THE subjoined extracts from a letter addressed to Mr. Bond by Major Emory sufficiently describe the instruments used in making the following observations, as well as the mode of conducting them. The letter is dated Panama, May 8th, 1849.

" Being detained here in our progress to San Diego with some of the instruments intended for the survey of the boundary between the United States and Mexico, I have occupied myself and assistants with making a short series of observations for latitude, longitude, magnetic dip, declination, and intensity ; and with a series of meteorological observations with the barometer, maximum and minimum thermometers, Daniell's hygrometer and the wet-bulb thermometer, and with a few observations for solar radiation with the black-bulb thermometer.

" The observations for latitude were made with a zenith telescope, with a focal length of forty-two inches. The results are not as good as those obtained by me on the Northeastern Boundary with the same instrument, owing to a slight derangement in its parts from long service. The results may no doubt be improved by a more accurate determination of the declinations of the stars used.

" The computations were made by myself and Professor James Nooney, one of my assistants.

"The observations for longitude were made by myself and Lieutenant A. W. Whipple, and those for magnetic dip, declination, and intensity, by Lieutenant A. W. Whipple and myself, but chiefly by the former.

"The results are as follows: —

Latitude, 8° 57′ 12″.15 north.
Longitude, 5h. 17m. 57s.63 west of Greenwich.
Magnetic declination, 6° 54′ 37″ east.
" dip, 32° 00′ 00″.
" intensity,* 0.87507 (uncorrected for difference of temperature).

"The place of observation was the northwest bastion of the fortification surrounding the city of Panama, and is north of the Cathedral 2″.75, and west of it 6″.85 (in arc).

"The results for latitude and longitude above given agree closely with those given by Bauza. His place of observation was the Cathedral.

"The results obtained by Espinar differ widely in longitude. The precise place where he observed cannot be ascertained.

"I have not been able to obtain the determination of latitude and longitude made by Sir Edward Belcher, nor have I ascertained the spot where his observations were made.

"I send you also my determination of the longitude of Chagres, as obtained by the transportation of chronometers from New York. The time at Chagres was determined by observations on east and west stars with a Gambey sextant."

Observations with Zenith Telescope, by Major W. H. Emory, for Latitude. Panama, New Grenada.

Date, 1849.	No. of Star, B. A. C.	North or South of Zenith.	Micrometers.		North Polar Distance.	Levels.			
						Direct.		Reverse.	
			No. 1.	No. 2.		North.	South.	North.	South.
					° ′ ″				
April 10	3033	N.	1776		56 30 48.24	35	34	35	29.5
"	3065	S.	1911		105 33 58.76	35	29.5	33.5	31.5
"	3160	S.	1675		95 43 51.28	31	34.5	32.5	32.5
"	3246	N.	1712		66 22 16.18	37	30	42	24
"	3409	N.	1061		59 38 10.90	35	32	34	33
"	3428	S.	132		102 34 30.29	34	33	35	31.5
"	3508	N.	693		65 50 03.16	36	32	45	22
"	3563	S.	348		96 18 15.83	36	31	32	35
"	3625	N.	1873		52 53 31.48	34.5	32	49	18
"	3733	S.	845		109 19 50.01	45	22	26	41
"	3964	N.	998		67 48 32.28	37.5	31	58.5	10
"	4030	S.	970		94 17 48.07	55	13.5	25	43

* Intensity at Falmouth, England, taken at unity.

Date, 1849.	No. of Star, B. A. C.	North or South of Zenith.	Micrometers.		North Polar Distance.	Levels.			
			No. 1.	No. 2.		Direct. North.	Direct. South.	Reverse. North.	Reverse. South.
April 10	4294	S.	1602		95° 28′ 37″.34	34	36	11	58
"	4388	N.	1327		66 34 21.09	17.5	54	21	50
April 11	3160	S.	727		95 43 51.28	26	38.5	44	21.5
"	3246	N.	777		66 22 16.10	46	20.5	37.5	30
"	3331	N.	1020		65 32 06.61	35	31	25	42
"	3363	S.	12		96 40 54.92	25	42	30	37.5
"	3508	N.	893		65 50 03.05	38	30	31	37
"	3563	S.	525		96 18 15.83	30	39	35	33.5
"	3625	N.	1334		52 53 31.34	32	36.5	43	26
"	3733	S.	293		109 19 50.10	40	29.5	28.5	41
"	3964	N.	660		67 48 32.16	38	31	50	20
"	4030	S.	593		94 17 48.07	46	24	29	41
"	4294	S.	848		95 28 37.34	35.5	35.5	46	25
"	4388	N.	459.5		66 34 20.94	45	26	46	24
April 12	3160	S.	577		95 43 51.28	25	41	20	47
"	3246	N.	679		66 22 16.02	21	47	38	30
"	3409	N.	1075		59 38 10.70	43	28	36	31
"	3428	S.	170		102 34 30.34	36	31	40	28
"	3508	N.	1081		65 50 02.95	39	30	50	20
"	3563	S.	755		96 18 15.84	48	21	34	35
"	3625	N.	1779		52 53 31.19	36	34	50	20
"	3733	S.	764		109 19 50.17	50	20	29	42
April 24	4294	S.	272		95 28 37.39	27	43	18	52
"	4388	N.		26	66 34 18.94	22	48	38	22
April 25	3033	N.	359		56 30 47.24	30	31	31.5	29
"	3065	S.	491		105 33 58.72	31.5	29	25	36
"	3160	S.	151		95 43 51.06	15	48	25	38
"	3246	N.	262		66 22 14.03	27	36	24	39
"	4516	S.		364	95 28 35.29	38	32	22	48
"	4566	N.	607		66 44 13.21	32	39	51	20
"	4294	S.	506		95 28 37.39	29	41	15	56
"	4388	N.	209		66 34 18.79	19	51	41.5	29
"	3508	N.	571		65 50 01.64	36	29	29	36
"	3563	S.	198		96 18 15.81	22	44	30	36
"	3625	N.	828		52 53 29.34	36	30	30	36
"	3733	S.		243	109 19 50.92	23	44	30	38
"	4127	N.		435	65 12 58.30	38	32	26	44
"	4269	S.	1187		96 40 15.54	26	44	22	49
"	3964	N.	331.5		67 48 30.38	38	31	30	39
"	4030	S.	190.5		94 17 48.08	22	48	29	40.5

Results of the foregoing Observations for the Latitude of Panama, Northwest Bastion, by Major W. H. Emory.

Date, 1849.	I. 3033 3065	II. 3160 3246	III 3331 3363	IV. 3109 3128	V. 3508 3563	VI 3625 3733	VII. 3961 4030	VIII. 4127 4269	IX. 4294 4388	X. 4516 4566	Mean of each Night's Observations.
April 10	08″.25	08″.10		10″.62	13″.10	18″.14	08″.79		10″.23		8° 57′ 11″.03
" 11		14.48	10″.79		12.79	16.20	12.58		13.02		8 57 13.31
" 12		09.56		11.98	14.73	16.49					8 57 13.19
" 24									14.85		8 57 14.85
" 25	06.08	11.25			11.02	17.14	16.27	07″.50	13.15	15″.75	8 57 12.27
Means by each pair,	07.17	10.85	10.79	11.30	12.91	16.99	12.55	07.50	12.80	15.75	8 57 11.86

Mean of all the observations, giving the same weight to each, 8° 57′ 12″.42.

The means of each night's observations agree with each other much closer than the means of the observations of each pair, which shows that the errors in the declinations of the stars used are greater than the errors of observation.

The probable error in the mean of a single pair is ± 1″.991, and the probable error in the mean of all the pairs is ± 0″.630.

Giving to each pair a weight depending on the number of observations on the pair, we have for the most probable determination of the latitude, 8° 57′ 12″.15.

Longitude of Panama, New Grenada, Station, Northwest Bastion of the City Wall, by Major W. H. Emory.

Date, 1849.	Phenomena observed.	Instruments used for observing the Phenomena.	Instruments used for obtaining the Time at Station.	Results obtained for Longitude.	Remarks.
				h. m. s.	
March 27	Emersion of Jupiter's 1st satellite observed with sidereal-time chronometer No. 420, by P. and F.	Telescope, by Mertz and Son, Munich, of 56 inches focal length.	Observations on east and west stars with sextant No. 1000, by T. and S.	5 18 05.70	(E.) Observation satisfactory and time well determined.
April 14	Emersion of Jupiter's 2d satellite observed with mean-solar-time chronometer No. 1481.	" "	" "	5 18 07.26	(E.) Observation satisfactory and time well determined.
April 26	Emersion of Jupiter's 1st satellite observed with sidereal-time chronometer No. 420, by P. and F.	" "	" "	5 17 45.20	(W.) Observation satisfactory and time well determined.
April 30	Culmination of moon's 1st limb.	Portable transit by Troughton & Simms of London. Length of telescope, 23 inches. Aperture of object-glass, 1⅝ in.	Portable 23-inch transit-instrument, previously described.	5 17 42.04	(W.) These observations are the less satisfactory from the impossibility of keeping the instrument up except while observing. No meridian-mark could be established, and the deviation was usually large. But high and low stars were observed for deviation, and stars near the moon for time.
May 2	" "	" "	" "	5 18 17.47	
May 4	" "	" "	" "	5 17 48.12	

Result from a mean of six observations for the longitude of the northwest bastion of the city wall, $5^{h.}\ 17^{m.}\ 57^{s.}.63 = 79°\ 29'\ 24''.45$.

Observation for the Magnetic Inclination.

Needle A. — *Station*, Chagres, near the centre of the plateau, east from the village, and 94 feet east from a ruin consisting of two rows of brick pillars, five pillars in each row, and about ten feet in height. *Instrument*, "Fox magnetic circle, made by W. George, of Falmouth; the property of the United States." *Observer*, A. W. Whipple. *Latitude*, 9° 20′ north. *Longitude*, 80° 01′ 21″ west of Greenwich, = 5h. 20m. 05s.41. *Face of instrument, north*, needle perpendicular, reading of azimuth circle, 23°.51. *Face of instrument, south*, needle perpendicular, reading of azimuth circle 23°.51. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 23°.51. *Date*, March 13th, 1849. *Weather*, clear.

Face of Circle.	Time of Local Observation.	Thermometer.	Change of Brackets.	End of Needle.	Reading of Needle A for Dip.	Remarks.
East.	5h. 30m.	79°	1st.	below	31° 55′	
				above	31 50	
			2d.	below	31 55	
				above	31 50	
			3d.	below	31 57	
				above	31 50	Mean inclination east, 31° 52′.8.
West.	5h. 55m.		1st.	below	31° 60′	
				above	31 60	
			2d.	below	31 58	
				above	31 55	
			3d.	below	31 55	
				above	31 50	Mean inclination west, 31° 56′.3.

Mean result for magnetic inclination of needle *A*, 31° 54′.5.

Needle B. — *Station*, Chagres, near the centre of the plateau. *Instrument*, Fox magnetic circle, made by W. George, and the property of the United States. *Observer*, A. W. Whipple. *Latitude*, 9° 20′ north. *Longitude*, 80° 01′ 21″ = 5h. 20m. 05s.41. *Face of instrument, north*, needle perpendicular, reading of azimuth circle, 24° 51′. *Face of instrument, south*, needle perpendicular, reading of azimuth circle, 25° 05′. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 24° 58′. *Date*, March 14th, 1849. *Weather*, clear.

Face of Circle.	Mean Time of Observation.	Thermometer.	Change of Brackets.	End of Needle.	Reading of Needle B for Dip.	Remarks.
West.	9h. 15m.	89°	1st.	below	31° 58′	At sunrise, therm. 80° and bar. 29.86 in.; at 8h. 30m. A. M., therm. 82° and bar. 29.86 in.; at noon, therm. 83° and bar. 29.83 in.
				above	31 58	
			2d.	below	31 60	
				above	31 60	
			3d.	below	31 65	
				above	31 65	Mean inclination west, 32° 01′.
East.	9h. 30m.	94°	1st.	below	31° 62′	
				above	31 65	
			2d.	below	31 60	
				above	31 65	
			3d.	below	31 58	
				above	31 62	Mean inclination east, 32° 02′.

Mean result for magnetic inclination of needle *B*, 32° 01′.5.

Observation for Total Magnetic Intensity.

Needle B. — *Station*, Chagres. *Latitude*, 9° 20′ north. *Longitude*, 80° 01′ 21″ west of Greenwich, = 5h. 20m. 05s..41. *Date*, March 14th, 1849. *Observer*, A. W. Whipple. *Weather*, clear. *Face of instrument*, east. *Hour of commencing observations*, 9h. 50m.. *Hour of ending observations*, 11h. 50m..

Deflection with Weight 2 grs.			Deflection with Weight 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
(1.) Deflection from the Vertical and past the Horizontal.	(2.) Deflection toward the Vertical.	Thermometer.	(1.) Deflection from the Vertical.	(2.) Deflection toward the Vertical.	Thermometer.	(1.) Deflection from the Vertical and past the Horizontal.	(2.) Deflection toward and past the Vertical.	Thermometer.
b. 4° 18′	*b.* 68° 05′	95°	*b.* 23° 28′	*b.* 40° 20′	92°	*b.* 30° 12′	*b.* 93° 58′	91°
a. 4 18	*a.* 68 02		*a.* 23 28	*a.* 40 23		*a.* 30 15	*a.* 94 00	
b. 4 15	*b.* 67 58		*b.* 23 28	*b.* 40 25		*b.* 30 15	*b.* 93 50	
a. 4 18	*a.* 68 00		*a.* 23 30	*a.* 40 28		*a.* 30 18	*a.* 93 55	
b. 4 15	*b.* 68 05		*b.* 23 28	*b.* 40 20		*b.* 30 15	*b.* 94 00	
a. 4 15	*a.* 68 00		*b.* 23 28	*a.* 40 22	90	*a.* 30 20	*a.* 94 02	
Mean 4 16.5	Mean 68 01.7		Mean 23 28.3	Mean 40 23		Mean 30 15.8	Mean 93 57.5	
Half the difference between (1) and (2) = angle of deflection, =	36 09.1			8 27.35			62 06.65	
Half the sum = angles of magnetic inclination, =	31 52.6			31 55.6			31 50.85	

Instrument, Fox magnetic circle. *Stand*, strong wooden tripod, free from iron. *Magnetic Meridian*, Azimuth, face north, 24° 51′; face south, 25° 05′; mean, 24° 58′. *Face of instrument*, west. *Hour of commencing observations*, 9h. 50m.. *Hour of ending observations*, 11h. 50m..

Deflection with Weight 2 grs.			Deflection with Weight 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical and past the Horizontal.	Deflection toward and past the Vertical.	Thermometer.
	b. 68° 07′						*b.* 93° 55′	
	a. 68 07						*a.* 93 55	
	b. 68 05						*b.* 94 00	
	a. 68 05						*a.* 94 00	
	b. 68 05						*b.* 93 52	
	a. 68 05	91°					*a.* 93 52	90°
	Mean 68 05.7						Mean 93 55.7	

Observations for Magnetic Inclination.

Needle A. — *Station*, Gorgona, Isthmus of Darien. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Face of instrument, north*, needle perpendicular, reading of azimuth circle, 4° 20′. *Face of instrument, south*, needle perpendicular, reading of azimuth circle, 4° 30′. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 4° 25′. *Date*, March 17th, 1849. *Weather*, clear. *Mean time of commencing observations*, 10h. 40m. A. M.; att. Therm. Fahr. 92°.5. *Mean time of ending observations*, 11h. A. M.; att. Therm. Fahr. 94°.

Face of Circle.	Change of Brackets.	End of Needle.	Reading of Needle *A*.	Remarks.
East.	1st.	above	31° 30′	
		below	31 28	
	2d.	above	31 20	
		below	31 17	
	3d.	above	31 28	
		below	31 28	31° 25′ 10″
West.	1st.	above	31° 12′	
		below	31 12	
	2d.	above	31 05	
		below	31 05	
	3d.	above	31 08	
		below	31 07	31° 07′ 20″

Magnetic inclination by needle *A*, 31° 16′ 15″.

Observation for Total Magnetic Intensity.

Needle A. — *Station*, Gorgona. *Date*, March 17th, 1849. *Observer*, A. W. Whipple. *Weather*, clear. *Face of instrument*, east. *Hour of commencing observations*, 11h..15. *Hour of ending observations*, 11h..35.

Deflection with Weight 2 grs.			Deflection with Weight 2 grs. + 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.
4° 20′	67° 45′	93°						
4 20	67 45							
4 18	67 47							
4 22	67 45							
4 15	67 45							
4 20	67 47							
Mean 4 19.1	Mean 67 45.6							
Angle of deflection,	36° 02′ 20″							
Angle of magnetic inclination,	31 43.2							

Observations for Total Magnetic Intensity.

Instrument, Fox magnetic circle, made by W George. *Stand*, strong wooden tripod, free from iron. *Magnetic Meridian*, on limb north, 4° 20′; south, 4° 30′; mean, 4° 25′. *Face of instrument*, west. *Hour of commencing observations*, 11h.15. *Hour of ending observations*, 11h.35.

Deflection with Weight 2 grs.			Deflection with Weight 2 grs. + 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.
° ′ 4 45	° ′ 67 30	° 93						
4 43	67 30							
4 45	67 45							
4 42	67 45							
4 45	67 32							
4 45	67 32	94						
Mean 4 44	Mean 67 35							
Angle of deflection,	36° 09′ 30″							
	31° 25′.5							

Observations for Magnetic Inclination.

Needle A. — *Station*, Panama, under a shed, upon the glacis just beyond the ditch, about 300 feet outside the western gate of the city. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, North, 8° 57′ 12″. *Longitude*, 79° 29′ 24″.5 west of Greenwich. *Face of Instrument*, *north*, needle perpendicular, reading of azimuth circle, 15° 18′. *Face of Instrument*, *south*, needle perpendicular, reading of azimuth circle, 15° 12′. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 15° 15′. *Date*, March 21st, 1849. *Weather*, clear.

Face of Circle.	Mean Time of Observation.	Thermometer.	Change of Brackets.	End of Needle.	Reading of Needle *A*.	Remarks.
East.	1h. 20m. P.M.	° 90	1st.	below	° ′ 31 35	
				above	31 35	
			2d.	below	31 40	
				above	31 45	
			3d.	below	31 45	
				above	31 45	
Mean Reading East, ...					31 40.8	
West.			1st.	below	° ′ 31 32	
				above	31 35	
			2d.	below	31 37	
				above	31 40	
			3d.	below	31 35	
	1h. 35m. P. M.	° 88½		above	31 35	
Mean Reading West, ...					31 35.7	

Magnetic inclination of needle *A*, 31° 38′.2.

Observations for Magnetic Inclination and Intensity.

Needle B. — *Station*, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, Major Emory. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24″.5 west of Greenwich, = 5ʰ· 17ᵐ· 57ˢ.63. *Date*, March 26th, 1849. *Weather*, clear. *Mean time of commencing observations*, 1ʰ· P. M. *Mean time of ending observations*, 2ʰ· P. M. *Thermometer*, 86°.

Face of Circle.	Direct.	Deflection North from App. Dip. 40° below.	Deflection North from App. Dip. 40° above.	Deflection South from App. Dip. 40° below.	Deflection South from App. Dip. 40° above.	Results.		
East,	° ′ 31 45	° ′ 8 40	° ′ 54 40	° ′ 7 10	° ′ 55 45			
	31 30	8 35	54 30	7 20	55 45			
	31 30	8 35	54 30	7 20	55 40		° ′ 31 46	Direct.
West,	32 00	8 20	54 45	7 00	56 30	N.	31 34.5	By Deflectors.
	32 00	8 20	54 50	7 02	56 35	S.	31 37.3	
	31 52	8 20	54 50	7 05	56 15			
Sums,	190 37	50 50	328 05	42 57	336 30		94 57.8	Sum.
Means,	31 46	8 28.3	54 40.8	7 09.5	56 05		31 39.26	Mean.

Needle B.— *Station*, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, Major Emory. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24″.5 west of Greenwich, = 5ʰ· 17ᵐ· 57ˢ.63. *Date*, March 26th, 1849. *Weather*, clear.

Face of Circle.	Thermometer.	Deflection North at App. Dip. (1.) Deflection toward the Vertical.	Deflection North at App. Dip. (2.) Deflection from the Vertical and past the Horizontal.	Deflection South at App. Dip. (1.) Deflection toward the Vertical.	Deflection South at App. Dip. (2.) Deflection toward the Vertical and past the Horizontal.	Results for Magnetic Inclination.		
East,	° 86	° ′ 72 45	° ′ 9 16	° ′ 74 05	° ′ 10 05			
		72 50	9 15	74 07	10 00			
		72 48	9 16	74 15	10 02			
West,		72 50	9 35	74 30	9 50	N.	° ′ 31 42.2 *	By Deflectors.
		72 45	9 30	74 31	9 55	S.	32 34 †	
		72 50	9 30	74 32	9 50			
Sums,		436 48	56 22	446 00	59 42		64 16.2	
Means,		72 48	9 23.6	74 20	9 12		32 08.1	

* Used with mean. † Not used in mean; probably error in observation.

Observations for Magnetic Inclination and Intensity.

Needle A. — *Station*, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″. *Longitude*, 79° 29′ 24″.5 = 5h. 17m. 57s.63. *Date*, March 28th, 1849. *Weather*, clear. *Time of commencing observations*, 1h. 27m..

Face of Circle.	Deflection North 40° from App. Dip.		Deflection South 40° from App. Dip		Thermometer.	Results.		
	Deflection toward the Vertical.	Deflection from the Vertical.	Deflection toward the Vertical.	Deflection from the Vertical.				
	° ′	° ′	° ′	° ′	°			
East,	54 32	8 50	56 35	7 10	86			
	54 35	8 55	56 35	7 10				
	54 40	8 55	56 35	7 07				
West,	54 30	8 55	56 25	6 58	86	N.	31 44.6	By Deflectors.
	54 37	8 58	56 28	6 58		S.	31 46.5	
	54 30	8 58	56 28	6 50				
Sums,	327 24	53 31	339 06	42 13			63 31.1	
Means,	54 34	8 55.2	56 31	7 02.1			31 45.5	

Observations for Magnetic Inclination.

Needle A. — *Station*, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24″.5 west of Greenwich, = 5h. 17m. 57s.63. *Face of instrument, north*, needle perpendicular, reading of azimuth circle, 49° 15′.5. *Face of Instrument, south*, needle perpendicular, reading of azimuth circle, 49° 16′. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 49° 15′.43. *Date*, March 28th, 1849. *Weather*, clear.

Face of Circle.	Mean Time of Observation.	Thermometer.	Change of Brackets.	End of Needle	Reading of Needle A for Dip.	Remarks.
East.	12h.10	87°	1st.	above	31° 37′	
				below	31 40	
			2d.	above	31 45	
				below	31 45	
			3d.	above	31 45	
				below	31 40	
Mean Reading East, ...					31 42.1	
West.			1st.	above	31° 32′	
				below	31 35	
			2d.	above	31 30	
				below	31 30	
			3d.	above	31 37	
	12h.15	87°		below	31 35	
Mean Reading West, ...					31 33 1	

Magnetic inclination by needle *A*, 31° 37′.5.

Observations for Total Magnetic Intensity.

Needle A. — *Station*, Panama. *Latitude*, 8° 57′ 12″. *Longitude*, 79° 29′ 24″.5 = 5h. 17m. 57s..63. *Date*, March 28th, 1849. *Observer*, A. W. Whipple. *Weather*, clear. *Face of instrument*, east. *Hour of commencing observations*, 2h. 30m.. *Hour of ending observations*, 3h. 30m..

Deflection with Weight 2 grs.				Deflection with Weight 2 grs + 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	End of Needle.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.	Deflection from and past the Horizontal.	Deflection toward and past the Vertical.	Thermometer.
° ′		° ′	°				° ′	° ′	°
4 15	*n.*	68 15	83.5				29 25	93 20	86
4 15	*s.*	68 17					29 30	93 20	
4 02	*n.*	68 20					29 40	93 20	
4 05	*s.*	68 00					29 28	93 20	
4 18	*n.*	68 45					29 30	93 25	
4 20	*s.*	68 30					29 15	93 25	
Mean 4 12.3	Mean	68 21.1					Mean 29 28	Mean 93 21.6	
Angle of deflection,		36 16.7					Angle of deflection,	61 24.80	

Instrument, Fox magnetic circle, made by W. George. *Stand*, strong wooden tripod, free from iron. *Magnetic meridian*, on limb north, 49° 15′.5 ; south, 49° 16′ ; mean, 49° 15′.43. *Face of instrument*, west. *Hour of commencing observations*, 2h. 30m.. *Hour of ending observations*, 3h. 30m..

Deflection with Weight 2 grs.			Deflection with Weight 2 grs. + 5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical.	Deflection toward and past the Vertical.	Thermometer.	Deflection from and past the Horizontal.	Deflection toward and past the Vertical.	Thermometer.
° ′	° ′					° ′	° ′	
4 33	67 50					30 18	92 30	
4 35	67 45					30 35	92 32	
4 45	67 45					30 00	92 30	
4 46	67 40					30 45	92 32	
4 35	67 50					30 35	92 45	
4 33	67 52					30 25	92 47	86°
Mean 4 37.5	Mean 67 47					Mean 30 36.3	Mean 92 36	
Angle of deflection,	36 12.25					Angle of deflection,	61 36.15	

Observations for Magnetic Inclination.

Needle C. — *Station*, Panama, Isthmus of Darien, New Grenada. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24″.5 west of Greenwich = 5h. 17m. 57s..63. *Date*, March 28th, 1849. *Weather*, clear.

Poles direct.

Face of Circle East.					Face of Circle West.				
Mean Solar Time of Observation.	Thermometer.	Change of Brackets.	Reading of North End of Needle.	Reading of South End of Needle.	Mean Solar Time of Observation.	Thermometer.	Change of Brackets.	Reading of North End of Needle	Reading of South End of Needle.
5h. 50m.	83°	1	31° 58′	32° 05′	5h. 50m.	83°	1	31° 55′	31° 47′
		2	31 45	31 50			2	31 50	31 47
		3	31 55	32 00			3	31 58	31 50
Mean with Poles Direct, ...									31 52.5

Poles reversed.

Face of Circle East.					Face of Circle West.				
Mean Solar Time of Observation.	Thermometer.	Change of Brackets.	Reading of North End of Needle.	Reading of South End of Needle.	Mean Solar Time of Observation.	Thermometer.	Change of Brackets.	Reading of North End of Needle.	Reading of South End of Needle.
6h. 15m.	81°	1	32° 05′	32° 00′	6h. 15m.	81°	1	32° 15′	32° 15′
		2	32 00	32 00			2	32 25	32 28
6h. 24m.		3	32 00	32 00	6h. 24m.		3	30 07	32 07
Mean with Poles Reversed, ...									32 08

Final result with needle *C*, poles direct and reversed, 32° 00′.25.

Needle B. — *Station*, Panama, northwest bastion of the city wall. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12′. *Longitude*, 79° 29′ 24″.5 = 5h. 17m. 57s..63. *Face of Instrument, north*, needle perpendicular, reading of azimuth circle, 11° 05′.5; 11° 03′.5; 11° 05′. *Face of instrument, south*, needle perpendicular, reading of azimuth circle, 11° 06′.5; 11° 06′.5; 11° 06′.5. *Reading of azimuth circle*, when the vertical circle was in the magnetic meridian, 11° 05′.5. *Date*, April 2d, 1849. *Weather*, clear.

Face of Circle.	Mean Time of Observation.	Thermometer.	Change of Brackets.	End of Needle.	Reading of Needle *B* for Dip.	Remarks.
East.	3h. P. M.	90°.5	1	below	31° 55′	
				above	31 52	
			2	below	31 50	
				above	31 57	
			3	below	31 55	
				above	31 55	31° 54′
West.	5h. 40m.	91°	1	below	31° 55′	
				above	31 52	
			2	below	31 59	
				above	31 55	
			3	below	31 55	
				above	31 50	31° 54′.3

Mean result for dip of needle *B*, 31° 54′.2.

Observations for Total Magnetic Intensity.

Needle B. — *Station*, Panama, northwest bastion of the city wall. *Latitude*, 8° 57′ 12″. *Longitude*, 5° 17′ 57″.63. *Date*, April 2d, 1849. *Observer*, A. W. Whipple. *Weather*, clear. *Face of instrument*, east. *Hour of commencing observations*, 5h. 25m.. *Hour of ending observations*, 6h. 00m..

Deflection with Weight 2 grs.			Deflection with Weight 2 grs. + 0.5 grs.			Deflection with Weight 2 grs. + 1 gr.		
Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.	Deflection from the Vertical and past the Horizontal.	Deflection toward the Vertical.	Thermometer.
° ′	° ′		° ′	° ′	°	° ′	° ′	°
a. 3 58	*b.* 68 07		*a.* 14 58	*b.* 79 58	90	*a.* 29 45	*b.* 93 15	84
b. 3 58	*a.* 68 05		*b.* 15 05	*a.* 79 55		*b.* 29 55	*a.* 93 20	
a. 4 15	*b.* 68 15		*a.* 15 30	*b.* 79 52		*a.* 29 58	*b.* 93 30	
b. 4 00	*a.* 68 15		*b.* 15 22	*a.* 79 50		*b.* 29 57	*a.* 93 15	
a. 4 02	*b.* 68 12		*a.* 15 07	*b.* 79 58		*a.* 29 50	*b.* 93 32	
b. 4 15	*a.* 68 20		*b.* 15 15	*a.* 79 58		*b.* 29 50	*a.* 93 28	
Mean 4 04.6	Mean 68 12.3		Mean 15 12.8	Mean 79 55.1		Mean 29 52.5	Mean 93 23.3	
Angle of deflection,	36 08.5		Angle of deflection,	47 33.95		Angle of deflection,	61 37.9	

Observations for Magnetic Declination.

Station, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24.″5 = 5h. 17m. 57s..63. *Date*, March 21st, 1849. *Weather*, clear.

Times of Observation.	Mean Time of Passage of Polaris over the Meridian.	Hour Angle in Sidereal Time.	Face of Instrument.	Reading of Circle for observing Azimuth.	Correction for True Azimuth of Polaris.	Reading of Circle when reduced to True Meridian.
h. m	h. m.	h. m.		° ′ ″	° ′ ″	° ′ ″
7 17	1 08	6 09		23 54	1 30 41	22 23 19
7 27		6 19		23 52 30	1 30 20	22 22 10
7 37		6 29		23 52	1 30 00	22 22 00
7 47		6 39	East.	23 51 30	1 29 30	22 22 00
7 57		6 49		23 51 30	1 28 34	22 22 56
8 09		7 01		23 50 30	1 27 34	22 22 56
9 24		8 16		23 35 35	1 14 30	22 21 00
						Mean 22 22 20.1
8 21		7 13		23 37 30	1 25 53	22 11 37
9 04		7 56	West.	23 34 30	1 19 15	22 15 15
9 13		8 05		23 34 30	1 16 42	22 17 48
9 17		8 09		23 33 30	1 15 34	22 17 56
						Mean 22 15 39

	° ′ ″
Reading of azimuth circle when reduced to true meridian,	22 18 59
Reading of azimuth circle when the vertical circle is in the plane of the magnetic meridian,	15 15
Magnetic declination east of north, deduced from observations on Polaris, March 21st,	7 03 59

Observations for Magnetic Declination.

Station, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″ north. *Longitude*, 79° 29′ 24″.5 = 5h. 17m. 57s.63. *Date*, March 28th, 1849. *Weather*, clear.

Time of Observation.	Mean Time of Passage of Polaris over the Meridian.	Hour Angle in Sidereal Time.	Face of Instrument.	Reading of Circle for Observing Azimuth.	Correction for True Azimuth of Polaris.	Reading of Circle when reduced to True Meridian.
h. m.	h. m.	h. m.		° ′ ″	° ′ ″	° ′ ″
6 21	0 40	5 42	East.	57 37 30	1 30 32	56 06 58
6 45		6 05		57 37 30	1 30 44	56 06 46
						Mean 56 06 52
6 52		6 14		57 32	1 30 30	56 01 30

Reading of azimuth circle when reduced to true meridian,	56° 01′ 11″
Reading of azimuth circle when the vertical circle is in the plane of the magnetic meridian,	49 15 45
Magnetic declination east of north, deduced from observations on Polaris,	6 48 26

Station, Panama. *Instrument*, Fox magnetic circle, made by W. George. *Observer*, A. W. Whipple. *Latitude*, 8° 57′ 12″. *Longitude*, 79° 29′ 24″.5 west of Greenwich = 5h. 17m. 57s.63. *Date*, April 2d, 1849. *Weather*, clear.

Times of Observation.	Mean Time of Passage of Polaris over the Meridian.	Hour angle in Sidereal Time.	Face of Instrument.	Reading of Circle for observing Azimuth.	Correction for True Azimuth of Polaris.	Reading of Circle when reduced to True Meridian.
h. m.	h. m. s.	h. m s.		° ′ ″	° ′ ″	° ′ ″
6 49	0 20 30	6 29 34	East.	19 31 00	1 29 59.5	18 01 00.5
6 50		6 34 30		19 30 30	1 29 40	18 00 50
6 57		6 37 30		19 31 00	1 29 33	18 01 27
6 58		6 38 30		19 30 30	1 29 29	18 00 01
7 00		6 40 00		19 30 00	1 29 21	18 00 39
						Mean 18 00 47
7 06		6 47 30	West.	19 22 00	1 28 46	17 53 14
7 06 30		6 48		19 22 00	1 28 40	17 53 17
7 08		6 49 30		19 22 00	1 28 34	17 53 26
7 10		6 51 30		19 21 45	1 28 22	17 53 23
7 15		6 56 30		19 21 30	1 27 52	17 53 38
7 19		7 00 00		19 21 15	1 27 37	17 53 48
						Mean 17 53 28
7 24		7 05	West.	19 21 00	1 27 01	17 53 59
7 26		7 07		19 21 00	1 26 43	17 54 17
7 28		7 09		19 20 30	1 26 25	17 54 05
7 30		7 11		19 20 30	1 26 07	17 54 23
7 32		7 13		19 20 00	1 25 53	17 54 07
						Mean 17 54 00
7 44		7 25	East.	19 24 30	1 24 30	18 00 00
7 48		7 29		19 24 00	1 23 34	18 00 26
7 50		7 31		19 23 30	1 23 06	18 00 24
7 55		7 36		19 23 30	1 22 51	18 00 39
7 58		7 39		19 22 00	1 21 19	18 00 41
						Mean 18 00 26

Results from the Observations of April 2d.

1st mean,	18° 00′ 47″
2d "	18 00 26
Mean reading face east,	18 00 36
" " west,	17 53 49
Reading of azimuth circle when reduced to true meridian,	17 57 12.5
" " " the instrument is in the magnetic meridian,	11 05 36
Magnetic declination deduced from observations on Polaris, April 2d, 1849,	6 51 36.5

Results for Magnetic Declination at Panama.

For March 21st, 1849,	6° 63′ 59″
" 28th, "	6 48 26
For April 2d, "	6 51 36
Final result for the declination of the magnetic needle at Panama, April, 1849, east of north,	6 54 37

Computation of the Preceding Observations for the Intensity of the Magnetic Force $I' = \frac{I \sin V}{\sin V'}$.

Mr. Fox observed with this instrument upon needles *A*, *B*, and *C*, at Falmouth, England, September, 1844, and at the temperature of 60° obtained an intensity of 1,000.

Major Graham and Mr. W. C. Bond observed with the same instrument upon needles *A*, *B*, and *C*, and obtained the following results, which are uncorrected for difference of temperature: —

1844, December 30th.	Temperature +39°.5,	needle *B*	with weight	3 grs.	gave an intensity	= 1.2963
	"	" "	"	3.5	" "	= 1.2961
	"	" *A*	"	3	" "	= 1.2900
	"	" "	"	3.5	" "	= 1.289
	"	" "	"	2 deflectors	" "	= 1.3014
1845, January 2d.	Temperature +36°,	needle *A*	with weight	3.5 grs.	gave an intensity	= 1.2870
	"	" *C*	"	2.5	" "	= 1.2940
	"	" "	"	3	" "	= 1.2986
1845, January 3d.	Temperature +13° to 19°,	needle *C*	with weight	2.5 grs.	gave an intensity	= 1.30106
	"	"	"	3	" "	= 1.30230
	" 26°	"	"	3.5	" "	= 1.31200

Mr. Bond and Mr. Whipple at the magnetic observatory at Cambridge made observations with the same instrument upon needles *A*, *B*, and *C*, and the following are some of the results obtained : —

1849, February 24th. Temperature 42°, magnetic inclination by needle *B*, ... 74° 33′.9
Angle of deflection of needle *B*, with deflector north at apparent dip, ... 32° 55′.6
" " " " south " . . . . . 34° 04

Feb. 24th.	Temperature 46°, angle of deflection of needle *B* with weight		2 grs.,	23° 32′.25
	" " " " " " "		2 + 1 grs.,	36 28.75
	" " " " " " "		2 + 1 + 0 5 grs.,	44 05.3
Feb. 25th.	" 36.5, " " "	*A* "	2 grs.,	23 26.55
	" " " " " " "		2 + 1 grs.,	36 25.65
	" " " " " " "		2 + 1 + 0.5 grs.,	43 55.25

Plane of instrument in magnetic meridian, magnetic declination 9° 28′ west.

Formula for Computation, $I' = \frac{I \sin V}{\sin V'}$.

I = Intensity of magnetism of the needle at Cambridge, Mass.
V = Angle of deflection " " " "
V′ = " " " " station.
I′ = Intensity of magnetic needle at station.

Results for Magnetic Intensity. Obtained by Computation of the Preceding Observations.

Date, 1849.	Station.	Needle used.	Weight deflected by	Angles of Deflection. V.	Angles of Deflection. V′.	Intensity at Cambridge Observatory, Mass.	Intensity at Station.
				° ′ ″	° ′ ″		
March 14	Chagres,	B.	2 grains,	23 32 21	36 09 06	1.2962	0.87745
" "	"	"	2 + 1 gr.	36 28 45	62 06 39	1.2962	0.87181
" 17	Gorgona,	A.	2 grains,	23 26 33	36 02 21	1.2900	0.87229
" 28	Panama,	A.	2 grains,	23 26 33	36 16 42	1.2900	0.87141
" "	"	"	2 + 1 gr.	35 45 27	61 24 48	1.2900	0.87648
April 2	"	B.	2 grains,	23 32 21	36 08 30	1.2962	0.87766
" "	"	"	2 + 1 gr.	36 28 45	61 37 54	1.2962	0.87573

Results for intensity at Panama, 0.87507
" " Gorgona, 0.87229
" " Chagres, 0.87493

Results for Magnetic Inclination.

Station	Date, 1849.	Needle used	Index Cor. for Needle.	Inclination Observed.	True Inclination Deduced.	Weights used.	Deflectors used.	No. of Observ. made.	Mean Result for Magnetic Inclination at Station.
Chagres,	March 13	A	+18.5	31° 54′.5	32° 13′.0			12	
Lat. 9° 20′ North.	" 14	B	+15.5	32 01.5	32 17.4			12	
Long. 5h. 20m. 05s..41 W.	" "	"	"	31 52.6	32 08.5	2 grs.		12	32° 11′.4
	" "	"	"	31 55.6	32 11.5	0.5 "		12	
	" "	"	"	31 50.8	32 06.7	3 "		12	
Gorgona,	March 17	A	+18.5	31 16.2	31 34.7			12	
	" "	"	"	31 43.2	31 61.7	2 grs. E.		12	31 46.8
	" "	"	"	31 25.5	31 44.0	2 grs. W.		12	
Panama, Glacis,	March 21	A	+18.5	31 38.2	31 56.7			12	
Lat. 8° 57′ 12″ North.	" "	"	"	31 49.7	31 68.2		N. face E.	12	
Long. 79° 29′ 24″.5 =	" "	"	"	31 41.4	31 59.9		N. face W.	12	
5h. 17m. 57s..63 W. of G.	" 26	B	+15.9	31 46.0	31 61.9			6	
	" "	"	"	31 34.5	31 50.4		N.	6	
	" "	"	"	31 37.3	31 53.2		S.	6	
	" "	"	"	31 42.2	31 58.1		N.	12	
	" 28	A	+18.5	31 44.6	31 63.1		N.	12	
	" "	"	"	31 46.5	31 65.0		S.	12	32 00.0
	" "	"	"	31 37.5	31 56.0			12	
	" "	"	"	31 49.5	31 68.0	2 grs.	E. and W.	24	
	" "	"	"	31 28.4	31 46.9	3 "	E. and W.	24	
Panama, N.W. bast.	April 2	B	+15.9	31 54.2	31 70.1			12	
of city wall,	" "	"	"	31 45.4	31 61.3	3 "		12	
Panama, Glacis,	March 28	C	0.0	31 52.5	31 52.50	Poles direct.		12	32 00.25*
	" "	"	0.0	31 60.25	31 68.00	" reversed.		12	

* Mean result for magnetic inclination at Panama, with needle *C*, poles direct and reversed.

Meteorological Observations

Station.	Date, 1849.	Hour.	Barometer. No. 2.	Thermometers.		Clouds.			Winds.	
				Att.	Det.	Name.	Direction.	Amount	Direction.	Force.
Panama.	March 22	9 A. M.	30.014	78°	78°	Stratus,		9	N.	2
	" "	5½ P. M.	29.919	82.5	81.5			1	N. N. E.	1
	" "	9 "	29.929	78	77.5			0	"	1
	" 23	9 A. M.	30.021	81	80.5			4	"	3
	" "	3 P. M.	29.984	84.5	84			3		3
	" "	9 "	30.009	78	77			1		1
	" 24	9 A. M.	30.020	79.5	78.5			7		1
	" "	3 P. M.	29.960	85	84			4		2
	" 25	9 A. M.	30.000	80	79					
	" "	3 P. M.	29.945	85	84		N. E.	5	N. W.	3
	" 26	9 A. M.	30.000	78.5	77.5		N. W.	1	"	1
	" "	3 P. M.	29.940	82.5	81.5			4		1
	" "	9 "	29.956	75	75.5	Clear,			W.	1
	" 27	9 A. M.	30.000	76	75.5			1	N. W.	1
	" "	3 P. M.	29.958	82.5	82			3		1
	" 28	9 A. M.	30.018	78	77			1		1
	" "	3 P. M.	29.940	83.5	82.5			2		2
	" "	9 "	30.075	75	75.5				N. E.	.5
	" 29	9 A. M.	30.000	80	79			4		1
	" "	3 P. M.	29.970	82.5	81.5			8		1
	" 30	9 A. M.	30.030	80	79			3		2
	" "	3 P. M.	29.970	86	83.5			6		.5
	" "	9 "	30.025	77.5	77.2					.5
	" 31	9 A. M.	30.020	81	80			6		2
	" "	3 P. M.	29.965	86.5	84.5			5		2
	April 1	9 A. M.	30.006	81.5	80			6		1
	" 2	9 "	30.031	82	82	Cirro cumuli,		8	N. E.	2
	" 3	9 "	30.022	78	78	Cumuli,		8.5		2
	" "	3 P. M.	29.980	85.5	84.5	"		5		2.5
	" 4	9 A. M.	30.040	81	80	"		3		1
	" "	3 P. M.	29.965	85	84	"		7		1
	" 5	9 A. M.	29.990	82	81	"		3		.5
	" "	3 P. M.	29.922	86.5	84.5	"		1		2
	" 6	9 A. M.	29.960	82.5	81.5	"		3		.5
	" "	3 P. M.	29.900	86	85			2		1
	" 7	9 A. M.	29.986	82	81.5			5		.5
	" "	3 P. M.	29.927	86	84.5			2		.5
	" 8	9 A. M.	29.960	82	81.5			3		.5
	" 9	9 "	29.960	82	81.5			3		.5
	" "	3 P. M.	29.916	85	84			4		.5
	" 10	9 A. M.	29.960	82	81.5			3		.5
	" "	3 P. M.	29.905	85.5	84.5	Cumuli,		5		.5
	" 11	9 A. M.	29.960	81.5	81.5	"		3		.5
	" "	3 P. M.	29.905	85.5	84			4		1
	" "	9 "	29.970	78.8	78.6					
	" 12	9 A. M.	29.980	82	81.3	Cumuli,		2		.5
	" 13	9 "	29.980	82	81	Cirro,		1	N E.	3
	" "	3 P. M.	30.000	86	85	Cumuli strata,		5	N. W.	2
	" 14	9 A. M.	30.050	80	78.3			3		2
	" "	3 P. M.	29.980	84.5	83.7					
	" 15	9 A. M.	30.000	77	76.5			1		1
	" "	3 P. M.	29.930	83	82					
	" 16	9 A. M.	30.040	78.5	77.7			.5		.5
	" 17	9 "	30.074	79	78.5			4		1
	" "	3 P. M.	30.001	84.5	83.2			7		2

made at Panama.

Hour.	Thermometers. Max.	Min.	Rad.	Dan. Hygrometer. Before being wet with ether.	After being wet with ether.	Difference = Fall of Therm.	Dew-point = Free Therm. — prec. Diff.	Wet Bulb. Free.	Wet.	Remarks.
9 A. M.	85.2	78						79	73.5	Barometer sixty-two feet above [medium tide.
6 P. M.								81.5	74	
9 "								77.5	72.5	Syphon barometer, No. 2, by [James Green, of Baltimore.
9 A. M.	85.2	74.5						81.5	73.5	
"	87	72.5						82.5	78.4	
"	86	71.5						79	77	
"	87	71.5						77.1	76	
9 P. M.								75.5	70.5	
9 A. M.	86.5	69.5						75.5	74.5	
"	86	70.5						77	71.5	
"	85.5	70						79	74	
"	85	72.5						79	72	
"	87	74						80	73	
"	87.5	75						80	75	
"	85.2	74.3						82	72	
"	86	73.5						77.5	72	Drizzly rain.
"	86	73.3						80	73	
"	86.3	73						81	74	
"	87.5	74.5						81.5		
"	86.5	74.5						81.5	76	
"	87.5	74.5						81.5	76	
"	87.5	74.8						81.5	76	
"	86.5	75.5						81.5	75	
"	87.5	77.5						81.5	77	
"	88	75						81.5	75.3	
"	87	73.5						81.5	74	
"	87.5	70.5						78.5	72	
"	86	69.5						76.5	70	
"	83.5	70.5						77.7	73.5	
"	85.5	72						78.5	75	

Meteorological Observations

Station.	Date, 1849.	Hour.	Barometer. No. 2.	Thermometers.		Clouds.			Winds.	
				Att.	Det.	Name.	Direction.	Amount.	Direction.	Force.
Panama.	April 18	9 A. M.	30.050	83°	81°	Cumulo stratus,		6		1
	" "	3 P. M.	29.938	84.8	84		N.	5	N. W.	3
	" "	9 "	29.990	77.8	77.4					
	" 19	9 A. M.	30 014	80.8	79.7		N.	5	N. W.	3
	" "	3 P. M.	30.020	80.2	79.8	Cirro cum. strat.,	N. E.	9	"	2
	" 20	9 A. M.	29.995	80.7	79.4		"	9	"	1
	" "	3 P. M.	29.910	81	80	Cumulo stratus,	"	9.5	"	2
	" "	9 "	29.980	78	77.7		"	1	"	2
	" 21	9 A. M.	30.010	82.7	81.6	Cumuli,	N.	2.5	"	1
	" "	3 P. M.	29.975	85	83.2	Cirro cumuli,	N. N. E.	4	N. N. E.	3
	" 22	9 A. M.	30.030	82.3	81	Cumuli,	N. E.	3.5	N. W.	1
	" "	3 P. M.	29.920	86.3	85.3	"	"	3.5	"	3.5
	" 23	9 A. M.	29.995	83	81.8	Cumulo stratus,	"	8	"	2
	" "	3 P. M.	29.933	86.2	84.8	"	"	5	"	2
	" "	6 "	29.935	81.5	81	Cirrus,	N. W.	3	"	1
	" "	9 "	29.917	79.5	78.8	Clear,			"	2
	" "	12 M.	29.945	77.5	77.8	"			None.	
	" 24	3 A. M.	29.949	77	77			0		0
	" "	6 "	29.936	81	77.8	Cirrus,		.3	W.	1
	" "	9 "	29.986	84.5	82.8	Cumulus,	N.	3	N. W.	2
	" "	12 M.	29.951	86.8	85	"	N. E.	4	"	1
	" "	3 P. M.	29.874	86.8	84.4	Cirro cumulus,	N.	3	"	2.5
	" "	6 "	29.988	83.5	82.3	Cirrus,	N. W.	3	"	2
	" "	9 "	29.907	75.5	78.8	Clear,			"	1.5
	" "	12 M.	29.913	76.5	73.5	"				0
	" 25	6 A. M.	29.920	75.8	75.2	Cumulus cirrus,		3	N. N. W.	1
	" "	9 "	29.972	83.6	81.8	Cirro cumulus,	N. N. E.	4.5	N. W.	2
	" "	12 M.	29.940	86.5	84.8	"	N. W.	5	S. W.	1
	" "	3 P. M.	29.885	85.8	84	"	N.	5	"	2
	" "	6 "	29.880	82.5		Cumulus,		2	S. E.	1
	" "	9 "	29.898	79	78.2	Clear,			S. W.	2.5
	" "	12 M.	29.913	76	76			0	W.	3
	" 26	6 A. M.	29.924	76	75.8	Cirrus,		1	N. W.	1
	" "	9 "	29.944	83.5	81.6	Cirro cumulus,	N. N. E.	2	"	1
	" "	12 M.	29.933	86.8	85	"	N.	3	"	1
	" "	3 P. M.	29.912	85.5	84	"	"	4	"	2
	" "	6 "	29.880	82.5	81.4					
	" "	9 "	29.915	78.5	77.6	Clear,		0	W.	2
	" 27	9 A. M.	29.970	83.8	82	Cirrus,	N.	3	N. W.	1
	" "	12 M.	29.958	85	83.5	Cirro cumulus,	S.	8		1
	" "	3 P. M.	29.909	81	80.6	Cumulus,	E.	6	W.	2
	" "	6 "	29.892	80	79.4	Cumulus stratus,		3	N. W.	1
	" "	9 "	29.943	78	77.5	Stratus,	E.	5	"	1
	" "	12 M.	29.904	76	76	"	"	3	W.	1
	" 28	6 A. M	29.953	75	74.8	"	N. N. E.	8		.5
	" "	9 "	29.993	81	79.5	Cumulus stratus,	S.	9	W.	1
	" "	12 M.	29.987	84	81.8			9.5		1
	" "	3 P. M.	30.000	85	82.3	Cumulus,	N. W.	9.5	W.	1.5
	" "	6 "	29.900	82.5	81	Cirro cumulus,	"	2	"	.5
	" "	9 "	29.930	78.6	77.7	Clear,		.5	"	1
	" 29	6 A. M.	29.920	76.2	75.6	Cumulus,	N. W.	9.5	N. N. W.	1
	" "	9 "	29.952	79	78	Cirro cumulus,	"	9	W.	1
	" "	12 M.	29.941	83.5	81.5				N. W.	
	" "	3 P. M.	29.891	82.5	81.2	Cirro cumulus,	N.	8.5	"	3
	" "	6 "	29.865	80.8	79.4	Cirro stratus,		3	"	1

made at Panama.

Hour.	Thermometers. Max.	Min.	Rad.	Dan. Hygrometer. Before being wet with ether.	After being wet with ether.	Difference = Fall of Therm.	Dew-point = Free Therm. — prec. Diff.	Wet Bulb. Free.	Wet.	Remarks.
9 A. M.	86.3	74.7						81	75.5	
"	86.5	74.5						79.5	76.7	
"	86.4	74.7						79.5	76.7	12 M. hard shower, thunder and [lightning to S. E.
"	83.1	74.5						80.7	76	Clouds near horizon.
"	86	73.3								
"	88	74.3						81.8	77.5	
3 P. M.			113	86	75	11	74	85	76.8	
6 P. M.								81	75.8	
12 M.								77.8	74.8	
3 A. M.								77	74.5	
6 "			96					79	76	
9 "	87	74.8						82.8	76.5	
12 M.				89	73	16	68.3	84.3	75.8	
3 P. M.			197.5	88.5	72	16.5	67.9	84.4	75.5	
6 "				85.5	74	11.5	70.8	82.3	77.5	
9 "								78.5	74.5	
12 M.								73.5	74	
6 A. M.				87.5	74	13.5	61.9	75.4	73	
9 "	89	74.5	100	96				82	76.4	
12 M.			101	89.5	74.2	15.5	69.5	85	76	
3 P. M.				88.5	73.5	15	69	84	78	
6 "				83.5	73	10.5	71	81.5	75.5	Clouds near horizon.
9 "								78.2	74	
12 M.								76	73	
6 A. M.				76.8	72.5	4.3	71.5	75.8	76	
9 "	88	74.4	103	82.8	74	8.8	72.8	81.6	78	
12 M.				87.5	74	13.5	70.7	84.2	77 5	
3 P. M.				87	76	11	73	84	79	Light shower, 2 P. M.
6 "				83	73	10	71.4	81.4	76.5	
9 "								77.8	74	
9 A. M.	88	75	99	85	75	10	72	82	76.5	
12 M.				88	76.5	11.5	72.1	83.6	77	Rain in the distance.
3 P. M.				84	76	8	72.3	80.3	77	Shower.
6 "				81	73	6	73.4	79.4	76	
9 "								77.5	74.5	
12 M.				77.5	76	1.5	74.5	76	74	
6 A. M.				75.4	72	3.4	71.4	74.8	72	
9 "	86.2	74		82	76.8	5.2	74.6	79.8	76.5	
12 M.				85.5	76	9.5	72.5	82	77	
3 P. M.				85.2	76	9.2	74.2	83	76	Shower in the distance.
6 "				83.3	74	9.3	71.7	81	75	
9 "								77.8	74	
6 A. M.				76.8	72.5	3.3	72.3	75.6	72.5	Slight shower, 7 A. M.
9 "	86.6	74.5		83	77.5	5.5	72.8	78.3	76	
12 M.								81.5		
3 P. M.				84	76	8	73.1	81.1	75	Squall of wind and rain.

Meteorological Observations

Station.	Date, 1849.		Hour.	Barometer. No. 2.	Thermometers.		Clouds.			Winds.	
					Att.	Det.	Name.	Direction.	Amount.	Direction.	Force.
Panama.	April	29	9 P. M.	30.000	78	77.5		N.	4	N. W.	2
	"	30	6 A. M	29.911	75.8	74.9	Cumulus stratus,	"	3	W.	1
	"	"	9 "	29.951	82.5	80.6	Cumulus,	"	8.5	N.	2
	"	"	12 M.	29.812	81	79.5	"	"	9.5	N. W.	1.5
	"	"	3 P. M.	29.882	80.2	79.4	"	N. W.	9	W.	1
	"	"	6 "	29.870	79.5	78.6	Cumulus stratus,	S. W.	7	"	1
	"	"	9 "	29.870	78	77	Cumulus,		2	"	1.5
	May	1	6 A. M.	29.906	76.8	76	Cumulus stratus,	N. W.	9.5	"	1
	"	"	9 "	29.942	81	79.8	Cumulus,	N.	9.5	N. E.	2
	"	"	12 M.	29.953	83.2	81.5	"	N. W.	9.5	W.	1
	"	"	3 P. M.	29.900	80	79	Stratus,	E.	9.5	N. E.	1.5
	"	"	6 "	29.885	80	79.4	Cumulus stratus,	N. E.	9.5	N. W.	1
	"	"	9 "	29.933	79	78	Cumulus,		9.5	"	1
	"	2	6 A. M.	29.915	77	76.5	"	N. E.	5		.5
	"	"	9 "	29.954	83.5	81.6	Cumulus stratus,		6	N. W.	1
	"	"	12 M.	29.947	83.5	81 6	" "	N.	6	"	1.5
	"	"	3 P. M.	29.900	80.5	79.7	Stratus,		9.5		1
	"	"	12 M.	29.958	77	77	Cirro stratus,		9.5	N. W.	2
	"	3	6 A. M.	29.940	78	77.4	Cumulus stratus,	N. W.	9	"	1
	"	"	12 M.	29.987	84.5	83.2	Cirro cumulus,	N. E.	4.5	N. E.	2
	"	"	3 P. M.	29.964	79.8	79.2	Cumulus stratus,		9	W.N.W.	3
	"	"	6 "	29.933	78.8	78	" "		9	"	3
	"	"	9 "	29.946	77.5	76.8	" "		9	N. W.	3
	"	4	6 A. M	29 935	76.5	76.1	Cirro stratus,			N. E.	1
	"	"	9 "	30.020	77.8	77	Stratus,			"	1
	"	"	12 M.	30 021	78.8	78.1	Cumulus stratus,		8		
	"	"	3 P. M.	29.944	80.7	79.7	" "		9	W.	1
	"	"	6 "	29.941	79	78.6	Cirro cum. strat.,	N.	7	S. W.	1
	"	"	9 "	29.996	77	77	Cirrus,	W	3	N. W.	2
	"	5	6 A. M.	29 997	76.5	76.1	Cumulus stratus,	N.	7		
	"	"	9 "	30.039	79.5	78.5	Cirro,		8		
	"	"	12 M.	30.029	83.8	82.2	Cumulus stratus,	S.	7	N. W.	2
	"	"	3 P. M.	29.995	82	80.8	Cirro cumulus,	S.	9	W.N.W.	2
	"	"	6 "	30.005	80	79.5	Stratus,		10	0	0
	"	"	9 "	30 027	78	77.4	Cumulus stratus,		9	0	0
	"	6	6 A. M.	29 975	74.8	74.5	Cirro stratus,		8	N. W.	1
	"	"	9 "	30.022	79.3	78.3	Cirro cumulus,	N. W.	8	"	1
	"	"	12 M.	30.032	81.5	80.2	" "	N.	8	W.	2
	"	"	3 P. M.	29.970	79.3	78.4	Cumulus stratus,	"	10	N. W.	3
	"	"	6 "	29.960	78.5	77.5	Cumulus,	"	10	N.N.W.	1
	"	"	9 "	29.994	77.5	76.5	Cumulo stratus,		9	W.	3
	"	7	6 A. M	29.949	75	74.8	Cumulus,	W.	2	N. W.	2
	"	"	9 "	29 987	80.5	79	"	N.		W.	3
	"	"	12 M.	29.971	83 5	82	"	"	4	N.	2
	"	"	3 P. M.	29.923	79.8	79	"	"	8	N. W.	2
	"	"	6 "	29.924	78	77.5	Cirro cumulus,		6	"	2
	"	"	9 "	29.944	77	76.6	Cirrus,		2	"	1
	"	8	9 A. M.	29.980	81.5	82.2	Cumulus,	E.	1	"	.5
	"	"	12 M.	29.984	83 5	82.2	"	N.	4	W.	3
	"	"	3 P. M.	29.921	80.5	79.3	"	E.	7	N. W.	2
	"	"	6 "	29.948	80.5	79.5	"	N.	7	N.N.W.	4
	"	"	9 "	29.980	77.8	77	Cirrro cumulus,		8	N. W.	.5
	"	9	6 A. M.	29.965	75	74.8	Cumulus,		1	"	1
	"	"	9 "	30.015	81.5	79.8	"	N.	.5	0	0
	"	"	12 M.	30 007	83	81.8	"	"	3	N. W.	3

made at Panama.

Hour.	Thermometers. Max.	Thermometers. Min.	Thermometers. Rad.	Dan. Hygrometer. Before being wet with ether.	Dan. Hygrometer. After being wet with ether.	Dan. Hygrometer. Difference = Fall of Therm.	Dew point = Free Therm. — prec. Diff.	Wet Bulb. Free.	Wet Bulb. Wet.	Remarks.
9 P. M.	°	°						77.5°	74°	
6 A. M.				76	74	2	72.9	74.9	72	
9 "	84	74		85	75.5	9.5	71	80.5	75	
12 M.				82	75	7	72.5	79.5	75	Slight shower.
3 P. M.				83	76	7	72.4	79.4	75	
6 "				80	75.5	4.5	75.1	79.6	75	
9 "								77	74	
6 A. M.				77.5	75.5	2	74	76	73.8	
9 "	85	74		82.5	76	6.5	73.3	79.8	75.5	
12 M.				85.5	77	8.5	73	81.5	76.5	
3 P. M.				81	76	5	74	79	75.8	
6 "				81.5	76	5.5	73.9	79.4	75	
9 "								78	73.5	
6 A. M.				77	75.5	1.5	7.5	76.5	74	
9 "	85	75						81.7	77.5	
12 M.				86	77.5	8.5	73.3	81.8	77.4	
3 P. M.				83	75.5	7.5	72.3	79.8	75	
12 M.				78.5	78	.5	76.5	77	75.3	
6 A. M.				78.5	76	2.5	74.9	77.4	74.2	
12 M.			121	84.5	73.5	11	72.2	83.2	79.8	2 P. M. hard shower, thunder and [lightning in N.
3 P. M.				80.8	75	5.8	73.4	79.2	77.5	
6 "				80	75.5	4.5	73.5	78	77	} Showery.
9 "				79	74	5	71.8	76.8	75.5	
6 A. M.				78.8	75	3.8	72.3	76.1	75	
9 "	86	75.5		78	75	3	74	77	75.3	Hard rain.
12 M.				80.5	75.5	5	73.1	78.1	77.3	No rain.
3 P. M.				82	77	5	74.7	79.7	76.6	
6 "				81.5	75	6.5	73.1	78.6	77	
9 "				79.5	77	2.5	74.5	77	75.8	Lightning N. W.
6 A. M.				78	73.5	4.5	71.6	76.1	75.4	
9 "	81	75	83.8	80	74	6	72.3	78.3	76.5	
12 M.			101.8	82.5	78	4.5	77.7	82.2	79.2	
3 P. M.				83	76.5	6.5	74.3	80.8	77.5	
6 "				81.5	74	7.5	72	79.5	77.6	Drizzly rain.
9 "				79.5	75	4.5	72.9	77.4	76.4	7 P. M. very hard rain. All over [at 8 P. M.
6 A. M.				76.5	72	4.5	70	74.5	73.5	
9 "	84.5	73.5	87.9	80.5	75.5	5	73.3	78.3	76.2	
12 M.			95.3	81.5	76	5.5	74.7	80.2	78.2	
3 P. M.				80.5	75	5.5	72.9	78.4	77	2½ P. M. drizzly rain.
6 "				79	75	4	73.5	77.5	76.5	5 P. M. "
9 "				78	74.5	3.5	73	76.5	75.3	
6 A. M.			82	75.5	73.5	2	72.8	74.8	74	Clouds near horizon.
9 "	82.5	73.5	92.5	80	76.7	3.3	75.7	79	76.7	
12 M.								82	78.5	2 P. M. hard rain.
3 P. M.								79	77.2	
6 "								77.5	75.1	
9 "								76.6	75.5	
9 A. M.	84	73	105.4					80.2	76.6	
12 M.			107.5					82.2	77.5	2 P. M. drizzly rain, 2½ P. M. [hard rain, 3 P. M. no rain.
3 P. M.								79.3	77	
6 "								75.5	77	
9 "								77	75	
6 A. M.								74.8	73	Clouds near horizon.
9 "	85	74	103.5					79.8	74.4	" "
12 M.			110.4					81.8	72.8	

Longitude of Chagres, New Grenada.

Longitude of Chagres (house of Don Luis Paredes) West from New York, as obtained by the Transportation of Chronometers in the Steamship Northerner, leaving New York March 1st, and arriving at Chagres March 13th, 1849.

Observer at Chagres, Major W. H. Emory.

No. of Chronometer.	Rate as determined at the Observatory, Cambridge, Mass.	Rate as determined at New York City.	Rate as determined at Panama, N. G.	Mean Rate.	Difference of Longitude between New York and Chagres by each Chronometer.
	s.	s.	s.	s.	m. s.
Charles Young, 76,		—2.7	—1.4	—2.05	24 22.29
Egbert & Son, 152,		—3.5		—3.50	24 07.40
Parkinson & Frodsham, 420,	+7.2	+7.4	+0.5	+5.05	23 58.38
Barraud, 738,	—0.6	—1.37	—1.6	—1.19	24 03.08
Parkinson & Frodsham, 719,	+4.2	+4.4	+4.52	+4.37	23 55.95

Longitude of Chagres West of New York $24^{m}\ 05^{s}.41$

" Columbia College West of Greenwich $4^{h}\ 56^{m}\ 00^{s}$ taken from the *Conn. des Temps* of 1849.

" Chagres " " $5^{h}\ 20^{m}\ 05^{s}.41 = 80°\ 01'\ 21''.15$

Latitude of Chagres as determined by Espinar (Boco del Foro), 9° 20′

II.

Plan of an Ancient Fortification at Marietta, Ohio.

By WINTHROP SARGENT.

(*Communicated to the Academy, May 29th,* 1787. *Brought to the Notice of the Academy at a Meeting held February 13th,* 1850, *by* Henry I. Bowditch, *M. D., Librarian.*)

Some months since, while examining some old manuscripts belonging to the library of the American Academy, I found the accompanying plan of the ancient structures at Marietta, Ohio. It bears a date four years earlier than any documents mentioned by Messrs. Squiers and Davis, in the first volume of the Smithsonian Contributions to Knowledge. It appears, by the records of the Academy, to have been received at the meeting held May 29th, 1787; but it has never been published in the Memoirs, and I am not aware that it has appeared in any other form.

These structures at Marietta are incidentally alluded to in a letter addressed by General Parsons to President Willard, of Harvard University, dated October 2d, 1786, and published in the Academy's Memoirs, First Series, Vol. II. p. 122. In this letter there is mention made of another plan that had been transmitted to President Stiles, of Yale College. Of that plan I have no knowledge.

On comparing the plan given in the Smithsonian Contributions with that belonging to the Academy, the two will be found to bear a very close resemblance. In fact, all the main features, and most of the details, completely correspond. There are, however, some discrepancies. Those most evident are the following, viz.: — The wall and lunette, marked *M* and *L* on the Academy's plan, which Mr. Sargent says were somewhat dilapidated when he examined them, have now disappeared. At least they are not found upon the Smithsonian drawing, which was carefully copied from one made by

C. Whittlesey, Esq., Engineer for the Survey of the State of Ohio. One mound of earth seems to have escaped the notice of Mr. Sargent; viz. that situated at the north-eastern part of the largest inclosure, as it appears on the Smithsonian plan. Finally, in several places, Mr. Sargent represents as a series of mounds what Mr. Whittlesey describes as continuous walls.

It is greatly to be deplored, that so little regard is generally paid by the inhabitants of our Western States to these monuments of a bygone and evidently powerful race. Some of these remains are, it is true, choicely guarded by the inhabitants of Marietta. The beautiful mound, *K*, for example, is inclosed in such a manner, that it will probably be preserved. Other portions are kept as public squares. But the walls of the graded way, *E*, Messrs. Squiers and Davis inform us, "are rapidly disappearing" under the encroachments of carriages, which pass and repass through Warren Street, Marietta, which is laid out upon it. I fear that this recklessness in reference to many curious remains of the same character, that are scattered through the West, exists very generally. Even in the city of Cincinnati, I learn that a mound has been wholly extirpated, and the only memento of its former existence is the name given to the street that runs over its former site. During a recent visit to the West, I examined, with some care, the extraordinary remains of a walled village, called "Fort Ancient." The husbandman was ploughing over it, and a long passage-way projecting from its main entrance, and only recently defended on each side by an embankment of considerable height, had, at the time of my visit, been so obliterated, that I could discover only the slightest traces of it. The United States government sends out its corps of observers to study the Dead Sea, and the Antarctic regions, and to learn the habits of the untamed inhabitants of the islands of the Pacific Ocean. It is right so to do. But why should it not also employ an efficient body of men thoroughly to investigate all these interesting structures in the West? Much has been done by individual observers; among whom all honor is due to the authors of the first volume of the Smithsonian Contributions. But much remains yet to be performed. It should be done by government, and done soon, or it will be too late.

H. I. B.

Commonwealth of Massachusetts; Boston, March the 27th 1787.

Sir

I beg Leave to communicate to your Excellency and the Academy a Plan of some antient Ruins in the Western Territory — they were discovered in the last year by an American Garrison at Fort Harmar, and have their Antiquity incontestibly evinced.

Altho' there are not wanting Proofs that the western Country was once populous, and of science, yet I believe that no Other works have been investigated which indicate so much the Appearance of military Knowledge — and I cannot but observe that *here* the Art of Defence seems to have been well understood.

At Grave Rivulet (which Receives its Name from a large artificial Mount of Earth about Seventy Miles from the Ruins) are very extensive Fortifications, consisting of large elliptical Forts, and circular Redoubts — they bear similar Testimonies of Antiquity with those in the annexed Plan, but are of inferior Style and Aspect. The Mount of Earth is an Object of great Curiosity to Travellers, and was once I imagine nearly in Form of a Cone, but at present the Top is irregularly sunken in, and of sixty feet Diameter. Human Bones are dug from every part of it, and to the very summit is a luxuriant Growth of fine tall Oaks.

I had no Instrument with me for taking the Altitude of this Grave, but I measured the Circumference, which was equal to seven hundred and eighty three Feet, and over the Summit from opposite Parts of the Base two hundred and ninety — which, by a Geometrical Construction of the Figure, gives nearly seventy Feet for its Height.

With great Respect
I have the Honor to be
your Excellency's
most obedient
most devoted Servant
W. SARGENT.

His Excellency GOVERNOR BOWDOIN,
President of the Academy of Arts and Sciences.

References and Explanations.

A. Square mound or Turret of Earth with four easy ascents to the Top.

B. An oblong Do. with three ascents and an upright Cut on the So. East side.

C. Another oblong square with two ascents.

D. A Lunette, with a small Turret of Earth rising from the centre.

E. A covert way, or communication with the low grounds at *ee*, where probably was once the bed of the River: The walls of this way are thirty feet thick, and as high in many places.

F. Appears a natural Ravine converted to an aqueduct.

g. One of the principal entrances of the place; about 132 feet wide. — The other apertions in the lines are only half that width, except at the angles.

The N. W. and N. E. Walls are generally about four feet high.

The S. E. and S. W. something lower, and all of them 30 feet thick, with an easy exterior and interior slope.

I. The largest of all the mounds along the lines of *G.* it is 15 feet high and 35 diameter, the others only of 7 or 8 feet high, and of smaller diameters.

K. A mound of Earth 30 feet high and 50 feet diameter, surrounded by a redoubt and internal ditch of 2½ feet deep.

L. An advanced Lunette, with an imperfect ditch.

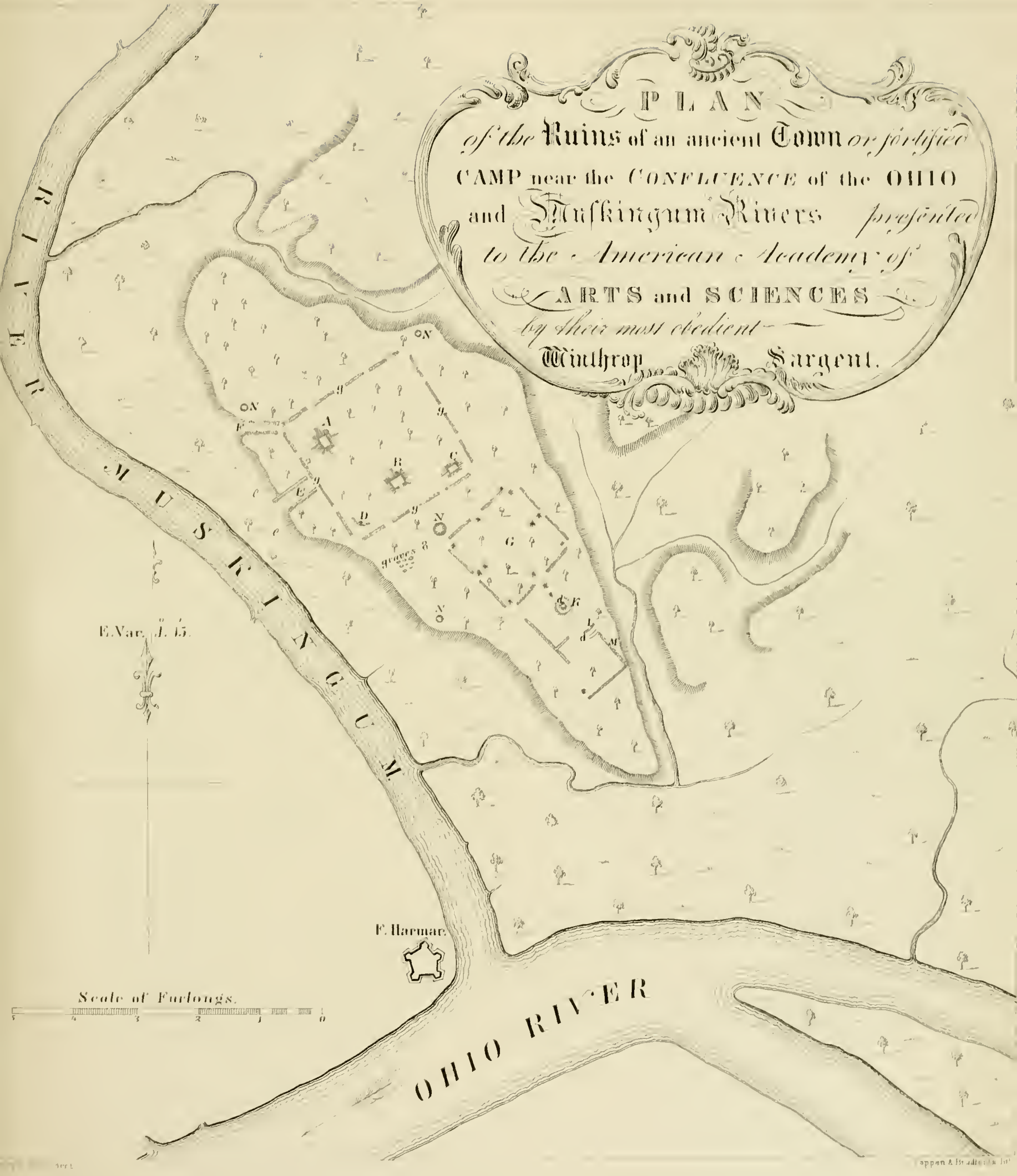
M. A Wall or parapet almost effaced at this time.

N. Excavations in the Earth from which it is supposed the walls and mounds were principally composed; that at 8 is 20 feet deep and 150 feet diameter.

∗ Mounds or Turretts of Earth. —— *d.* ditches.

Walls or parapets of Earth.

N. B. There is at this time on the mounds and Walls of Earth timber of 4 and 5 feet diameter, and evidently not the first growth.


PLAN
of the Ruins of an ancient Town or fortified
CAMP near the CONFLUENCE of the OHIO
and Muskingum Rivers presented
to the American Academy of
ARTS and SCIENCES
by their most obedient
Winthrop Sargent.
RIVER
MUSKINGUM
OHIO RIVER
F. Harmar.
E. Var.
Scale of Furlongs.
graves
ON
N
O

III.

Researches upon the Origin, Mode of Development, and Nature of the SPERMATIC PARTICLES *among the Four Classes of Vertebrated Animals.*

BY WALDO J. BURNETT, M. D.

(*Communicated July*, 1850.)

IN the minds of those who are interested in, or have pursued, physiological studies, there appears to be a kind of predilection for that branch relating to the primitive conditions of being. The existence of an animated being, and the modes of its continuation, considered as physiological facts, are such mysteries, that the mind naturally turns, for the removal of these obscurities, to the very conditions attending its primitive elimination.

To watch the new being, as it arises from an amorphous mass, starting into life, gathering constantly the material forms for the expression of its type, — to watch its gradual growth until it shall burst forth a living, thinking being, — to do all this has, without doubt, been the source of higher delight, and of a happiness more transcendently pure, than that afforded by any other study in which the scientific mind has ever been engaged. It has been, perhaps, for this reason, that, from the earliest days, and more particularly since those of available artificial optics, men of nearly every civilized part of the world have been devoted with an untiring patience to the most thorough and correct study of embryology; a branch of knowledge which can boast of more details, and yet which is more unfinished, than any other in physiology.

All studies of this kind are attended with difficulties of no usual character. Nature, if I may so say, appears to have taken care that the finest expressions of her wisdom and skill should be located in the most recluse situations. The paraphernalia surrounding the production of a new being are in exact accordance with the importance of that process. To these difficulties may be added those of the minuteness and delicacy of the objects. One would suppose that these latter difficulties might have been done away in the present condition of optical science. In some respects they have been, but in others they never have been, and never can be. It is rather a remarkable fact, that most of the material objects actively concerned in the processes of reproduction have a delicacy such as is nowhere else found, and such as evades our correct appreciation of their character by any mode of illumination. So that, while the grosser parts (if I may so call them) in this department are well understood, it has been within the few past years only that those of a more minute, and perhaps, on that very account, of a more important character, have been pursued.

The study of the growth of the impregnated germ has a counterpart at least as important in the study of the means of that impregnation.

Every thing connected with our existence is enveloped in wonder, and the man of science, standing on material facts, is continually brought to the knowledge of the truth, that he can go no farther. However this may be, and however wonderful all around us may seem, yet the mind recognizes degrees of these wonders and of our ignorance, and this according as they are with or without analogy, or have or have not preliminary facts with which we may start. And I do not hesitate to affirm, that the fact that the simple, minute particles of one being should, by the mere agency of contact, not only give rise to a living whole, but in this way convey to it many of the moral and physical properties of the being of which it comes, — all this has a wonder about it more mysterious than any other phenomenon with which the man of science has to do.

It is for this reason that I have for a long time thought, that a course of study to ascertain the real nature of these fecundating particles of the male, the Spermatozoa, has an importance paramount to that of what may be called the secondary processes, included under the name Embryology.

Although attention to the study of the Spermatozoa dates back a long time, yet it is within a few years only that researches of value have been made. I know of no better example in science how a single false conception of an object is a source of constant retardation of its progress, than that furnished by the Spermatozoa. The notion that they are animals, adopted when they were first known, and continued until within a few years, was of itself a sufficient bias against any knowledge of their true character. Such has been the opinion of Czermak,* who regarded them as *Vibrios* ; of

* *Beiträge zu Lehre von den Spermatozoiden.* Vienna, 1833.

Valentin,* who thought he had seen traces of a high organization in those of a bear, which has since been shown to be a delusion; of Gerber,† who was certain he perceived organs of generation in those of the *Cabiai;* of Schwann,‡ who thought he perceived in those of man a sucking lip; of Pouchet,§ who fancied he saw a digestive system, and has given figures to that effect. I cannot here stop to speak of the fanciful figures found in the *Suites à Buffon*, where objects appear to have been seen rather as the observers would wish them to be seen, than as they really were.

The whole amount of these observations seems to be based on the assumption, that, as they were animals, they must at any rate have an animal structure, a view which the philosophers (perhaps not their observations) bore out. To Wagner‖ and to Kölliker ¶ we are indebted for researches far more trustworthy, and which have shed a great degree of light and interest upon the subject. Most of what is really known about these particles is referable to these men and their co-laborers. I shall not here refer to the grounds in support of the view that they are not animals; they will come up more fittingly another time.

I have thus, as a prologue, referred to the general condition of the subject, a digression which could hardly be excused, considering the vague manner in which it even now presents itself to the minds of many.

I should consider that I had not begun my subject at the beginning, did I not preface the more minute details of microscopic structure with some general remarks upon the secreting male or testicular organs, which alone, throughout the animal kingdom, are the tissues from which these particular bodies are eliminated.

Physiologically speaking, the testicles are, like all the other organs of the animal body, endowed with a peculiar function, — simply a basement tissue, on which the peculiar secreting tissues rest. And throughout the whole vertebrated kingdom this secreting tissue has, anatomically, common characters, the differences of these organs being traceable to the mode of the packing of the tissue, and the means for its more or less constant production. As to this latter point, there is the same grade preserved as appears in the other characters of the types.

* *Repertorium*, 1837, p. 134.

† *Allgemeine Anatomie*, p. 210.

‡ *Mikroscopische Untersuchungen.* Berlin, 1839.

§ *Théorie positive de l'Ovulation spontanée et de la Fécondation*, p. 321. Paris, 1847.

‖ *Histoire de la Génération et du Développement*, p. 26. Bruxelles, 1841.

¶ *Beiträge zur Kenntniss der Geschlechts-Verhältnisse und Samenflüssigkeit Wirbelloser Thiere.* Berlin, 1841.

In fishes, the lowest vertebrates, we find the structure of the testicle the most simple. And even here, we perceive a grade as to their two grand divisions, marking differences as wide as those of their other characters. In the Plagiostomes and Cyclostomes the structure of the organ does not appear to have risen above the primitive cellular type, that is, it is but a collection of parent cells, which have never advanced to the condition of losing their identity as such by passing into seminal tubes.

In the higher osseous fishes, a higher condition of things exists. There is an advancement beyond the cell-type, and the large cells appear to have passed either into tubes or bundles of transverse folds, on the inner surfaces of which the parent sperm-cells are produced, as before they were inside the large cells of those of a lower character.

The prolific nature of the testis, as a secreting organ, is just in proportion to these convolutions and variations. And we find this prolificness in a ratio corresponding to the liabilities of the semen reaching the ova of the females. Thus, in the lower orders, the species of which are dormant and sluggish in their character, and which are almost constantly in contact with the bottom of the water, the quantity of sperm to insure the continuation of the species is necessarily less than in those higher and more active orders, where, from their constant movement and travelling, the contact of the two may be looked upon more in the light of an accident than otherwise. If, then, we are allowed to reason on the relation of things, I think that in this fact may be found the reason of the larger and more fertile character of the testes of the higher fishes.

Among the *Reptilia*, *Aves*, and *Mammalia*, with which the process of fecundation takes place only by the conjunction of the sexes, a different and stricter economy is manifested. The testes are more compact, their product less in quantity, and the value of this quantity is shown by the means adopted for its contact with the ova by efferent ducts, receptacles, and an intromittent organ.

With these three grand classes, I need not refer to the differences of size and external character everywhere met with; they bear not at all upon the grand type of testicular structure, but are referable to the economy of the species to which they belong. And only this much may be mentioned, that, generally speaking, as we approach nearer and nearer the higher forms, the size of the testis compared with the whole body is less and less, and the prolificness of the animal is less and less, because, perhaps, the liabilities for the destruction of the species are in the minimum.

We have now the organs for the elimination of the sperm. Our next inquiry is, What are the preliminary steps of that process?

There is, in all the real glandular organs of the animal body, a common structure. This is a layer or layers of epithelial cells, situated on a basement membrane, which last is conformable to the structure of the organ generally. And I think it pretty clearly settled now, that all the products of secretion are the results of the functions of these cells; that is, the elaboration of bile or milk, for instance, is accomplished by the material transuding the walls of these cells.*

Considering the testicle as a glandular organ, it is a matter of considerable physiological importance, to ascertain if its epithelial lining serves as the real secreting tissue of the sperm. In other words, if parent sperm-cells are not epithelial cells. In the very able and complete article entitled "Semen," by Drs. Wagner and Leuckardt, in *The Cyclopædia of Anatomy and Physiology*, this question is raised and discussed, but no positive opinion given, as they think it not yet mature.

I have had the good fortune to conduct some observations bearing upon this point with success. The result of these may be briefly stated as follows. The tubes of the testes of animals which have not arrived at the age of puberty have a simple epithelial lining, the cells of which do not differ at all from those of a *pavement form* covering mucous membranes. When, however, the animal begins to have the generative impulses, the character of the cells seems in a manner modified; they appear to pass to a higher grade of function, exactly as do those of the mammary gland at the time of lactation, and this without losing their primitive type as epithelial cells. It may be thought that the thin vesicular character of the parent sperm-cells would separate them distinctly from the category of epithelium; but this difference can, I think, be considered only as an expression of their higher relation and function.

Of this much I feel pretty certain, and, aside from the facts just mentioned, it may be considered as deciding the matter, at least as far as can be in questions of this kind:

We see in the field simple nucleated cells, differing from the common epithelial cells in no respect, except their slightly increased size. By the side of these, perhaps, we see a similar cell with the nucleus divided, and then, again, these divided nuclei subdivided, and so on, the original cell simply dilating, being thinned and rendered quite transparent; and this process goes on until the embryology of the Spermatozoa is completed, the whole being referable to an epithelial cell, undergoing the highest metamorphoses attainable by cell-structure.

Our next inquiry is, What is the histology of *these* epithelial cells? For an *exposé* of this part of our subject, I must refer to my former investigations on these matters.

This is, in brief, that the cells arise from minute hollow nuclei, — consisting most probably of a particle of oil, having an albuminous envelop (the *haptogen membrane* of

* See an article in the July number of the *American Journal of Medical Science*, upon Epithelial Structures.

Acherson), — which, by expansion from endosmosis, become hollow vesicles, inside of which are formed nuclei, by a kind of condensation of their granular contents, they then being nucleated cells. This mode of cell-formation, and which, as far as my observation goes, is *the* mode of cell-genesis in the animal economy, differs, it will be seen, essentially from that set forth by Schwann and Schleiden, as to these two points, viz.: — 1st. That the nucleus and cell are one and the same as to their histological character; and 2d. That the cell precedes, as to its formation, its nucleus, instead of the reverse.

These histological facts are more than interesting, because, as I have stated in another place, Professor Agassiz, in his studies of the formation of the ovum, has arrived at the conclusion that the primitive cell, on which the ovum starts, (and this, I have no doubt, is an epithelial cell from the lining membrane of the ovary,) arises in the same manner. And the bearing of this will be the more forcibly seen, as we pass on to show that the formation of Spermatozoa is strictly but a miniature embryology.

Having thus passed the preliminaries of our subject, concerning which little has hitherto been done, and about which, therefore, little has until now been known, we next come to a section to which the direct processes of the formation of the Spermatozoa belong, and upon which most of the labors in this direction have been spent. That it may appear that I do not ignore what has been done in former times, it will be proper for me to allude briefly to the history of this subject.

Although this subject has been one in that category which has been pursued since the days of *assisted* optics, yet most of what is valuable may be dated only as far back as the early labors of Siebold.* These were soon followed by those, well marked for their elaborate character, of R. Wagner.†

The researches of Kölliker,‡ however, since 1840, claim the highest credit, and it is to these that some of our clearest ideas of the "Spermatic Particles" can be traced. Kölliker was the first to break up those rude notions of the animality of these bodies, and, considering them no longer meriting the name of *Spermatozoa*, he termed them *Spermatic Particles.* I need not review the wide field over which these men have passed.

Both Wagner and Kölliker have described and figured the size and form of these bodies in very many of the genera of the animal kingdom. They have shown that they

* In Müller's *Archiv*, 1836, p. 232.

† *Fragmente zur Physiologie der Zeugung; Beiträge zur Geschichte der Zeugung und Entwickelung.* Munich, 1837.

‡ *Beiträge zur Kenntniss der Geschlecht-Verhältnisse und Samenflüssigkeit Wirbelloser Thiere.* Berlin, 1841. Also, *Die Bildung der Samenfälen in Bläschen.* Nuremberg, 1846.

are formed inside parent-vesicles, and, according to Kölliker, developed under *five* different types; and, notwithstanding these changes have been described with a detail indicative of indefatigable labor, yet those preliminary changes which seem, as it were, to mark the philosophy of the whole process, and which make the whole analogous to the corresponding function of the other sex, — all this seems to have been overlooked, or, if perceived, to have been passed over without recognizing their significant value.

Early in 1849, Dr. Charles Robin of Paris presented to the *Académie des Sciences* a memoir entitled (as translated), "The Existence of an Ovum as well in the Male as in the Female of Plants and Animals; producing, in the one case Spermatozoa, in the other the Primitive Cells of the Embryo." This memoir was submitted to a *commission*, consisting of MM. Serres, Dumas, and Milne-Edwards, and their report may be found in the *Comptes Rendus*, 1849. The grand fact of the memoir is the announcement of the fact of the segmentation of the nucleus of the male sperm-cell, as well as of the female ovarian cell of plants and animals, preceding the elimination of their special products. The memoir had more a botanical than a zoölogical import, because the data on which it rested appeared to be furnished almost entirely from vegetable, instead of animal morphology. In fact, his support of these views with reference to the sperm-cells of animals appears referrible to the observations of M. Reichert * upon the Spermatozoa of *Strongylus auricularis* and *Ascaris acuminata*. Also upon observations of his own upon one of the Acalephæ, *Rhizostoma Cuvieri*.

If M. Robin's inferences were based upon his paucity of observation alone, they certainly were not scientifically warranted, considering that M. Kölliker had then just published his memoir, in which there appeared no less than five dissimilar methods by which the spermatic particles were formed in the parent vesicles. The merit of a broad suggestion, however, certainly belongs to Robin, and I am free to admit that I have borrowed it from him; but its application, and the testing of its correctness, traced by innumerable details throughout the four classes of the vertebrated animals, I must humbly claim for myself. And, in so doing, I have not relied upon the observations of Wagner or Kölliker, but have traversed the whole field myself. In this way, I have been able to perceive what I think to be important errors made by others, as well as to travel new and unexplored grounds. I say this with that humility which belongs to all scientific

* It is quite remarkable that Reichert, whose observations Robin quotes in support of his theory, declares that this *segmentation* of the vitellus (the very virtue of the whole) is "une sorte d'illusion produite par la mise en liberté de vésicles préexistantes, emboîtées les unes dans les autres." Quoted from Longet's *Traité de Physiologie*, in *De la Génération*, p. 144, where reference is made to Reichert, Müller's *Archiv*, 1841, p. 523.

investigation, and especially in the department of minute and vital morphology, where the contingencies to error and illusion are more prominent than in grosser studies.

The grand result at which I have arrived in these investigations, and which has an importance sufficient to justify me in the details already given, and those which shall be presented hereafter, may be stated as follows: —

That, throughout the range of vertebrated animals, the morphological changes in the sperm-cell preceding the formation of the spermatic particles are identical in their character with the morphological changes in the ovum preceding the formation of the new being.

The processes are the vitalization of the sperm-cell in the male, and of the ovum in the female, by the continued segmentation of the nucleus or vitellus, until each is a mulberry mass. The changes sequent upon this are of several kinds. Two of them, however, may be mentioned as apparently the most important and best known, viz.: — 1st. The liquefaction of the segmented contents into a minute granular blastema, out of which are formed, in the one case, spermatic particles, in the other, a new being; and 2d. The immediate passage of the segmented contents; in the one case, each cell becoming a spermatic particle, in the other, masses of cells forming the organs of the embryo.

There appear to be other modes than these, both with the sperm-cell and the ovum; but they are very imperfectly understood, and may here be omitted.

I shall now take up the description of my observations in the four grand classes, commencing with the lowest: —

1st. *Fishes.* — The spermatic particles of fishes exist under two forms, and these corresponding to the two forms of their testes of which we have already spoken.

In the higher *osseous fishes*, where the structure of the testes is tubular, these bodies consist of a very minute globular or cordate cephalic portion, to which is appended a still more minute tail, the presence of the latter, however, being far from constant in all specimens.

In the *Plagiostomes*, where, as we have seen, the structure of the testicle is cellular, and not tubular, the form of these bodies is quite different; they are of a much larger size, and are long and filiform, their cephalic portion being only thickened, and gradually tapering off into a tail, which, compared with the body, is not very long. The existence of these two forms is important, as we shall soon perceive.

The formation of the spermatic particles among fishes has, as far as I am aware, been observed only in the *Plagiostomes*. And with the observations of Hallman *

* Müller's *Archiv*, 1840, p. 467.

and Kölliker* may be found nearly all that relates to the subject. My own observations have shown this much :

Each of the large testicular cells arises from small nucleated cells, situated in the stroma of the organ. I have seen them nucleated, and as small as one two-thousandth of an inch in diameter. Soon after this, each has a nucleolus, and the whole increasing, we have regular nucleated cells inside of vesicles. Soon after this, the nucleus of the cell (not the vesicle) begins to segment, until the cell is full of minute cells. The next stage at which I perceived the progress was this mulberry mass composing the nucleus or vitellus, disappearing and apparently replaced by a fasciculus of spermatozoa. (Vid. Fig. 1 – 5.) The stage of their real formation, or the metamorphosis of this granular cellular mass into the bodies, I have always failed to observe. It has, notwithstanding, appeared to me quite probable, that the filamentous bodies are formed by the gradual elongation of the subdivided cells, and this because I have seen cell-like bodies of a more or less pyriform shape, as though in a state of transition, and also because the subdivided cells appear of too small a size to admit of a spermatic particle to be formed within them.

However, according to both Hallman and Kölliker, they are formed within " vesicles of formation." Although this may be the case in many instances, yet their production *in the other way does occur in other cases.* At any rate, the discussion of these questions does not appear to bear upon the grand formula of vitalization by segmentation.

In the higher osseous fishes, where the testes are either tubular or ampullar, the formation appears somewhat dissimilar. Upon the inner surface of the tubes or ampullæ there are developed vesicles, simple at first, but which soon become nucleated. This nucleus or vitellus soon divides, and this segmentation goes on until the parent vesicle is filled with minute cells. Next, the vesicle has its cellular contents replaced by Spermatozoa, the cephalic portion of which is about the size of one of the subdivided cells, a fact which would lead me to infer that they are these last, slightly metamorphosed. I am, however, quite unwilling to entertain any opinion on this point, as my observations have not been sufficient, and as it is, of all microscopy I ever handled, the most difficult clearly and definitely to make out. (Vid. Fig. 6 – 11.)

Spermatic particles of this form do not appear to be very dissimilar wherever they occur ; and of many species of several families which I have examined, the differences were far from being well marked. They consist generally of a pyriform body (the small portion in front), to which is attached, when they are fresh, a remarkably thin tail.

In my earlier observations, I denied the statement that they had a caudate portion, which was certainly true of the specimens I examined, — as they were subjected to the

* *Op. citat.*

highest and best optical power known. Investigations of a later date, and upon specimens taken fresh from the animal, have shown that the normal spermatic particles have tails, but perhaps of the most transient nature.*

Unless one has the best of eyes, and a still better instrument, I should think that they would be unwise to attempt the study of those bodies with fishes; their bodies, or rather cephalic portions, are from one eight-thousandth to one twelve-thousandth of an inch in diameter, and their tails, when present, of a diameter nine or ten times more minute, being in fact the smallest organic objects coming under the eye of the microscopist, and the clear definition of which may be taken as a fine test for a most superior instrument.

2d. *Reptilia.* — The spermatic particles of this class have been more thoroughly and satisfactorily studied than those of any other class. This is due to their larger size and more permanent characteristics throughout their several orders. Although there are marked differences, yet they seem to have a general form, consisting of an oblong, staff-like body, to which is attached a long thin tail. Among some of the different genera of the same order, they appear so nearly alike, that, were one examining them together, care would be necessary in order to know from which genus they were taken.

My own observations have been mostly among the *Batrachia*, and the mode of development here seen may be, I am well assured, considered as expressing that of all the other orders of this class.

If, at the approach of the season of *heat*, the testicles be examined, there will be found, in the midst of the normal epithelial cells lining the tubes, others larger, and having a more opaque and prominent nucleus. These are the sperm ovules or cells. After they have increased to four or five times their original size, the granulated nucleus segments, by a slight sulcus, which gradually deepens until the whole is divided into two spheres. Each of these divides, and this subdivision goes on until the parent vesicle, which has all this time been increasing in size, is filled with small nucleated vesicles. This condition of things is replaced by the presence of the spermatic particles, sometimes scattered in a random way throughout the vesicle, but commonly in a fasciculus. (Vid. Fig. 12 – 21.)

Having thus watched the vitalizing processes immediately preceding their formation, our inquiry is here, as it has been before, — Are they formed by the elongation of the

* Czermak (*Beiträge zu der Lehre von den Spermatozoen*, Wien, 1833) says positively that the spermatic particles of fishes have *no* tails. Dujardin, however, from his observations on the Carp, believes that they are tailed, but shows that they can only be seen *as such* when fresh. (Vid. *Annal. des Sci. Nat.*, N. S., Tom. VII. pp. 291 – 297.)

segmented cells, or are they the ultimate product of a granular mass produced by the liquefaction of these divided cells? The presence in the field of *pyriform moving* cells, of about the size of the subdivided ones, would certainly favor the former view, as these were probably cells in a state of transition. On the other hand, the presence of a fasciculus of these bodies in a parent vesicle would favor another mode of development, if the fasciculi are the result of development, and not of a *subsequent* grouping, as some have supposed.* This point I shall have occasion to refer to at another time. The grand fact of vitalization has here been seen more distinctly than in the other classes.

3d. *Aves.* — The spermatic particles of birds resemble quite closely, as to their form and other gross characteristics, those of reptiles. As they were the animals on which the first exact observations of the *genesis* of these bodies were made,† more observations have subsequently been made upon this than upon any other class, and those of a vast number of genera have been delineated.

My own observations have been made for the most part upon *Passerinæ* and *Columbidæ*, and, as there is a singular uniformity throughout the whole class as to *genesis*, those of these orders are good representatives of the whole. Exactly as in the preceding class, the sperm-cells appear on the inside of the testicular tubes among the normal epithelial cells. Segmentation here goes on as previously described, and in place of the crowded vitelline cells we have a fasciculus of spermatic particles. These, when inside the parent vesicle, are never, as far as I have seen, very numerous, but appear to bear a pretty close ratio with the number of segmented cells that the vesicle would contain. This fact will admit of two constructions; namely, either that each of these segmented cells was changed into a spermatic particle, and that, therefore, the fascicular form was from a *subsequent* arrangement; or, according to both Kölliker and Wagner, that each of these served as a "cell of development," in which a single spermatic particle was formed. The latter view is most supported by direct observation; in fact, I have never been able to see any condition looking at all like a stage of transition from a cell to a spermatic particle; but notwithstanding this, I should much hesitate offering any decided opinion. The appearance of these bodies in fasciculi, as though they might have been thus formed out of a solid mass, merits our attention here, because Kölliker has based this type of genesis on observations of this class.

According to Kölliker, there is formed inside the parent vesicle a granular mass,

* Vid. Longet, *Traité de Physiologie*, (*De la Génération*,) p. 114.

† Wagner's *Histoire de la Génération et du Développement*, *etc.*, p. 26. Bruxelles, 1841.

which splits up into the spermatic bodies. There are several facts which ought here to be considered before this view is admitted. One is, that the number of bodies composing the fasciculus appears to be in a pretty close ratio with the number of preëxisting cells the vesicle would contain; so that there appears to be a morphological connection, indicating that the structure of the cells as such does not become lost in a granular mass. This may be clearly seen in many of the Passerine birds. Again, it is difficult to conceive how a granular mass can split up into a group of bodies which have not a trace of a granular structure, at least as far as we can perceive, and especially so when many of these bodies have in their interior the remains of an old nucleus, the relics of the former cells. Lastly, it is quite common to perceive in the testicular tubes of birds fasciculi of these bodies of a size so large as shows that it could not have been attained within the parent vesicles, but is rather the result of an accidental coincidence, they having a strong tendency whenever they come together to unite in a regularly formed manner; and large groups are continually gathering as they pass along, and not broken up until forced through the vasa deferentia. This point will again come up for consideration in the general remarks upon the modes of genesis. (Vid. Fig. 22 – 28.)

4th. *Mammalia.* — The spermatic particles of this class have a uniformity as to form and shape, and a delicacy of structure, exceeding any other class. They are characterized by a broad, disk-like, neatly sculptured anterior extremity, to which is appended a tail, generally of considerable length. Among the higher orders, there is a remarkable similarity, which meets with a considerable modification in those of less rank. Both Wagner and Kölliker have illustrated these forms by many figures. My own observations have been made as to their *genesis* upon the orders *Bimana*, *Carnivora*, *Rodentia*, and *Ruminantia.* With the exception of a few important points, the same mode of procedure is observed as in the former classes. Sperm-cells appear, their nucleus is divided, and so on as in the former classes. The spermatic particles, however they may be formed, are more often found, especially in the higher Mammalia, in a free, unconnected state in the parent cell, rather than in fasciculi. In many species of the genus *Mus*, where the large size of these bodies allows them to be easily seen, I have sometimes perceived them in small fasciculi in the parent vesicle, and have often particularly noticed the fact of these fasciculi being made up of an even number of bodies, and this number corresponding to the results of segmentation, 2, 4, 8, 16, &c., thus making it exceedingly probable that these particles are not formed from a granular mass, but rather directly *from* or *in* the segmented cells. (Vid. Fig. 29 – 35.) There are some peculiarities of these bodies among some of the Mammalia, that deserve our notice.

Among the *Sciuridæ* the cephalic portion of the spermatic particle has its largest and finest development, it being a thin and quite transparent disk-like body, as though from the flattening of a cell, the two membranes coming in contact; and in it may be often seen granules of considerable size, which go to support the view of its cell-membrane origin; these disks, generally circular, have often a slightly pyriform shape, and are of a size equalling one twenty-five-hundredth or one three-thousandth of an inch in diameter. To these is appended a rather long and delicate tail. When making observations on these animals, one must be struck with the similitude of these disk-like bodies to the segmented cells floating beside them in the field.

Among the *Muridæ*, we meet with a marked peculiarity of form, such as is not met with elsewhere. It consists in a curved, sickle-shaped body, to which is appended a very long tail. This sharp, knife-like portion of the body is situated on one side, so that the spermatic particle has a rather symmetrical aspect. It is difficult to understand how they are formed in this manner, and more particularly so if we attempt to trace them to a cell-origin. The genesis of these bodies in *man* does not differ at all from that of the higher brute Mammalia. Their form and general characters are too well known to need mention, and I have seen nothing particularly distinguishing them from those of some of the *Solipedes* and *Ruminantia*.

The figures of Buffon * and Pouchet † savor so much of the fanciful, and offend so much our best notions of the most minute morphological changes, that I shall not allude to them here. And here I may as well say, that most of the spermatic particles of the Mammalia are of such character as to admit of being studied only as a whole. And even admitting the very absurd view that they are animals, I should hesitate long before I believed that any one had ever seen their *internal* structure.

I have thus rather hastily described the mode of genesis of the spermatic particles in the four grand classes of the vertebrated animals; a fuller detail would have been inappropriate, as illustrating the grand formula of their genetic morphology, which we have seen is always present.

I shall now turn to some considerations upon the alleged various modes of their production, *after* the vitalization by segmentation has taken place, especially as they bear upon the formula just stated, and the commonly received embryological changes of the ovum after segmentation.

Kölliker ‡ has spoken of five types by which they are developed, viz.: —

* *Op. citat.* † *Op. citat.*

‡ *Beiträge zur Kenntniss der Geschlechts-Verhältnisse, etc.* Berlin, 1841.

Type A. Each filament arises from a special cell, by the increased growth of whose walls it passes into an elongated or filamentous condition.

Type B. Out of each cell formed springs a bundle of seminal filaments.

Type C. The filaments are developed in crowds within large cells, probably in an analogous manner to the generation of the primitive muscular fibres.

Type D. Each filament arises within a special cell.

Type E. The filaments are formed in bundles from minute granular cells, these cells becoming dissolved, as it were, into each other, and assuming a delicate filamental form.

Of these, types *A* and *D* I think I have myself observed. The other three, I think, may be included under the head of the *Fasciculus mode.* I have, on a preceding page, expressed my doubts, and the reasons for them, of the reality of this mode of genesis.

The other two forms merit our attention.

1st. Genesis *out of* nucleated cells. In the ovum fecundated and segmented we have this peculiarity; namely, that the homogeneous individual parts blend together and lose their individuality as such, for the formation of a perfect whole, the vitelline cells dissolve and mingle, and their characteristics as individuals are lost. Nevertheless, holding to the view which I have some time ago announced of cell-types as the basis of all higher types, it must be that each of these vitelline cells is a miniature and correct representation of the whole ovum; and therefore, could morphological changes sufficiently minute occur within it, it would form a new being exactly like that resulting from hundreds together.

Exactly so is it with the Spermatozoa. Each of the subdivided vitelline cells represents the whole, and instead of all dissolving together to form one large body, each forms the same body in miniature, and this is in this form accomplished by a slight modification of the cell, which forms the body or anterior extremity of the particle.

In these cases, it is very probable that the nucleus of the cell plays an important part. But whether or not it is the chief agent I am unprepared to say. This kind of elongation, this metamorphosis, has its analogue in the organizable cells of the higher tissues, and must be considered indicative of a higher vitality, seeking its expression in a metamorphosis of form above the cell grade, a view still better borne out by the fact, that, in the cephalic portions of some, the nucleus is persistent. Thus reminding one of the higher metamorphotic tissues, where the nuclei, the only indices of their former cell-days, have not passed away.

2d. Genesis *in cells.* In this case, each of the divided cells serves as a parent, in which is developed a particle. When fully developed, they rest upon the side, their cephalic portion appearing to form a portion of the parietes with the caudate portion curled around. Nevertheless, this may be considered only an accidental relation, the particle, most probably, having no relation with the parietes.

I have always noticed that in these cases the nucleus is absent, and this fact has led me to adopt the view, that it is transformed directly into the particle, the cell-membrane acting simply as a protecting shield for the process. This view would involve no new or anomalous morphological process, if we consider the real nature of the nucleus, and its relation to the parent cell; namely, that it differs not at all from the cell, except in being the active metamorphosing agent.*

Both Kölliker and Wagner have inclined to the opinion, that this form was developed on the inside of the cell by aggregated particles, exactly as *lignine* is deposited on the inner surface of vegetable cells of woody plants. This is quite plausible, but the fact, that I have seen among the higher Mammalia the *sperm-vesicles* undoubtedly filled previously with segmented cells, having, *on their inner side*, particles, and these generally four and eight in number, would seem to show that they were formed either *from* or *in* segmented cells, and became there situated afterwards.

The *tail* of the spermatic particle, from its constant presence, has most probably an inappreciable importance.

As to their genesis, I do not think it referrible to exactly the same processes as those of the body proper. It appears to be a subsequent formation, and not formed from either the cell or the nucleus, but rather from a minute granular matter.

The parietes of the parent vesicle of most of the spermatic particles of Mammalia have a delicacy amounting almost to real transparency. It is difficult to conceive of an organized structure having a fineness more delicate than this; and yet the very spermatic particles formed within have tails far more delicate than this membrane as to thickness.

Among the osseous fishes, the tail has a still greater delicacy of structure, and it would be very absurd to suppose that these are formed from a cell-membrane, since this last is formed of *layers* of granules, each of which very granules has a diameter equal with the tail itself, and perhaps larger. Moreover, it not unfrequently occurs, that, within the field you are viewing, there are some bodies with no tails. And I have noticed, that, during the unprocreative season among the lower classes, a few spermatic particles are formed, but they are generally deficient as to tails. This may easily be seen with some of the common Batrachians.

These two facts, and another, that these bodies generally lose their tails with their

* Vid. *Transactions of the American Association for the Advancement of Science*, 1849, p. 261.

vitality, have led me to adopt the opinion, that this portion is intimately connected with their vitality, and that generally of the whole process of their elimination. It would seem to be this wise: after the cephalic portion has been formed, the minute organic granules with which it is surrounded begin to take a linear arrangement at one of its extremities, and by this means, modified by the type of spermatic particle in question, the tail of variable length is formed. This will account for its excessive tenuity and the variations in its length. Of course, when the vitality of the particle has ceased, the tail would, as a granular body, be the first to lose its integrity, and therefore drop off. During the intervals of the procreative period, when the sexual impulse is passed, and the corporeal forces are abstracted from the testicular organs, the elimination of these bodies must be less perfect than at any other time. Less vitalized organizable blastema is thrown out, and of course less of the primitive granular matter formed.

This would account for the fact above mentioned, that the spermatic particles of the Batrachians in the month of October do not generally have tails, or, if so, they are short and imperfectly formed.

In this connection I ought to mention a fact M. Lallemand * has noticed in patients broken down by seminal losses. It is, that, in these cases, the spermatic particles are imperfectly formed, their tails being rough, irregular, and indistinct.

This mode of the genesis of the filamentous portion of the spermatic particles is not without its very apt analogue in the common morphology of tissues. In the process of inflammation, this granular blastema is thrown out in abundance, and that portion which does not take the organization of pus or other cells, is very apt to form by a single aggregation in a linear way that *fibrillated* structure, extremely delicate, met with in inflammatory products.

The Motion of Spermatic Particles.

This, from several considerations, should claim our attention for a few moments. I think there can be but little doubt, that the movements are effected by means of the tail, and therefore expressive of the vitality of the body. But I should be unwilling to assert that these movements are entirely due to this organ, since among some of the *Articulata*, and especially with some of the *Arachnidæ*, no tails are found.

It is useless here to discuss a question, when we have no data to stand upon. Of the whole class of cell-motions we know nothing, excepting that they are purely

* *Des Pertes Séminales involuntaires.* Montpélier, 1841. Also, *Annal. des Sci. Nat.*, Tom. XV. p. 30.

molecular, and are indicative of the higher vitality of these molecules. We have yet to learn every thing about *any* animal motion, and my own impression is, that all (muscular, &c.) will be found to be essentially molecular, or belonging to molecules, which are the first expressions of vitality, and serve as the basis of all organized tissues whatsoever. During my investigations, I have tried the influence of various agents. Electricity had no well-marked effect. But all those chemical agents that infringed affinitively upon the material structure, thereby impairing their integrity and vitality, put a stop to the motion. All my own experiments went to show that all these movements were identical in character with those of the cilia of epithelial cells, a matter that I have fully discussed in another place.*

Signification of Vitelline Segmentation.

Before closing this interesting subject, I have thought it essential to a clear understanding of the whole ground of analogy existing between the sperm-cell and the true ovum, that a survey should be taken of the process of segmentation and its meaning, since it forms the basis of the analogy. We will take it up as studied with the ovum.

The earliest phases of change the observer is able to perceive with the fecundated ovum is the fissuration of the vitellus. Upon a single surface of the vitellus, a kind of retreat of substance from a given point occurs; this produces a slight sulcus, which, deepening, divides the vitellus into two spheres. Upon each of these spheres the same process is repeated, and this goes on increasing in a geometrical proportion, until the whole is a granular mass. Succeeding this subdivision is the immediate process of the embryo's formation.

The true signification of the segmentation of the vitellus has not, I am convinced, been fully understood. Noticed first by Prevost and Dumas † in the frog, it has since been more carefully watched by Rusconi, ‡ Baer, § Bergman, || Ruchert, ¶ Vogt,** Agassiz,†† and others of a later day. It has, until quite recently, been considered

* *American Journal of Medical Science*, July, 1849.

† *Annal. des Sci. Nat.*, Tom. II. p. 129.

‡ *Développement de la Grenouille commune.* Milan, 1826.

§ Müller's *Archiv*, 1834, p. 481.

|| Müller's *Archiv*, 1841, p. 89.

¶ Müller's *Archiv*, 1841, p. 523.

** *Untersuchung über die Entwickelungsgeschichte von Alytes obstetricans*, 1842, p. 3.

†† *Lectures on Embryology.* 1848.

as the first grand expression of impregnation, and most certain it is, that no fecundated ovum goes on to the formation of the embryo, without first experiencing these changes. But, on the other hand, later and more extended inquiries in this wide field have shown that it occurs to a certain extent without fecundation.

Late morphological inquiries have shown the complete analogy existing between cells and ova, and that these same segmentary changes occur, to a certain extent, not only in the unimpregnated ovum, but in individual non-organic cells.* I have observed it with the ova of many fishes, before they have left the female, and therefore before impregnation. I have also observed its many heterogenous pathological cells, such as those of cancer, pus, &c. But, however this may be, there appears to be this difference, that in the one case they are purely abortive in their character, the segmentation rarely going on beyond twice, and here ceasing, whereas in the impregnated ovum these changes have a definite end, which is accomplished by the appearance of the new being. And it is the furtherance of this process, for this end, that characterizes the ovum from a cell, in regard to morphological changes.

Wherever it occurs in cells, it is only among the higher individual species, and may be considered an index of vitality, having no end except the production of its own species. While in the ovum and sperm-cells, the vitalizing process is more finely marked, and the cells lose their individuality by a metamorphosis into higher form or forms. And perhaps one of the best evidences that such segmentation to a definite end lies at the bottom of the primitive development of all new individual beings, is the fact that it occurs most extensively in those portions of the embryo that afford the highest expressions of the animal as such, viz. the nervous system.

Let us now take a survey of the whole matter, and the true relations of the sexes. With nearly all the processes of life, the *male* bears the marks of a higher physiological being than the female. All those functions that are characteristic of an individual isolated being are with *him* more finely pronounced than with *her*. *His* energies tend to vitalizing and animalizing processes, *hers* to a development of his by processes of a more vegetative nature. Although, in the reproductive process, the one sex is the counterpart of the other, and without each of no avail; yet I think it may be affirmed that the male exercises the higher function, and is the grand moving agent of the whole process. After the sperm-cell is produced, there occur, from forces innate,

* This phenomenon has been quite extensively observed among vegetables. Vid. Prof. Hugo von Mohl, *Vermischte Schriften*, p. 362, et seq. Also by Griesbach, Weigman's *Archiv*, 1834. See, in addition, the works of Nägeli, Karl Müller, Schaffner, &c.

a complete set of processes, ending in the elimination of bodies which are, in a physiological sense, the miniature representatives of the whole being. And it is the function of these bodies to come in contact with the ovum, and to awake within it those dormant energies which find their expression in changes identical with those attending the elimination of the awakening body. And these forces, thus called into action by the combined agency of the two sexes, have their final expression in the elimination of a being possessing the characteristics of both.

Such appears to be the philosophy of fecundation. You ask, "How is it accomplished?" I have for some time thought it might be called a kind of *Catalysis*; that is, as the magnet awakens in the iron slumbering forces like its own, so that it possesses nearly the characteristics of its awakener, so the spermatic particle, coming in simple contact (not mixing) with the ovum, awakens in the latter slumbering forces like its own, — life being the result.

We see exemplifications of this *Catalysis* in organized forms in the production of cells, having types according to their local character. And although the word may serve to cover up our ignorance, yet, as it is expressive of a power which the scientific mind by analogy only can comprehend, it may be adopted. For, after all, the *ultimata* of all science having any thing to do with vitality must ever rest on words or conditions equally as vague and unsatisfactory.

I subjoin, in a tabular form, the analogies existing between the Sperm-cell and the Ovum.

The Sperm-Cell.	*The Ovum.*
1. Is a nucleolated cell.	1. Is a nucleolated cell.
2. The nucleus, increasing and becoming granular, undergoes segmentation.	2. The nucleus (vitellus) increasing, becoming granular, undergoes segmentation.
3. The result of this segmentation is, that *each* of the subdivided cells forms a *spermatic particle.*	3. The result of this segmentation is, that *all* the subdivided cells, by a metamorphosis, form an *embryo.*
4. The function, then, of the sperm-cell, is to eliminate the vitalizing *spermatic particles.*	4. The function, then, of the ovum, is to eliminate the vitalized product, the *embryo.*
5. In the lowest sense of the term, the spermatic particle is *alive;* that is, it is an organized acting form. But it is so in the lowest sense only, since it holds no relations whatever to the external world. On this account it can never be an *animal.*	5. In the lowest sense of the term, the embryo is *alive;* that is, it is an organized acting form. But it is so in the lowest sense only, since it holds no relations whatever to the external world. It is *not an animal* until it does.

Explanation of the Plate.

Fig. 1 – 5. *Platessa Flesus;* Fig. 1, nucleolated sperm-cells in testicular cells; fig. 2, the same segmented; fig. 3, increased to the maximum and extensively segmented; fig. 4, spermatic particles in testicular cell; fig. 5, free spermatic particles.

Fig. 6 – 11. *Leuciscus chrysoleucas;* fig. 6, nucleolated sperm-cells; fig. 7, nucleus singly segmented; fig. 8, nucleus doubly segmented; fig. 9, extensive segmentation; fig. 10, free spermatic particles in parent cells, the tail most distinctly seen; fig. 11, free spermatic particles, the tail excessively minute.

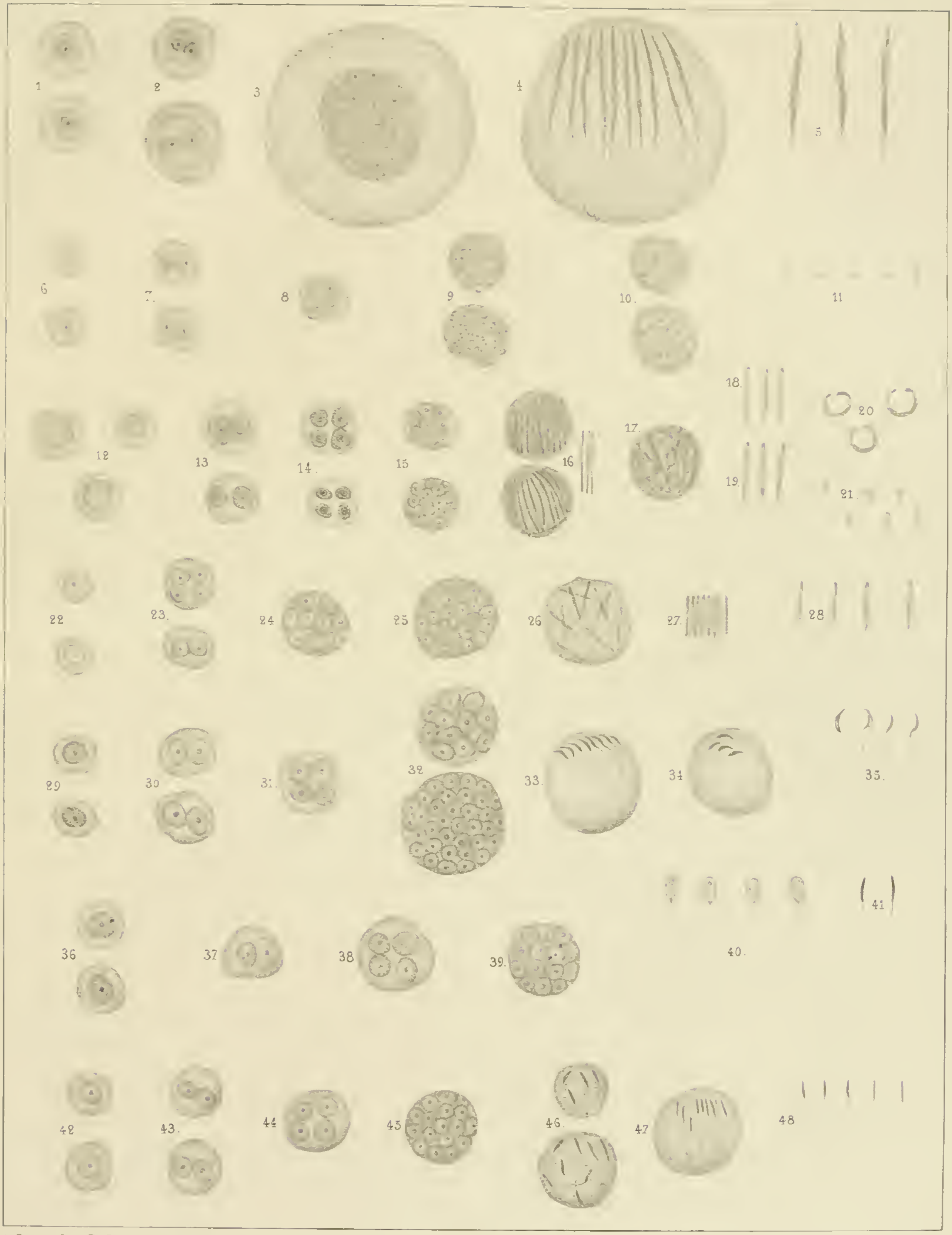
Fig. 12 – 21. *Rana pipiens;* fig. 12, spermatic ovules, with nucleus as a vitellus; fig. 13, vitellus dividing and divided; fig. 14, each still dividing, so as to make four; fig. 15, still further fissuration, so that there are eight and sixteen segments; fig. 16, spermatic particles formed in parent cells in fasciculi; fig. 17, spermatic particles formed in parent cells, scattered; fig. 18, spermatic particles without tails; fig. 19, spermatic particles with tails; fig. 20, spermatic particles curved like a hoop, no tail; fig. 21, moving, slightly caudate cells, in the field, probably escaped spermatic cells.

Fig. 22 – 28. *Columba livia;* fig. 22, nucleolated sperm-cells; fig. 23, nucleus divided and subdivided; fig. 24 and 25, still further segmented; fig. 26, free spermatic particles among granules in sperm-cells; fig. 27, spermatic particles in a fasciculus; fig. 28, free spermatic particles.

Fig. 29 – 35. *Mus decumanus;* fig. 29, nucleolated sperm-cells; fig. 30, the same increased in size with nucleus singly segmented; fig. 31, doubly segmented; fig. 32, segmentation more and more extensive; fig. 33, eight spermatic particles in sperm-cell; fig. 34, four spermatic particles in sperm-cell; — in both cases they have probably been developed out of or in cells, and assumed this disposition from convenience; fig. 35, free sickle-shaped spermatic particles.

Fig. 36 – 41. *Sciurus hudsonicus;* fig. 36, nucleolated sperm-cells; fig. 37, singly segmented; fig. 38, doubly segmented; fig. 39, extensive segmentation; fig. 40, spermatic particles with thin, broad, disk-like anterior extremity, containing granules; fig. 41, the same seen sideways to show the thinness.

Fig. 42 – 48. *Ovis aries;* fig. 42, nucleolated sperm-cells; fig. 43, the same described; fig. 44 and 45, still further segmented; fig. 46, spermatic particles free in sperm-cells; fig. 47, spermatic particles in a fasciculus in sperm-cell; fig. 48, free spermatic particles.



A Sonrel from Dr Burnett's drawings

Printed by Tappan & Bradford

IV.

A History of the Fishes of Massachusetts.

By DAVID HUMPHREYS STORER, M. D., A. A. S.

As one of the Commissioners on the Zoölogy of Massachusetts, in the year 1839, I prepared a Report on the Ichthyology of the State. From the brief time occupied in its preparation, it was necessarily imperfect, and, not being accompanied by figures, was comparatively useless, except to scientific men. Since the appearance of that communication, much information has been obtained respecting several of the most common and valuable fishes, and quite a number of new species have been ascertained to exist in our waters.

Having carefully re-described all the species, I trust the following paper will present an accurate history of the fishes of our State. Considering this as the completion of my former Report, I have kept in view the primary object of the commission, — to ascertain the value of our Fauna in an economical point of view, rather than to prepare labored scientific descriptions.

To all who have aided me since this paper was commenced, or rather since my attention was first directed to our ichthyology, I would return my grateful acknowledgments. The following gentlemen, to whom in my previous Report I remarked I was under peculiar obligations, I cannot pass by unnoticed : —

Thomas Kidder, Esq., of the General Inspection Office, Boston, for his polite attention in furnishing me with all the statistical information in his power regarding the quantities of fish inspected in the State ;

C. R. Vickery, Esq., of Taunton, for his very acceptable remarks respecting the fisheries of Taunton River ;

Hiram Hosmer, M. D., of Watertown, for his numerous and valuable facts concerning the fisheries of Charles River ;

Elisha Bartlett, M. D., of Lowell, for his interesting account of the fisheries of the Merrimack River ;

J. B. Forsyth, M. D., of Chelsea, formerly of Sandwich, for much useful information respecting the fishes taken along " the Cape " ;

Jonathan Johnson, Jr., of Nahant, for several very rare species, and many valuable observations concerning more common fishes.

To Captain Nathaniel Blanchard, a veteran fisherman of Lynn, and Leroy M. Yale, M. D., of Holmes's Hole, I am most deeply indebted ; — to the *former*, for his constant and unwearied efforts to serve me amid the fatigues of his arduous occupation, during the entire period I was engaged in the State Survey, and for many judicious remarks and valuable details imparted to me, respecting the fishes and fisheries of the northern shore of Massachusetts Bay ; and to the *latter*, for his *invaluable aid*. To him I am not only obliged for specimens of nearly *one fifth* of all the species I have described, and which, but for him, I could not have procured, but also for many specimens of more common species, and much valuable information respecting them. Since these observations were made, my excellent friend, Dr. Yale, while in the faithful discharge of his professional duties, contracted a malignant disease, the attack of which he survived but a few days. By his death, science has lost an enthusiastic votary, and his profession a most honorable member.

During the last six or eight years, no individual has rendered me such essential assistance as Captain Nathaniel E. Atwood, of Provincetown. For nearly thirty years a practical fisherman, thoroughly acquainted with the habits of most of our fishes, and willing and ready to do all in his power to advance my wishes, he has placed me under obligations which I cannot express. For several fishes never before described, and for much acceptable information respecting each of our marketable species, I am indebted to him, the best practical ichthyologist in our State.

To Professor Agassiz my thanks are due for many valuable suggestions in the preparation of this work, and to his accomplished draughtsman, Mr. Sonrel, for the admirable plates which illustrate it.

In my nomenclature, I have been guided, as far as possible, by the principle which would give the credit of a species to the author who first placed it under its appropriate genus. This plan, I am led to understand, is about being adopted by our most eminent naturalists.

In addition to the works mentioned in my " Synopsis of the Fishes of North America," the following have been consulted in the preparation of this paper : —

Richardson. Report on North American Zoölogy. London. 1837.

Schomburghk. History of Barbados. London. 1848.

Zoölogy of Beechey's Voyage to the Pacific. 4to. London. 1839.

Magasin de Zoölogie, par Guérin de Méneville. 8vo. Paris.

Agassiz. Lake Superior. 8vo. Boston. 1850.

Storer, H. R. Observations on the Fishes of Nova Scotia and Labrador, in Boston Journal of Natural History, Vol. VI. 1850.

Perley. Catalogue of the Fishes of New Brunswick and Nova Scotia. Frederickton. 1837.

CLASS I. OSSEOUS FISHES.

Skeleton bony, the osseous matter being deposited in fibres. Sutures of the cranium distinct, with maxillary or intermaxillary bones, always one, and generally both, present. Gill-membrane with rays.

ORDER I. ACANTHOPTERYGII. SPINE-RAYED.

They are known by the spines which represent the first rays of the dorsal fin, or which alone sustain the anterior fin of the back, when they have two. Sometimes, instead of an anterior dorsal fin, they have nothing but a few free spines. Their anal fin has also some spines instead of the first rays, and there is, in general, one to each ventral.

FAMILY I. PERCIDÆ.

Comprehends fishes with an elongated body, covered with hard or rough scales, in which the operculum or preoperculum, and frequently both, have indented or spinous edges, and in which the jaws, the front of the vomer, and almost always the palatines, are furnished with teeth.

GENUS I. PERCA, Cuv.

Two dorsal fins distinct, separated; the rays of the first spinous; those of the second flexible; tongue smooth; teeth in both jaws, in front of the vomer, and on the palatine bones; preoperculum notched below, serrated on the posterior edge; operculum bony, ending in a flattened point directed backwards. Branchiostegous rays. Scales roughened, and not easily detached.

PERCA FLAVESCENS, *Cuv.*

The American Yellow Perch.

(PLATE II. FIG. 1)

Bodianus flavescens, Yellow Perch, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 421.
La Perche jaunatre d'Amérique, Perca flavescens, CUV. et VAL., Hist. Nat. des Poissons, II. p. 46.
Perca flavescens, American Perch, RICH., Fauna Boreal. Americ., III. p. 1, pl. 74.
" " *Common Perch of Massachusetts*, STORER, Massachusetts Report, p. 5.
Bodianus flavescens, Yellow Perch, KIRTLAND, Rep. on Zoöl. of Ohio, pp. 168, 190.
Perca flavescens, Yellow Perch, KIRTLAND, Bost. Journ. Nat. Hist., V. p. 337, pl. 27, fig. 2.
" " *American Yellow Perch*, DEKAY, N. Y. Report, p. 3, pl. 1, fig. 1.
" " AYRES, Bost. Journ. Nat. Hist., IV. p. 256.
" " *American Yellow Perch*, LINSLEY, Cat. of Fishes of Conn.
La Perche à opercules grenues, Perca serrato-granulata, CUV. et VAL., II. p. 47.
Perca serrato-granulata, GRIFFITH'S CUV., X. pl. 39, fig. 1.
" " DEKAY, N. Y. Report, p. 5, pl. 22, fig. 64.
" " *Common Perch*, THOMPSON, Hist. Vermont, p. 129.
La Perche à tête grenue, Perca granulata, CUV. et VAL., VII. p. 48, pl. 49.
Perca granulata, JARDINE, Nat. Lib., I. p. 92, pl. 1.
" " DEKAY, N. Y. Report, p. 5, pl. 48, fig. 220.
" " LINSLEY, Cat. of Fishes of Conn.
La Perche à museau pointu, Perca acuta, CUV. et VAL., II. p. 49, pl. 10.
Perca acuta, Sharp-nosed Perch, RICH., Fauna Boreal. Americ., III. p. 4.
" " " *Yellow Perch*, DEKAY, N. Y. Report, p. 6, pl. 68, fig. 222.
La Perche grêle, Perca gracilis, CUV. et VAL., II. p. 50.
Perca gracilis, RICH., Fauna Boreal. Americ., III. p. 4.
" " *Slender Yellow Perch*, DEKAY, N. Y. Report, p. 6.
Perca flavescens, STORER, Mem. of Amer. Acad., New Series, II. p. 269.
" " STORER, Synopsis, p. 17.
" " AGASSIZ, Lake Superior, p. 291.

Color. Above of a greenish-yellow; sides golden-yellow, crossed by seven transverse dark bands, all broader above than below, and those upon the middle of the body broadest. Abdomen white; lower jaw tinged with pink. Centre of operculum of a deep green. Head darker than rest of body. Pupils back; irides golden. Dorsal and caudal fins yellowish-brown; pectorals yellow; ventrals and anal a bright scarlet.

Description. The length of the head is less than one fourth of the entire length. Top of head broad and flattened; that portion of it between and in front of eyes is naked, and covered by a smooth membrane; the portion back of eyes is bony, and roughened by raised, radiating striæ. The preoperculum is scaled, and serrated along its entire edge, save a small portion of its superior posterior angle, which is naked and smooth. The operculum is a subtriangular bone, covered at its upper part by a few scales, but otherwise almost entirely scaleless, and exhibiting numerous raised lines diverging to its outer edge, which presents in some instances a few serrations, and terminates posteriorly in a sharp angle or spine. The subopercle is scaled above, naked beneath, and minutely denticulated along its edge. The scapulary bones are slightly corrugated by striæ. The humeral bones are strongly denticulated. Eyes of moderate size, preceded by several mucous pores. The anterior nostril much in advance of the posterior, which is the larger. The lateral line commences at the humeral bone, and, assuming the curve of the body, is continued to the base of the tail.

The first dorsal fin arises nearly on a line with the pectorals; its height is equal to one third of its length. The rays are very stout, their naked extremities projecting above the transparent membrane connecting them; fin rounded posteriorly. I have seen several specimens in which the fourth and sixth rays of this fin were about one half the height of the third and fifth rays, and the connecting membrane was continued directly above their extremities, as if they were absent. The membrane stretching from the last ray of the first dorsal fin extends to the first of the second dorsal.

The second dorsal is subquadrangular, rounded above; it is more than half the length of the first. The first ray is very minute, and, as well as the second, is spinous; the third ray is simple: all the soft rays are articulated.

The pectorals arise just beneath the humeral bone. They are quite long; fan-shaped; their rays are bifurcated and articulated.

The ventrals are subtriangular; they arise at a distance back of the pectorals equal to one third their height; their outer ray is a strong spine, the others are multifid.

The anal is higher than long, and arises about opposite the middle of the second dorsal; its first two rays are spinous, the first less than one half the height of the second.

The caudal is deeply emarginate.

The fin rays are as follows: — B. 7. D. 13. 2 - 13. P. 15. V. 1 - 5. A. 2 - 8. C. 18. Length 12 to 15 inches.

In this species, as in many others, I have represented two scales, one from the lateral line, and one from above it, whose characters will sufficiently distinguish them.

Remarks. This species is universally distributed throughout the State. In the spring and autumn, it is frequently found in the market, and is readily sold. When young, it usually swims in extensive shoals, while the larger ones remain in the deepest water, and by themselves. It does not take its food timidly, but seizes it instantly without nibbling. It is not only caught with the hook in summer, but also through the ice in winter, with pickerel, and in pretty large quantities in brooks while netting for alewives. Individuals are seldom taken which measure more than twelve or fifteen inches in length. Mr. Ayres has seen a specimen weighing two and a half pounds, and

Dekay has caught them weighing nearly three pounds. This species has been repeatedly transported from one pond to another with complete success. Dr. Mitchill transferred them a distance of forty miles.

It has been noticed in Maine, Massachusetts, STORER; New Hampshire, H. R. STORER; Vermont, THOMPSON; Connecticut, AYRES; New York, MITCHILL, DEKAY; Pennsylvania, HALDEMAN; Ohio, KIRTLAND; and in all the ponds and streams of the great lakes, RICHARDSON, AGASSIZ; New Brunswick and Nova Scotia, PERLEY.

GENUS II. LABRAX, Cuv.

Distinguished from the Perch by the scaly opercula, terminating with two spines, and by a tongue covered with prickles.

LABRAX LINEATUS, *Cuv.*

The Striped Bass.

(PLATE I. FIG. 4.)

Sciæna lineata, BLOCH, pl. 304.
Perca Mitchilli, *Striped Bass or Rock-fish*, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 413, pl. 3, fig. 4.
Rock Bass, MEASE, Trans. Lit. and Phil. Soc. of N. Y., I. p. 502.
Le Bar rayé (ou Rock-fish) des Etats-Unis, *Labrax lineatus*, CUV. et VAL., II. p. 79.
Labrax lineatus, GRIFFITH'S CUV. X. p. 103.
" " RICH., Fauna Boreal. Americ., III. p. 10.
" " STORER, Report, p. 7.
" " AYRES, Bost. Journ. Nat. Hist., IV. p 257.
" " DEKAY, N. Y. Report, p. 7, pl. 1, fig. 3.
" " LINSLEY, Cat. of Fishes of Conn.
" " STORER, Mem. of Amer. Acad., New Series, II. p. 273.
" " STORER, Synopsis, p. 21.

Color. The upper part of the body is silvery brown, with a greenish-blue tinge; the sides are lighter; the abdomen of a beautiful, clear silvery color; the opercula are more or less golden. Eight or more longitudinal black bands pass from behind the operculum towards the tail; the upper bands are lost just back of the termination of the second dorsal fin; the three or four central ones extend to the caudal fin; while the lower ones reach only the posterior portion of the anal, or are even lost anterior to that fin. Sometimes these bands are all entire; in other specimens, more or less of them are interrupted at intervals; while in others still, instead of being straight throughout, frequent undulations or curves are observed. It sometimes happens that all the bands on one side of the fish are perfect, while all on the other side of the same specimen are broken or irregular. Pupils black; irides golden.

Description. The form of this species is cylindrical. Length of head to entire length of fish is as 1 to 4. The scales on the body are large and quadrangular, less than one third of scale attached, marked by concentric lines upon their sides; numerous very delicate striæ diverge from the centre of the attached base to the entire extent of the free edge. Sixty-two scales along the lateral line; ten scales in an oblique line from the origin of the dorsal to the lateral line. The whole head is covered with scales, including the intermaxillary bones, save the suborbitar bones and the portion in front of and between the nostrils. The scales are largest on sides of body; smaller towards tail and on anterior back, smallest on top of head. The eyes are circular, their diameter equal to about one third the distance between them. The nostrils are situated anterior to eye, at a distance about equal to diameter of eye; the posterior is circular and the longer; the anterior is larger. The lower jaw is the longer. Teeth in jaws numerous and very small; the largest are at the middle of the upper jaw. Teeth upon the palatine bones. Tongue rough at its base and upon its sides, smooth in its centre. The *operculum* at its posterior angle is armed with two spinous processes, the lower of which is the larger and more acute; they are margined with a dark-colored membrane. The *preoperculum* at its posterior edge is very delicately and minutely serrated; these serrations are larger at its inferior margin.

The *lateral line*, which is very distinct, arises just above the superior spinous process of the operculum, and is continued in a straight course through the middle of one of the longitudinal bands, to the centre of the tail, upon the rays of which it is lost.

The first dorsal fin arises on a line with the posterior half of the pectorals; it is twice as long as high; the first ray is one sixth the height of the fourth and fifth, which are the longest rays in the fin.

The second dorsal is not as long as the first. The first ray is spinous; the second ray, which is the longest, is two thirds as high as the length of the fin.

The pectorals are situated just beneath the inferior spine of the operculum; their length to their height is as 1 to 5.

The ventrals are situated just back of the pectorals; their first ray is spinous, and three fifths as long as the second ray, which is the longest of the fin; the rays are multifid. They are of the same length as the pectorals.

The anal arises on a line with the middle of the second dorsal; its first three rays are spinous; the first of these is one fourth the height of the third. This fin is shorter than the second dorsal; it is one fifth longer than high.

The caudal at its base is equal in depth to the length of the pectorals; it is as wide again at its extremity, when expanded, as its depth at base. Fin quite deeply forked.

In each of the fins, the scales are more or less continued upon them.

The fin rays are as follows: — D. 9. 1 – 12. P. 18. V. 1 – 5. A. 3 – 11. C. 18. Length, 3 to 4 feet.

Remarks. This fine species is taken in considerable numbers upon our coast. It is generally found upon shoals near the land, where frequently a dozen or more may be seen at a time beneath the water, quietly lying upon the rocky bottom. Large quantities of small bass are caught with nets near Chelsea and Nantasket beaches. Captain Atwood writes me, that at Provincetown a few are caught in the summer with hook and line, by men standing upon the shore; and that in the months of September and October, when this fish is passing by, on its way to the South, large quantities are sometimes taken with nets, in the following manner. Several men put off from the Race in a boat, with a net from seventy to eighty fathoms long and from three to four fathoms deep; when the boat is at a short distance from shore, a line attached to the net is thrown ashore, and secured by some of the fishermen there in waiting, and a portion of the net is dragged from the boat. As soon as the fish are seen swimming along, near the bottom, the rest of the net is let out of the boat, which is now rowed ashore, while the other extremity of the net is drawn thither by the rest of the gang. In this way hundreds are taken at a haul; but as a large number of men is required, and considerable time is necessarily expended, this business is not very profitable, and is not attended to, unless it be at times of leisure from other pursuits. At Buzzard's Bay they are speared by torch-light to some extent, in the month of May.

In the winter, this species goes up into the rivers and arms of the sea. It is most common in Boston market in autumn and winter. At some seasons of the year it is taken in large numbers in seines, while at others the market is partially supplied by those taken with the hook, and consequently its price varies, from three to twelve cents per pound. It is most readily taken by the hook, when it is báited with the Squid (*Loligo illecebrosa*). The larger individuals feed voraciously upon this animal, and are hence called "Squid-hounds." The flesh of this species, particularly of the larger ones, is rather coarse, but meets with a ready sale when fresh. In 1836, a small number of barrels (67) was packed and inspected. Bass of considerable size are often taken in Boston harbor. In July, 1837, I saw a specimen weighing 36 pounds, which had been taken from one of the city bridges over Charles River; and I have been told that another, weighing 77 pounds, had been taken from the same bridge. The largest individual I have known to be taken by any of our fishermen weighed 84 pounds.

New Brunswick, Perley. Maine, New Hampshire, and Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Cuvier, Dekay.

LABRAX RUFUS, *Dekay.*

The White Perch.

(PLATE I. FIG. 1.)

Bodianus rufus, Red Perch, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 420.
Le petit Bar d'Amérique, Labrax mucranatus, CUV. et VAL., II. p. 86, pl. 121.
Labrax mucronatus, Small American Bass or *White Perch,* STORER, Report, p. 8.
Labrax rufus, Ruddy Bass, DEKAY, Report, p. 9, pl. 3, fig. 7.
Labrax mucronatus, AYRES, Bost. Journ. Nat. Hist., IV. p. 257.
" " *White Perch,* LINSLEY, Cat. of Fishes of Conn.
Labrax rufus, STORER, Mem. of Amer. Acad., New Series, II. p. 274.
" " STORER, Synopsis, p. 22.

Color. A silvery gray, darker above the lateral line. The sides and gill-covers exhibit metallic reflections. Lips, intermaxillaries, and tongue minutely dotted with black. Dorsals, pectorals, and caudal brown; ventrals and anal rose-colored at their base; throat also rosaceous. Pupils black; irides silvery.

Description. Body much compressed, a perceptible convexity in front of the first dorsal fin. The depth of the body across from the first dorsal is to the length about as $3\frac{1}{2}$ to 10. The length of the head to the whole length of the body is as 1 to 4. The gill-covers, intermaxillary bones, and the space between the eyes are scaled; the portion in front of the eyes and nostrils is naked. The eyes are circular; their diameter is to the distance between the eyes as 3 to 5. The nostrils are situated just in advance of the superior anterior angle of the eye; the posterior is oval, the larger, and placed obliquely, pointing backwards; the anterior is circular. The upper jaw is protractile; both jaws are armed with numerous very minute teeth. The tongue has a row of very delicate teeth upon its sides. The preoperculum is serrated posteriorly and inferiorly, the serrations upon the inferior edge being much the larger. The operculum has at its posterior edge a sharp spinous process, and above this, separated by an emargination, is an obtuse point.

The scales upon their exposed surface are covered with minute dots, like those of the lips and tongue; they are denticulated at their edge. Seven scales are found in an oblique line from the lateral line to the origin of the first dorsal fin. The lateral line, which is very distinct, commences just beneath the subscapular bone, and, rising a little at first, pursues nearly a straight course, from a line opposite the commencement of the first dorsal, to the tail, including 55 scales.

The first dorsal fin arises opposite the anterior half of the pectorals, and is entirely composed of spinous rays; the first of these is the shortest, and the fourth the longest; the fin is about half as long as high. The membrane of the last ray of this fin is continued to the base of the first ray of the second dorsal, which is nearly quadrangular, and is composed of soft rays, with the exception of the first, whose height is about two thirds that of the next. This fin is longer than high.

The pectorals are quite broad when expanded; in height they are equal to the length of the second dorsal.

The ventrals are just back of the pectorals; their height is equal to that of the pectorals.

The anal arises on a line with the fifth ray of the second dorsal. Its height and length are equal. It terminates on the same plane with the second dorsal. The second spinous ray is very stout.

The caudal is considerably emarginated; the depth at its base is equal to half the depth of extremity when expanded.

The fin rays are as follows: — D. 9. 1 – 12. P. 15. V. 1 – 5. A. 3 – 9. C. $17\frac{3}{3}$. Length 12 to 15 inches.

Remarks. This species is brought to Boston market in the spring and autumn, from the mouths of the neighboring rivers, and the ponds to which the sea has access.

By the fishermen it is known as the "White Perch." Its usual weight is about half a pound. December 12th, 1837, I saw a specimen in Boston market which measured fifteen inches in length, and weighed one pound and three quarters, and its stomach contained a specimen of the shiner, *Leuciscus chrysoleucas*, more than five inches long.

Found in New Brunswick, Perley; Maine, Massachusetts, Storer; Connecticut, Ayres, Linsley; New York, Mitchill, Cuvier, Dekay; South Carolina, Dekay.

Although the *Labrax pallidus* of Dekay was introduced in my "Synopsis" as belonging to this State, I am inclined to think the two species above described to be the only ones we possess; and that perhaps the *pallidus* and *rufus* may prove to be one and the same.

GENUS III. CENTROPRISTES, Cuv.

A single dorsal fin; branchiostegous rays seven; all the teeth small and crowded; no canines. Their preoperculum is dentated, and the operculum spinous.

Centropristes varius, *Storer.*

The Black Sea-Bass or Perch.

(Plate II. Fig. 4.)

Perca varia, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 415, pl. 3, fig. 6.
Centropristes nigricans, Griffith's Cuv., x. p. 117.
Le Centropriste noir, Centropristes nigricans, Cuv. et Val., iii. pp. 37, 44.

Centropristes nigricans, Règne Animal, ed. VAL., pl. 9, *a*, fig. 1.
" " *Black Perch*, *Black Sea-Bass*, STORER, Report, p. 9.
" " *Black Sea-Bass*, DEKAY, Report, p. 24, pl. 11, fig. 5.
" " LINSLEY, Cat. of Fishes of Conn.
" " STORER, Mem. Amer. Acad., New Series, II. p. 287.
" " STORER, Synopsis, p. 35.
(*Lutjanus trilobus*, LACÉP.?)

Color. Of a dark brown, almost black, above; lighter beneath; of the head, sea or bronze green. In some specimens, after death, there is a greenish tinge upon the abdomen, and a bluish one upon the top and back of head. The dorsal and anal fins are white; the former crossed by black bars, the latter marked by fuliginous blotches. The pectorals are of a leaden color, varied with dark brown; the membrane of the ventrals is white, while the rays are nearly black.

Description. Body elongated, compressed; convex in front of the dorsal fin. Greatest depth of body equal to one fourth the length of the fish. Length of head to the posterior angle of the operculum equal to rather more than one third the length of the fish. Head, between and in front of eyes, without scales. Scales upon the sides of the body large; small upon the preopercle, and at the base of the tail. Eyes of moderate size. Nostrils double, situated just anterior to the superior anterior angle of the eyes; the anterior is tubular; the posterior much the larger. Jaws equal in length, armed with a great number of minute, sharp, card-like teeth; upper jaw protractile. Lips fleshy. The whole posterior edge of the preoperculum is denticulated; the inferior edge is serrated. A flat, sharp spine is situated at the posterior angle of the operculum, below which is a broad, fleshy elongation projecting beyond it, the posterior portion of which is destitute of scales. By the union of the opercle and interopercle, a slight notch is produced. Humeral bone denticulated. The lateral line, which is of a dark color, arises at the lower edge of the humeral bone, and assumes the curve of the body.

The dorsal fin arises on a line with the base of the pectorals; its first ten rays are spinous. At the posterior portion of each of these spines, suspended from the upper edge of the connecting membrane, is a small fleshy tentacle. The first ray is shortest, the fourth longest. The eleven fleshy rays are higher than the spinous ones, articulated and bifid; this portion extends farther back than the anal fin.

The pectorals arise just below the fleshy projection of the operculum; they are fan-shaped, quite broad when expanded, and rounded posteriorly.

The ventrals are just in front of the pectorals; the middle rays are longest; their length equal to that of the pectorals.

The anal fin commences back of the soft rays of the dorsal; the first three rays are spinous. Fin higher than long.

The caudal is slightly convex at its centre, and its upper portion projects beyond the lower. It is scaled quite high upon its rays, which are bifid and articulated.

The fin rays are as follows: — D. 10 – 11. P. 17 or 18. V. 1 – 5. A. 3 – 7. C. 17 or 18. Length about one foot.

Remarks. This species, which is known among our fishermen as the "Black Bass" and "Black Fish," is taken in large numbers in the months of May, June, and July at Holmes's Hole, and carried to the New York market, where it is considered one of the most valuable fishes, and meets with a ready sale. While visiting Gay-Head in August, 1846, I learned that this species had become much less abundant there than formerly. Thirty years since, it was not an uncommon circumstance for sixty sail of vessels to be fishing about Gay-Head at a time. And even fifteen years ago, this species was quite numerous; but several years since it disappeared almost entirely. They are beginning to reappear again within the last two or three years, but are quite small. They are taken about ledges in deep water, and weigh from five to eight pounds. They seldom wander into Massachusetts Bay; the few that are met with in Boston market are brought from New Bedford. July 1st, 1846, a specimen was taken at Nahant.

Massachusetts, Storer. New York to Florida, Dekay.

This is evidently Mitchill's *Perca varia*, and I have therefore retained his specific name.

GENUS IV. POMOTIS, Cuv.

A few denticulations, more or less obvious, on the borders of the preoperculum. Palatines and tongue smooth, and without teeth. Minute teeth on the jaws, vomer, and pharyngeals. Branchial rays, six. A membranous elongation at the angle of the operculum.

Pomotis vulgaris, *Cuv.*

The Bream.

(Plate III. Fig. 1.)

Le Pomotis Commun, *Pomotis vulgaris*, Cuv. et Val., iii. p. 91, pl. 49, et vii. p. 465.
Pomotis vulgaris, Règne Animal, ed. Val., pl. 10, fig. 3.
" " *Northern Pomotis*, Rich., Fauna Boreal. Americ., iii. p. 24, pl. 76.
" " Jardine, Nat. Lib., i. p. 162.
" " *Fresh-water Sun-fish*, *Pond Perch*, *Bream*, Storer, Report, p. 11.
" " Ayres, Bost. Journ. Nat. Hist., iv. p. 258.
" " *Sun-fish*, *Roach*, Kirtland, Report on Zoöl. of Ohio, p. 191.
" " *Harlequin Roach*, Kirtland, Bost. Journ. Nat. Hist., iii. p. 470, pl. 28, fig. 2.
" " Thompson, History of Vermont, p. 130.
" " *Common Pond-fish*, Dekay, Report, p. 31, pl. 51, fig. 166.
" " Linsley, Cat. of Fishes of Conn.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 292.
" " Storer, Synopsis, p. 40.
" " Agassiz, Lake Superior, p. 293.

Color. Greenish-brown above, with irregularly distributed rusty blotches; in some specimens a certain regularity is observed in the arrangement of these blotches, producing longitudinal bands along the sides. Beautiful, undulating, longitudinal deep-blue lines across gill-covers. Opercular membrane black, with a bright scarlet blotch at its posterior portion. Abdomen whitish. Dorsal, anal, and caudal fins dark brown. Ventrals and pectorals yellowish.

Description. Body compressed, oval. The back curves very gradually as far as the posterior extremity of the dorsal fin, then abruptly gives place to the fleshy portion of the tail. Head less than one fourth the length of the body. Eyes large, circular. Nostrils double, the anterior tubular. Mouth small; teeth very minute and sharp. The edge of the preopercle very finely denticulated. The lateral line arises at the upper posterior edge of the operculum, and, assuming the curve of the body, is lost at the base of the caudal rays. Scales upon the body large, dentated at their bases; those at the base of the fins, small.

The soft portion of the dorsal fin is highest and rounded posteriorly. The extremities of the spines of the anterior portion of this fin project above the connecting membrane; attached to them are small tubercles. The first dorsal spine is shortest; the fourth and fifth spines are the longest.

The pectorals are long, when extended reaching the soft portion of the dorsal fin.

The anal terminates on a line with the dorsal.

The caudal is emarginate.

The fin rays are as follows: — D. 10 – 12. P. 13. V. 1 – 5. A. 3 – 10. C. 17.
Length rarely exceeds eight inches.

Remarks. As Agassiz, in his work on Lake Superior, considers our species as distinct from that which is known in the Southern States by the same scientific name, I have omitted several references in my list of synonymes which were retained in my "Synopsis." It is a common species in the ponds of the various portions of the State, and is taken with the *Perca flavescens*, *Leuciscus chrysoleucas*, *Esox reticulatus*, &c. By many it is considered a very sweet fish, although it is but seldom brought to market. It is known by the names of "Bream," "Ruff," "Pumpkin-seeds," and "Kivers."

They build circular nests by removing the weeds from the bottom, and excavating the sand or gravel to so great an extent that they are often two feet in width and a half foot in depth. They are commonly placed near each other, and sometimes in so shallow water that the usual falling of the river in summer will leave them dry. In this way, besides the ordinary chance of falling a prey to the appetite of other fishes, a large proportion of the species is yearly destroyed. In its care of the nest, it is very assiduous, and at this time it can be not only closely observed, but sometimes even handled, without its deserting its charge.

New Brunswick, Perley. Massachusetts, Storer. Vermont, Thompson. Connecticut, Ayres, Linsley. New Hampshire, H. R. Storer. New York, Mitchill, Dekay. Ohio, Kirtland. Kentucky, Raf. The Great Canadian Lakes, Richardson.

Pomotis appendix, *Dekay.*

The Red-tailed Bream.

(Plate III. Fig. 4.)

Labrus appendix, Black-eared Pond fish, Mitchill, Supp. to Amer. Month. Mag., II. p. 247.
Pomotis appendix, Dekay, Report, p. 32.
" " Linsley, Cat. of Fishes of Conn.
Pomotis rubri-cauda, Red-tailed Pomotis, Storer, Bost. Journ. Nat. Hist., IV. p. 177.
" " Linsley, Cat. of Fishes of Conn.
Pomotis appendix, Storer, Mem. Amer. Acad., New Series, II. p. 294.
" " Storer, Synopsis, p. 42.

Color. When alive, of a general rusty brown, or in some specimens golden brown, more strongly marked above the middle of the body by ferruginous spots being densely distributed along the scales; these spots are more sparse and more distinct below the lateral line; the body, beneath and in front of the ventral fins, of a blood-red color; the throat is bluish-white. A bluish-white undulating line runs from the upper jaw just beneath the eye, across the operculum and beneath the opercular membrane to its posterior extremity; a second line of a similar character arises just above this, and, interrupted by the eye, again commences back of it, and passes over the opercular membrane; so that the membranous appendage of the operculum, which is broad, rounded posteriorly, and of a uniform black color, is between these lines. Beneath the undulating lines just spoken of are bluish-white blotches irregularly distributed upon the preoperculum, some of them passing downwards towards its lower edge. Pupils black, irides red. The dorsal fin is anteriorly of a dark-brown color; its posterior membranous portion is red. The ventrals are red at their base and black at extremities. The pectorals are of a yellowish-brown color. The anal is yellowish at its base and fuliginous at its margin. The caudal is of a blood-red color. After death, the body becomes of a bluish-gray color; the abdomen changes to orange; the extremities of the ventrals are purple; and the tail is rust-colored, livid posteriorly.

Description. Length of head, including the opercular membrane, equal to about one third the length of the body; greatest depth of fish, exclusive of the dorsal and anal fins, equal to more than one third the length of the body. The head, between and in front of the eyes, is naked. The eyes are circular; their diameter less than the distance between them. Gape of mouth large. The posterior nostril is the longer. The lateral line commences above, and in front of, the base of the opercular membrane, and assumes the arch of the body.

The dorsal fin commences above the posterior portion of the opercular membrane; its first and second spines are the shortest; the membranous portion is rounded above and posteriorly.

The pectorals are broad and rounded.

The rays of the ventrals are multifid.

The soft portion of the anal is rounded along its entire margin.

The caudal fin is somewhat emarginated.

The fin rays are as follows: — D. 10 to 11 – 9 to 11. P. 11 to 12. V. 1 – 5. A. 3 – 9 to 10. C. 18. Length about six inches.

Remarks. The specimens I have seen of this species were sent me from Concord, by Mr. Edward S. Hoar; they were taken with *P. vulgaris.* Although Mitchill, in his description of the *Labrus appendix,* makes no mention of the color of the fins, which is a striking character, it agrees in other particulars so nearly with the species before me, that I cannot but think they are identical; and therefore suppress here, as I have previously done in my Synopsis, my specific name of "*rubri-cauda.*"

Massachusetts, Storer. New York, Mitchill.

The Genus *Sphyræna,* which has usually been included in the Family *Percidæ,* will be introduced hereafter in a different group.

FAMILY II. TRIGLIDÆ.

Contains a numerous series of fish, to which the singular appearance of their head, variously bristled and covered with armor, gives a peculiar physiognomy. Their general character consists in having the suborbitar bone more or less extended over the cheek, and articulated behind with the preoperculum.

GENUS I. PRIONOTUS, Cuv.

Pectorals very large, with numerous rays. A band of even teeth on the palatines.

PRIONOTUS LINEATUS, *Dekay.*

The Banded Gurnard.

(PLATE V. FIG. 4.)

Trigla lineata, *Gurnard* or *Sea-Robin*, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 430, pl. 4, fig. 4.
Le Prionote strié, *Prionotus strigatus*, CUV. et VAL., IV. p. 86.
Prionotus strigatus, Règne Animal, ed. VAL , pl. 20, fig. 2.
" " *Sea-Robin*, *Gurnard*, *Grunter*, STORER, Report, p. 12.
" " AYRES, Bost. Journ. Nat. Hist., IV. p. 258.
" " LINSLEY, Cat. of Fishes of Conn.
Prionotus lineatus, *Banded Gurnard*, DEKAY, Report, p. 45, pl. 4, fig. 12.
" " STORER, Mem. Amer. Acad., New Series, II. p. 302.
" " STORER, Synopsis, p. 50.

Color. The recent specimen is of a reddish-brown color above, and the entire surface, including the head, is covered with numerous black dots. The gill-covers and intermaxillaries in some specimens are orange. The dead fish is of a slate-color above the lateral line, with a few black dots irregularly distributed over its surface, the sides are lighter, with a reddish tint ; abdomen white. Beneath the lateral line, and parallel to it, runs a broader brownish line, which arises under the humeral spine ; this line is broken at its posterior extremity with interrupted points or spots. Beneath the anterior portion of this line are several broken brown bands. The first dorsal fin is of a light reddish tint, with a black blotch upon the upper portion of the membrane between the fourth and fifth, or third, fourth, and fifth rays. The anterior edge of the first three rays barred with black. The second dorsal is reddish. The pectorals are fuliginous beneath and reddish above ; fuliginous also in centre of upper portion, with numerous transverse black lines, which are more obvious at the base of the fin. The ventrals are white.

Description. Head broader than the body ; its length rather less than one third the length of the fish ; its depth equal to more than half its length, and made up of seven distinct bony plates, which form a perfect helmet of defence. The whole upper part of the head, the occiput, the space between the eyes, and the portion anterior to the snout, are composed of one plate ; this portion is roughened throughout its whole extent by irregular corrugations, and terminates posteriorly in two strong, very acute spines ; at the upper anterior and posterior angles of the eyes, minute spines are also observed. This plate is emarginated anteriorly, deeply truncated posteriorly. The operculum is a distinct plate, of an irregularly triangular form, having two spines at its posterior extremity ; the lower larger and pointing directly back, the upper pointing obliquely upwards ; this plate is covered with elevated striæ radiating from the anterior portion towards the circumference, and is separated from the preopercle by a membrane, which renders it movable; its margin is bordered by a wide membrane. The preoperculum is rather small and is triangular, slightly movable, and divided at its lower portion by a horizontal, serrated, bony ridge, which terminates posteriorly in a naked spine; beneath this ridge, the inferior portion is corrugated and granulated; from the base of the preopercle, radii diverge to its upper portion. Suborbitar bones roughened like the top of the head; cheek-bones covered with elevated striæ, slightly serrated upon their whole lower margin, and strongly serrated anteriorly on each side of the snout. A strong ridge upon the humeral bone, serrated on its under edge, terminating in a naked spine. All the spines upon the head are much more acute in young specimens. In front of the emargination of the frontal bony plate is a naked membranous portion, equal in width to the distance between the eyes; in this space, half way between the eyes and the extremity of the snout, are situated the nostrils, the posterior of which is the larger. Eyes oblong; longest diameter equal to the distance between the eyes. Jaws armed with numerous, small, card-like teeth; upper jaw projecting beyond the lower. Tongue colorless, fleshy. The lateral line arises above the posterior angle of the operculum, and, curving slightly downwards to a line opposite the space between the dorsal fins, thence pursues a straight course to the tail.

The first dorsal fin is situated in a groove which partially receives it when closed, and arises just back of a line with the termination of the occipital spines; it is longer than high. Its first ray is spinous, and serrated upon its entire anterior edge; the second and third rays are serrated at their upper anterior portion; the third and fourth rays are the longest. It is composed of ten spinous rays; the three posterior are exceedingly small, and look like isolated spines, between the fins.

The second dorsal is one third longer than high; its rays are bifid, and their tips slightly project beyond the connecting membrane.

The pectorals are very broad when expanded, and are one third the length of the body. On a line with the base of the pectorals, beneath them, are three fleshy appendages, somewhat similar in their appearance to the fin rays, though larger, and of equal size throughout their entire length; the upper, which is the longest, is equal to half the length of the pectorals.

The ventrals are situated beneath the base of the pectorals; their longest rays are equal to two thirds the length of the pectorals; the connecting membrane is emarginated between the tips of the rays. The first ray is spinous, and shorter than the others.

The anal fin arises back of, and terminates posteriorly to, the second dorsal, which fin it equals in length.

The caudal is composed of stout articulated rays, and is nearly straight at its extremity.

The fin rays are as follows: — D. 9 to 10 – 12 to 13. P. 12 to 13. V. 6. A. 10. C. $12\frac{4}{4}$. Length, a foot to 18 inches.

Remarks. This pretty species, which is much more common than the *P. Carolinus*, is frequently taken in the Vineyard Sound while fishing for Scapaug (*P. argyrops*), but is not used as an article of food.

Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Cuvier, Dekay.

Prionotus palmipes, *Storer.*

The Web-fingered Gurnard.

(Plate V. Fig. 1.)

Trigla Carolina, Lin., p. 528, Cuv. et Val.
Trigla palmipes, *Web-fingered Gurnard*, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 431, pl. 4, fig. 5.
Le Prionote de la Caroline, *Prionotus Carolinus*, Cuv. et Val., iv. p. 90.
Prionotus Carolinus, *Web-fingered Grunter*, Storer, Report, p. 14.
" " Ayres, Bost. Journ. Nat. Hist., iv. p 258.
" " *Web-fingered Gurnard*, Dekay, N. Y. Report, p. 46, pl. 5, fig. 15.
" " Linsley, Cat. of Fishes of Conn.
" " Storer, Mem. of Amer. Acad., New Series, ii. p. 303.
" " Storer, Synopsis, p. 51.

Color. When first taken, the body above is of a reddish-brown color, with irregular blotches and shadings of a darker brown appearing like indistinct transverse white bands across the dorsum; beneath nearly white. Branchial membrane fuliginous; margined anteriorly and posteriorly with white. The connecting membrane of the first dorsal is transparent, slightly dusky, marked by oblique white lines, and has a large dark-brown spot, the greater portion of which is between the fourth and fifth rays; in young specimens this spot is confined *entirely* to the space between the fourth and fifth spines. The second dorsal is of a dull white color, marked by interrupted longitudinal orange bands. The pectorals are reddish-brown above, slate-colored beneath, with the exception of the two posterior rays, which are white. The pectoral appendages are reddish-brown at their base, and orange at extremities. The ventrals are reddish-white above, white beneath. The anal is of the same general color as the second dorsal.

Description. Length of head rather less than one fourth the length of the entire fish; width of head more than half its length. The armature of the head is very similar to that of *P. lineatus*, and yet there are striking differences; the several bones are less deeply furrowed and ridged, appearing more like shagreen ; at the anterior angle of the eye are three distinct spines. The occipital spines are not so acute as in *P. lineatus*, but are the terminations of carinæ in two arrow-shaped plates of bone ; in *P. lineatus*, there is a small spine at the posterior angle of the eye ; in this species are two elevated ridges which run posteriorly ; these ridges are not prominent in the immature fish. Nostrils of moderate size ; the anterior the larger. Eyes high up on the head. Sides of snout strongly serrated. Jaws armed with numerous card-like teeth ; the upper jaw the longer. The lateral line, arising between the occipital spine and the posterior superior edge of the operculum, is very indistinct throughout its whole course, but more so at its origin, and is continued in a straight line to the middle of the base of the tail.

The first dorsal fin is situated in a deep groove. The whole anterior edge of the first three rays is serrated, and the upper portion of the fourth.

The second dorsal is nearly straight upon its margin.

The pectorals are large, broad, rounded, and about one third the length of the body. Just in front of and beneath the pectorals are three fleshy appendages, widened at extremities ; the posterior the largest. The anal commences just back of, and terminates upon the same plane with, the second dorsal.

The caudal is lunated.

The fin rays are as follows : — D. 9 or 10 - 13. P. 13 or 14. V. 6. A. 12. C. $12\frac{4}{4}$. Length 15 to 18 inches.

Remarks. This species is much more rare than the *P. lineatus.* It was well described by Mitchill, who makes no mention of its infrequency in the waters of New York ; but Dekay remarks, that in the course of twenty years he had not met with more than six or eight specimens. As one of its names implies, it is a Southern species. Individuals are not unfrequently taken in the Vineyard Sound, during the entire summer, while fishing for Tautog. It is caught in deeper water than *P. lineatus.* Dr. Yale informed me that he had eaten this species, which, when skinned and boiled, is quite palatable. Occasionally this species is captured north of Cape Cod. In September, 1840, I received from Captain Nathaniel Blanchard of Lynn a specimen twelve inches in length, taken in a net at Green Island ; and Henry Sheafe, Esq., of this city, the next year sent the Boston Society of Natural History two specimens which were captured at Phillips's Point, Lynn. I have also seen two or three other individuals in the market, which have been caught in Massachusetts Bay. The specimen here described is the largest of those I had the good fortune to procure while on a visit at Tisbury, in August, 1846. Mr. Ayres, in his enumeration of the Fishes of Brookhaven, L. I., contained in the fourth volume of the "Boston Journal of Natural History," when speaking of this species, says: "When at rest, they lie on the bottom, with their broad pectorals sometimes spread and sometimes closed; in swimming, however, the pectorals are closed and flat upon the body. If alarmed by the approach of a boat or any other object, they bury themselves so completely in the sand, that a very close observation is necessary to detect them. This concealment is effected by a rapid lateral movement of the body, which displaces the sand from beneath, and causes it to fall upon their sides and back, covering them entirely, except the eyes and top of the head. Probably they often resort to this manœuvre when approached by the large fish which feed upon them."

Massachusetts, STORER. Connecticut, AYRES. New York, MITCHILL, CUVIER, DEKAY. Carolina, CUVIER.

Although this species was supposed by Cuvier to be the *Trigla Carolina* of Linnæus, I am compelled to reject his specific name, as his description is altogether too indefinite to identify the fish. He makes no mention of the characteristic palmation of the pectoral appendages.

PRIONOTUS PILATUS, *Storer*.

(PLATE VI. FIG. 1.)

Prionotus pilatus, STORER, Proceedings of Bost. Soc. of Nat. Hist., II. p. 77, 1845.
" " STORER, Mem. of Amer. Acad., New Series, II. p. 522.
" " STORER, Synopsis, p. 270.

Color. Upper part of body a reddish-brown; head a lighter red; body beneath yellowish-white; throat color of pectorals; pectorals dark blue; ventrals color of abdomen. First dorsal fuliginous, crossed by two transverse white lines, one near its base, and the other through its centre; the upper membranous portion between the fourth and fifth rays is marked by a large black blotch. The second dorsal of the same color as the first, with undulating whitish lines crossing the connecting membrane from its base to its margin, presenting a marbled appearance. Anal fin of a dirty white color. Caudal fin colored like the pectorals, but rather lighter.

Description. Body oblong, cylindrical. Head one fourth the length of the body; depth of head nearly equal to two thirds its length. Width of snout equal to nearly twice the distance between the eyes. Eyes moderate, oblong, their longest diameter equal to one sixth the length of the head. Nostrils small, nearer to the tip of the snout than to the eyes. Jaws, palatines, and pharyngeals armed with numerous small, card-like teeth. Upper jaw the longer.

The lateral line commences just beneath the occipital spine, and pursues nearly a straight course to the caudal fin.

The first dorsal arises between the posterior projections of the occiput; the first spinous ray is serrated throughout its entire anterior portion; the second is serrated only on its right side; the third only on its left; the remaining rays are smooth; the third and fourth rays are longest. Fin one half as high as long.

The second dorsal rather more than a third as long as the first dorsal; its rays are bifid and slightly projecting at their extremities.

The pectorals when expanded are equal in their depth to one half their length.

Anterior to and beneath the pectorals are three fleshy appendages, tapering at their extremities, the anterior two thirds the height of the posterior.

The longest rays of the ventrals are nearly two thirds as long as the pectorals; the anterior ray is short and spinous, the other rays are multifid at their extremities.

The anal fin commences on a line just back of the second dorsal, and terminates opposite the extremity of that fin.

Caudal fin deeply emarginated; the outer rays projecting beyond the others.

The fin rays are as follows: — D. 10 – 13. P. 13. V. 6. A. 12. C. $12\frac{4}{4}$.

I have seen but one specimen of this species, which was taken in Massachusetts Bay.

Massachusetts, Storer.

In the "Proceedings of the Boston Society of Natural History," Vol. II. p. 77, I stated that the *Prionotus punctatus* had been found in our waters. Thinking it possible I may have been mistaken, and that the specimen belonging to the Boston Society of Natural History was not taken in Massachusetts Bay, as it was said to have been, I prefer not to admit it in this communication.

GENUS II. DACTYLOPTERUS, Lacép.

The rays under the pectorals are numerous and large; and instead of being free, as in the preceding genera, they are united by a membrane into a supernumerary fin, larger than the fish itself, and which supports it in the air for some length of time. The muzzle, which is very short, appears to be cleft like the lips of a hare; the mouth is situated beneath; there are, in the jaws only, certain rounded teeth, arranged like pavement; the head is flat, rectangular, and granulated; the preoperculum is terminated by a long and strong spine. All the scales are carinated.

DACTYLOPTERUS VOLITANS, *Cuv.*

The Sea-Swallow.

(PLATE VI. FIG. 5.)

Trigla volitans, *Flying Gurnard*, L., SHAW'S Gen. Zoöl., IV. p. 622, pl. 91.
Morcielago, PARRA, p. 25, pl. 14.
Polynemus sex-radiatus, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. pl. 4, fig. 10.
" " MITCHILL, Supp. Amer. Month. Mag., II. p. 323 (?).
Le Dactyloptère commun, *Dactylopterus volitans*, CUV. et VAL., IV. p. 117.
Dactylopterus volitans, GRIFFITH'S CUV., X. p. 138.
" " RICH., Fauna Boreal. Americ., III. p. 40.
" " WILSON, Encycl. Brit., art. Ichthyology, p. 173.
" " *Sea-Swallow*, DEKAY, Report, p. 49, pl. 17, fig. 46.
" " LINSLEY, Cat. of Fishes of Conn.
" " STORER, Mem. Amer. Acad., New Series, II. p. 304.
" " STORER, Synopsis, p. 52.
" " *Bat-fish*, SCHOMBURGK, Hist. of Barbados, p. 667.

Color. The specimen now described is of a slate-color above, with indistinct darker blotches; top of head darker than back; upper jaw yellowish-white, with several dark-brown spots beneath the eyes. Abdomen yellow. Dorsal fin white, banded with brown; pectorals dull brown, irregularly spotted with darker blotches, lighter beneath, white at their inferior base; caudal yellowish, transversely banded with black.

My specimen, however, having been preserved in spirits, and its colors consequently being in a great measure destroyed, I shall avail myself of this portion of Dr. Dekay's description: "Light brown above, (darker on the summit of head,) with irregular darker spots. Sides silvery with flesh-color, which latter is predominant beneath. Dorsals gray, with brown spots on the membrane of the first, and the rays of the second annulated alternately with brown and lighter. The posterior pectorals blackish, with bluish iridescent spots; the anterior dark brown varied with black. Ventrals and anal flesh-colored. Caudal light brown, with irregular brownish bands."

Description. Body cylindrical anterior to vent; abdomen flattened posterior to vent; sides compressed at posterior extremities. Head flattened above. Back and sides covered with rows of fixed raised scales; the six or eight rows upon the sides are most elevated, sharp with minutely denticulated edges, and their summit with more marked denticulations. There are fifteen rows of scales, passing longitudinally on the sides, between the origin of the second dorsal and the abdomen. Posterior to the second dorsal, these rows are less marked than anterior to it; the rows back of the head and beneath the pectorals are much more numerous than posteriorly; these gradually approximate, and, as it were running into each other, are for the most part lost, so that at the termination of the second dorsal fin there remain but about twelve rows, and at the fleshy portion of the tail but four; two of these elevated, bounding the edge of the back and abdomen, and the others, much less raised, between them.

The length of the head to the termination of the subscapular spine equal to more than one third the entire length of the fish. Head above bony, very broad, granulated throughout, deeply emarginated behind, concave between the eyes, and terminating posteriorly on each side in very pointed subscapular bones, which have an elevated ridge passing through their centres. Suborbitar bones emarginated posteriorly; their posterior superior angle passing upward and backward to the centre of the orbit of the eye; their posterior inferior angle is continued backward in a sharp point to the preoperculum; the inferior edge of this inferior portion is slightly denticulated, the teeth looking forward.

A branch of the preoperculum marked with vertical striæ passes upward above the termination of the posterior superior angle of the suborbitar bone; its posterior angle terminates in a long spine, which passes backward to the posterior half of the subscapular bone; this spine is strongly serrated upon its outer edge, denticulated upon its lower edge, and granulated along its base. The operculum small, triangular, scaled. The eyes are large and circular. The nostrils are double, and of nearly equal size; the anterior and inferior is tubular. The mouth is small; the lips are fleshy. The lower jaw is the shorter. Both jaws armed with several rows of small conical teeth; minute teeth exist also in the pharynx. Snout blunted.

Just anterior to the spinous rays of the first dorsal, and higher than they, are two membranous rays opposite to each other and connected at their bases.

The first dorsal is of a triangular form, the posterior rays being higher than the first. This fin, when closed, is received into a groove.

Between the first and second dorsal fins is a short, stout, triangular spine. Directly back of this spine arises the second dorsal, which is quadrangular, and has its rays connected together by an exceedingly delicate membrane. Its six anterior rays are simple.

The pectorals are very broad when expanded; and reach, when closed, the fleshy portion of the caudal fin. The shortest rays are the six which are separated at the anterior portion from the fin, save at the base, where they are connected to it by a membrane. The central rays of this fin are the longest.

The ventrals are beneath the pectorals; their height is about equal to that of the first six rays of the pectorals; the third and fourth rays are the longest.

The anal is situated beneath the second dorsal.

The caudal is deeply concave; with two elevated scales, looking like finlets, approximating each other at its base.

The fin rays are as follows: — D. 2 – 4 – 1 – 8. P. 30 – 6. V. 1 – 4. A. 6. C. $10\frac{4}{4}$. Length about 6 inches.

Remarks. The accompanying description and figure are prepared from a specimen sent me by Dr. Yale from Holmes's Hole; it is the only individual I have seen.

This species was very well described by Dr. Mitchill in his supplement to his fishes in "The American Monthly Magazine and Critical Review," and still better by Dekay in his New York Report.

Newfoundland, Cuvier. Massachusetts, Storer. Connecticut, Linsley. New York, Mitchill, Dekay. Gulf of Mexico, Parra. Caribbean Sea, Cuvier, Schomburgk.

GENUS III. COTTUS,* Artedi.

Inhabiting only fresh water. But one small spine at the angle of preoperculum; sometimes another still smaller, always hidden under the skin and perceptible to the touch only, at the lower margin of the suboperculum. Head very depressed, more or less truncated in front, generally broader than high, but always very uniform, being scarcely detached from the body unless by its more considerable breadth. Second dorsal always higher than first. Ventrals with three or four soft rays. Lateral line usually interrupted.

Cottus gracilis, *Heckel.*

The River Bull-head.

(Plate IV. Fig. 3.)

Uranidea quiescens, Little Star-gazer, Dekay's Report, p. 61, pl. v. fig. 914.
Cottus gobio, Ayres, Bost. Journ. Nat. Hist., v. p. 121, pl. xi.
" " Storer, Synopsis, p. 52.
Cottus gracilis, Heck., Girard, Proceedings of Bost. Soc. Nat. Hist., iii. p. 189.

Color. Light green mottled with irregular dark-brown blotches, which are larger on the posterior part of the body.

Description. Length of the head about one fifth that of the body; much broader than the body; flattened above back of the eyes. Preoperculum armed at its posterior superior angle with a sharp spine curving upwards, and below this upon its edge

* The genus Cottus has heretofore been composed of two separate groups, consisting of fluviatile and marine species. Mr. Girard, after having devoted much attention to the subject, has formed from these two distinct genera, and gives as his reason for not accepting Dekay's Uranidea, that, according to the principles of nomenclature, Cottus must be retained for the fresh-water group, having been at first applied to them. It remains, however, to be seen whether these changes will be accepted by succeeding ichthyologists.

with another very minute spine. Eyes prominent, obliquely oblong. Jaws equal, with numerous exceedingly minute teeth. Gape of mouth moderate.

Lateral line commences at the superior posterior angle of the operculum, and is continued in a straight line to just below the extremity of the second dorsal fin, where it curves, and ends at the centre of the caudal rays.

The first dorsal fin arises just back of the origin of the pectorals; its length is equal to about one third that of the second dorsal.

The second dorsal, which arises directly back of the first, is of equal height throughout, a little higher than the first dorsal, and is of a quadrangular form.

The pectorals are broad, higher than the length of the head.

The ventrals are composed of three rays of nearly equal length, and united at their base.

The anal fin commences back of the second dorsal, and terminates anterior to the termination of that fin.

The caudal fin is about the length of the head, and is straight at its extremity.

The fin rays are as follows: — D. 8 – 7. P. 14. V. 3. A. 12. C. 12. Length of fish $2\frac{1}{2}$ inches.

Remarks. The individual from which my description has been drawn up was sent me from Shirley, by Dr. C. D. Dowse.

Mr. Horatio R. Storer caught two specimens near the source of the Saco River, in the town of Bartlett, New Hampshire, among the White Mountains, where the water was about three inches deep. When first seen they were lying under little stones, with the head and expanded pectoral fins alone visible, and so motionless that he would have overlooked them, had he not been carefully examining the bottom in search of salamanders. When disturbed, they immediately darted under the stones, and were only secured by cautiously placing the hand before them so that they could not escape, on which they would dart directly into it. On account of their viscid secretion, they are retained by the hand with difficulty.

Massachusetts, Storer. New York, Dekay. Connecticut, Ayres. New Hampshire, H. R. Storer.

GENUS IV. ACANTHOCOTTUS, Girard.

Always marine. Spines upon each of the opercular bones. Surface of head and often circumference of orbits either armed with spines, serrated, or notched. Mouth more deeply cleft than in Cottus. Lateral line uninterrupted.

Acanthocottus variabilis, *Girard.*

The Greenland Sculpin.

(Plate IV. Fig 1.)

Cottus scorpius, Fabricius, Fauna Groenlandica, p. 156, No. 113.
Le Chaboisseau du Groenland, (Cottus Groenlandicus,) Cuv. et Val., iv. p. 185.
Cottus Groenlandicus, *Greenland Bull-head*, Rich., Fauna Boreal. Americ., iii. pp. 46 and 297, and admirably figured, pl. 95.
" " *Greenland Sculpin*, Storer's Report, p. 16.
" " *Greenland Bull-head*, Dekay, Report, p. 54, pl. 4, fig. 2.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 305.
" " Storer, Synopsis, p. 53.
Cottus quadricornis, Sabine, App. to Parry's First Voyage.
Cottus variabilis, Ayres, Proc. Bost. Soc. Nat. Hist., i. 1842, p. 69.
" " Ayres, Bost. Journ. Nat. Hist., iv. 1843, p. 259.
Acanthocottus Groenlandicus, Girard, Proc. Bost. Soc. Nat. Hist., iii. p. 185.
Acanthocottus variabilis, Girard, Bost. Journ. Nat. Hist , vi. p. 248.

Color. Upper part of the body dark brown, with large clay-colored blotches on the top of the head and upon the gill-covers, with a few smaller ones on the back and sides, and small circular yellow spots on the sides towards the abdomen. Large perfectly white ocelli upon the abdomen, beneath the pectorals. Abdomen yellow tinged with red, throat of a dull white color. The first dorsal fin of a dark-brown color, variegated with yellow; the second dorsal is brown, with several transverse yellowish bands; the pectorals are marked with irregular transverse brown bands and yellow spots; the rays of this fin are orange-colored; the ventrals are white, with three transverse dark-brown bars; the anal is marked like the second dorsal; the rays of the caudal are black, while their connecting membrane is yellowish.

Description. Body oblong; very stout anteriorly; tapering towards the tail.

The sides, both above and beneath the lateral line, are roughened by granulated tubercles which feel like spines when the finger is drawn towards the head.

The length of the head, measured to the posterior extremity of the occiput, is equal to about one fourth the length of the body; its width across the occiput equal to its length; its greatest depth equal to two thirds its length. The head is armed with several spines; those upon its top are blunted, those on the gill-covers are longer, with projecting, sharp points. The nasal spines are sharp and recurved; at the posterior superior angle of the eye is a strong, slightly recurved, short spine, stouter than the nasal spine. Upon the occiput are also situated two strong, blunt, and somewhat recurved spines; between these and the former is a quadrangular depression. The preoperculum has three spines, naked at their extremities, two of which are situated at its superior angle; the upper of these spines is much the largest, and points upwards; the second is smaller and nearly straight; the third and smallest, at its inferior angle, points directly downwards. The operculum is armed with two spines; the larger at its superior angle; the second, much the smaller, at its inferior angle.

Eyes circular, their diameter equal to one sixth the length of the head. The gape of the mouth very large; the distance between the tips of the jaws, when distended, is equal to one third the length of the head; the upper jaw the longer; both jaws are armed with numerous, very small, card-like teeth; similar teeth on the vomer and pharyngeals. Nostrils tubular, just in front of the eyes.

The first dorsal fin commences on a line above the pectorals; it is rounded above, about as long again as high.

The second dorsal commences at the termination of the first; appearing almost to be united with it.

The pectorals are very broad when expanded; their length at base is less than the height of the first rays; roughened granulations may be perceived beneath several of the rays of these fins; the inferior rays are much the shorter and stouter.

The outer ray of the ventrals is very stout.

The anal commences just posterior to the second dorsal, and is shorter than that fin.

The caudal stout, with the rays bifurcated at their posterior extremities.

The fin rays are as follows: — D. 9 or 10 - 16 or 18. P. 17. V. 3. A. 13. C. $12\frac{2}{2}$. Length about a foot.

Remarks. In a monograph of the Genus Cottus, which he published in the "Proceedings of the Boston Society of Natural History," Vol. III., Mr. Charles Girard considered the *Cottus variabilis* of Ayres as the young of the *Groenlandicus*. At a subsequent period, having received from Mr. Horatio R. Storer a species of Cottus from Labrador, he was enabled to decide that it was not the same as the species on our coast which is known as the *Groenlandicus*, and consequently has retained Ayres's specific name for the Massachusetts fish. So that what has been known by us as the *Groenlandicus* is now to be called *variabilis*, and the fish so called by Ayres is the young.

This beautiful fish is much less common than the *Virginianus*. Though the other species is said to be a favorite food of the Greenlanders, this is not used with us. It is frequently seen swimming upon the sandy bottoms of the numerous small coves of Massachusetts Bay, and is taken with the hook while fishing from the rocks for the Conner. Specimens of the young of this species were presented to me by Mr. Desor, who procured them at the South Shoals, fifteen miles from Nantucket, with the dredge, in eleven and a half, fifteen, and eighteen fathoms of water respectively, from a bottom abounding with barnacles and membranipora. It is exceedingly voracious, devouring all kinds of Crustacea, Mollusks, and Echini. In the stomach of one I found three entire specimens of the *Portunus pictus* of considerable size; in others I have seen large quantities of the *Echinus granulatus*, and several species of Algæ.

Maine, Massachusetts, Storer. Connecticut, Ayres. New York, Dekay.

Acanthocottus Virginianus, *Girard.*

The Common Sculpin.

(Plate IV. Fig. 2.)

Scorpius Virginionus, Willoughby, Hist. Pisc., App., p. 25, pl. 10, fig. 15 (?).
Cottus octodecimspinosus, *Eighteen-spined Cottus*, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 380.
Le grand Chaboisseau à dix-huit épines de l'Amérique du Nord, *Cottus octodecimspinosus*, Cuv. et Val., iv. p. 181.
Cottus octodecimspinosus, *Sculpin*, Rich., Fauna Boreal. Americ., iii. p. 46.
" " Griffith's Cuv., x. pl. 43, fig. 4.
Cottus Virginianus, *Common Sculpin*, Storer, Report, p. 18.
" " *Common Bull-head*, Dekay, Report, p. 51, pl. 5, fig. 13.
" " Linsley, Cat. of Fishes of Conn.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 305.
" " Storer, Synopsis, p. 53.
Acanthocottus Virginianus, Girard, Proc. Bost. Soc. Nat. Hist., iii. p. 187.
" " H. R. Storer, Bost. Journ. Nat. Hist., vi. p. 250.

Color. While alive, some individuals of this species are of a greenish-yellow color, with four transverse dark-brown bars, which extend from the dorsum to the lower part of the sides; the anterior of these is nearly as wide at its base as the first dorsal fin at which it commences; the second is situated at the anterior half of the second dorsal; the third, which is narrower than the second, is at the posterior half of the second dorsal; the fourth band crosses the fleshy portion of the tail. In others the general color is of a greenish-brown, the bands are very indistinct and appear rather like large blotches. Abdomen white. The first dorsal is fuliginous, and crossed by distinct dark-brown bands. The second dorsal is crossed by three longitudinal bands of dark brown. The pectorals are of a light-yellow color; broad when expanded; the inferior rays are flesh-colored; these fins are crossed by six dark-brown concentric bands of different widths. The ventrals are yellowish-white; the intermediate membrane clouded by indistinct bands of dark brown. The anal is yellowish, crossed by indistinct dark bands. The caudal is yellowish-white, with five very distinct bands. Pupils bluish; irides reddish, with a coppery hue when alive.

Description. Length of head equal to one third the length of body; its greatest width equal to two thirds its length. Twenty spines are seen upon and about the head, ten on each side; all these are naked at their extremities. The nasal spines are small and recurved; the post-orbitar spines are a little longer than the nasals; they are barely elevated above the top of the head, and point directly backwards; the occipital spines are erect and slightly recurved; they are rather stouter than the post-orbitars;

three spines are situated upon the preoperculum; that at the posterior angle is the largest of any upon the head; it is very stout, is naked throughout its greatest extent, and is partially covered by a loose membrane as a mere sheath, which is readily recurved to its very base; this spine extends backwards nearly to, and in some specimens as far as, and I have seen it continued even beyond, the posterior extremity of the opercular spine. Directly under the base of this spine is situated a second very small one, pointing obliquely backwards and downwards; at the inferior angle of the preopercle is a third spine, pointing downwards and forwards. Two spines are seen upon the operculum; the larger passes from its upper anterior portion to the posterior angle, pointing obliquely backwards; the other, which is quite small, is at the inferior angle, and points directly downwards. Just above the origin of the pectorals is a strong scapular spine, directed upwards and backwards. And above the commencement of the posterior fleshy membrane of the operculum is seen the humeral spine, which is but little longer than the occipital spines.

The head is flattened above and furrowed by ridges which are the continuations of the spines; a slight ridge passes from the nasal spines backwards to the eyes; another extends from the post-orbitar to the occipital spines, and exterior to this is another ridge; the whole upper portion of the head is dotted with minute granulations. The gape of the mouth is large; the jaws, pharynx, and palatine-bones are armed with numerous sharp, compact teeth, like those of a card; the upper jaw is the larger. The eyes are very large and prominent. The nostrils are small; the posterior is just back of the nasal spine; the anterior is tubular, and on a line with the base of the nasal spine exterior to it. The lateral line is very prominent, resembling an interrupted series of tubercles. It commences at the scapular spine, and is continued to the caudal rays, being much less marked at its posterior extremity.

The first dorsal fin, which is composed of nine spinous rays, is longer than high. The third ray is the longest; the first ray is about half the height of the second; the extremities of the first six rays project beyond the connecting membrane. Dr. Dekay, in speaking of this fin, says, "the second ray longest." He omits mentioning the first very short ray; and it does not appear in his figure.

The second dorsal arises just back of the first, at the termination of a membrane extending from the first dorsal. It is nearly as long again as the first dorsal; its rays are articulated.

The pectorals are large and rounded.

The ventrals arise beneath the lower rays of the pectorals; simple. Rays free at extremities; first ray quite strong.

The anal commences back of the second dorsal, and is shorter than that fin.

The caudal is even at extremity.

In some specimens the membrane connecting the rays of the second dorsal, anal, and caudal fins extends to their extremities, causing the fins to appear even at their edges; while in others the extremities of the rays project like those of the pectorals and ventrals.

The fin rays are as follows: — D. 9 – 16. P. 17. V. 3. A. 14. C. 12. Length 10 to 18 inches.

Remarks. This is our most common species of Cottus. As the "Sculpin" or "Toad-fish" it is well known, and is the pest of the numerous boys and idlers who at certain seasons of the year are constantly fishing from the wharves and bridges for more marketable species.

Mitchill described this species in his "Fishes of New York," under the name of *octodecimspinosus;* but as it has the same number of spines as the *Cottus scorpius*, its specific name alone cannot distinguish it; and as it was previously called by Willoughby *Virginianus*, from a specimen sent him by Lister from Virginia, I have no hesitation in prefixing his specific name to my description.

Newfoundland, Richardson. Massachusetts, Storer. New York, Mitchill, Dekay. Virginia, Willoughby. Labrador, H. R. Storer. New Brunswick and Nova Scotia, Perley.

The *Acanthocottus æneus* I now omit, thinking I have previously mistaken for it a variety of *A. variabilis* of Girard.

GENUS V. BOLEOSOMA, Dekay.

The form of the body is that of a dart; the head is very short, rounded like an arc of a circle, below which the mouth, generally small and slightly protractile, opens horizontally; the upper jaw sloping over the lower. The neck and the sides of the skull compressed. The opercular apparatus and the cheeks covered with scales.

Boleosoma Olmstedi, *Agassiz.*

The Tessellated Darter.

(Plate IV. Fig. 4.)

Etheostoma Olmstedi, Storer, Bost. Journ. Nat. Hist., iv. p. 61, pl. 5, fig. 2.
" " Ayres, Bost. Journ. Nat. Hist., iv. p. 257.
Percina minima, Hald., Journ. Acad. Nat. Scien., viii. p. 330.
Boleosoma tessellatum, *Tessellated Darter*, Dekay, N. Y. Report, p. 20, pl. 20, fig. 57.
Perca minima, Dekay, N. Y. Report, p. 7.

Etheostoma Olmstedi, Ground-fish, LINSLEY, Cat. of Fishes of Conn.
" " STORER, Mem. of Amer. Acad., New Series, II. p. 271
" " STORER, Synopsis, p. 19.
Boleosoma Olmstedi, AGASSIZ, Lake Superior, p. 304.

Color. Yellowish-green, with blackish blotches upon the sides like interrupted bands. A large dark-brown blotch is seen upon the occiput, and back of this, upon the dorsum, six broad similarly colored transverse bands; the first, just over the pectorals; the second, at the anterior portion of the first dorsal; the third, between the first and second dorsal; the fourth, at the middle of the second dorsal; the fifth, at the termination of the second dorsal; and the sixth, at the base of the tail. These bands all usually disappear at death. Pupils black, irides golden. A narrow deep-black band runs from the tip of the upper jaw to the anterior superior angle of the eye, and a second band passes upwards from the lower anterior angle of the preoperculum to the middle of the lower edge of the eye, and thence to the upper edge of the orbit, interrupted by the globe of the eye. The preoperculum is golden. The first dorsal is almost colorless; the rays of the second dorsal, as well as those of the pectorals, ventrals, and caudal, are elegantly crossed transversely by reddish lines.

Description. Form cylindrical. The head is less than one sixth the length of the body; it is flattened above, between, and back of the eyes. The operculum is scaly above, and terminates posteriorly in a sharp spine. Jaws furnished with very minute teeth. The orbits of the eyes are very prominent.

The first dorsal fin commences some distance back of the opercular spine; it is rounded posteriorly.

The second dorsal, of a quadrangular form, commences just posterior to the first; the extremities of its rays bifurcated.

The pectorals are situated just back of the posterior portion of the opercula. Their length is equal to one fifth their height.

The ventrals are situated just back of the base of the pectorals.

The anal arises just posterior to the commencement of the second dorsal; it is rounded at its extremity.

The caudal is slightly emarginated.

The fin rays are as follows: — D. 9 – 13. P. 15. V. 6. A. 11. C. 15. Length three inches.

Remarks. This species is not uncommon in the small streams of the western portion of the State.

Massachusetts, STORER. Connecticut, OLMSTED, AYRES. New York, DEKAY. Pennsylvania, HALDEMAN.

GENUS VI. ASPIDOPHORUS, Lacép.

Body octagonal, covered with scaly plates; head thicker than the body, with points and depressions above, flattened below; teeth in both jaws only, none on the vomer; snout with recurved spines; branchiostegous rays, six; body tapering to the tail; one or two dorsal fins distinct.

Aspidophorus monopterygius, *Cuv.*

The Aspidophore.

(Plate VIII. Fig. 1.)

Cottus monopterygius, Bloch, 178.
" " *Single-finned Bull-head*, Shaw, Gen. Zoöl., iv. p. 265.
L'Aspidophore à une seule dorsale, *Agonus monopterygius*, Bl., Schn.
Aspidophoroide Tranquebar, Lacép., Cuv. et Val., iv. p. 224; vi. p. 554.
Cottus (Aspidophorus) monopterygius, Cuv., *Aspidophore with one dorsal*, Rich., Fauna Boreal. Americ., iii. p. 50.
Aspidophoroides monopterygius, *Bull-head*, Storer, Report, p. 22, pl. 1, fig. 1.
" " Cuv., Règne Animal, ed. Val., pl. 21, fig. 3.
Aspidophorus monopterygius, *American Aspidophore*, Dekay, Report, p. 62, pl. 2, fig. 6.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 309.
" " Storer, Synopsis, p. 57.

Color. Above, a light brown, with six indistinct transverse black bands extending from the head to the tail; those upon the anterior portion of the body the broader. Beneath lighter.

Description. Body elongated, gradually tapering to the tail; divided longitudinally by eight rows of scaly plates. Those which are situated just back of the head are much the largest. Above, from just back of the eyes to the dorsal fin, are two rows of these plates; two rows on each side for some distance, and two rows beneath; making the fish anterior to the dorsal fin octagonal, and posterior to that fin, hexagonal. The angles of the large scales upon the back form prominent ridges, and between them is thus formed a groove, which extends from the snout between the orbits of the eyes to the posterior extremity of the dorsal fin. Back of this fin is seen a dorsal ridge, instead of the furrow, which is continued to the tail.

The length of the head is equal to about one seventh the entire length of the body; width of head less than that of body. The whole head is bony; the eyes are very large; the orbitar bones prominent. The snout has two recurved spines at its extremity, and a third and smaller one back of them, curving forwards. Mouth small; numerous minute teeth are observed in both jaws.

The dorsal fin is situated upon the posterior half of the body, at the extreme portion of the dorsal furrow.

In this specimen, as well also as in those I previously examined, it is almost impossible to make out the number of fin rays; but the following, if not perfectly accurate, is a near approximation: — D. 5. P. 10. V. 4. A. 4. C. 16. Length 5 inches.

Remarks. This species was first described by Bloch as the *Cottus monopterygius*, and afterwards more minutely by Cuvier as the *Aspidophorus monopterygius*, in the fourth volume of the "Histoire Naturelle des Poissons." Lacépède formed the genus *Aspidophoroides* to receive the species above described, it being the only known *Aspidophorus* with a single dorsal fin. At the time this genus was formed, the species of which we have been speaking was supposed to have been brought from the East Indies. Cuvier, however, in his description, says he has not received it from the East Indies in any of his numerous collections from that quarter of the world; and finally, Richardson, in his "Fauna Boreali Americana," observed, "that it has lately been discovered to be an inhabitant of the Greenland seas, so that this sub-genus belongs entirely to the Northern hemisphere, and chiefly to the higher latitudes." Early in May, 1838, Mr. Jonathan Johnston, Jr., sent me three specimens of this species, which he had taken from the stomachs of haddock just caught within two miles of Nahant. They were each more or less mutilated; from one of them, however, my friend Jeffries Wyman, M. D., was enabled to sketch the plate contained in my "Report on the Icththyology of Massachusetts." In 1848, Captain Nathaniel E. Atwood sent me a specimen taken from a cod's mouth at Provincetown. This specimen, although somewhat injured when received, has furnished me with the accompanying figures, and given me an opportunity to revise my former description. Besides the specimens above referred to, Mr. William O. Ayres procured two others, in February, 1851, from the stomach of a halibut taken at Cape Cod; and Mr. Stimpson one in May, from the stomach of a haddock caught in Boston Bay. These are the only individuals I have ever known to be taken south of Greenland.

Massachusetts, STORER. Greenland, RICHARDSON.

GENUS VII. CRYPTACANTHODES, NOBIS.

Body elongated, very much compressed, and gradually tapering to the tail. Destitute of scales. Head broad, with no projecting spines; the scapular and humeral spines, and the inferior edge of the preoperculum, prominent to the touch. Numerous depressions in frontal, suborbitar, inferior maxillary, and preopercular bones; branchiostegous rays, seven; mouth oblique; a single dorsal fin, composed of strong spinous rays enveloped by a common membrane, runs nearly the entire length of the fish, and unites, as well as the anal, with the tail. No ventral fins.

C. MACULATUS, *Nobis.*

Spotted Wry-mouth.

(PLATE VIII. FIG. 6.)

Cryptacanthodes maculatus, Spotted Wry-mouth, STORER, Report, p. 28.
" " DEKAY, Report, p. 63, pl. 18, fig. 50.
" " LINSLEY, Cat. of Fishes of Conn.
" " STORER, Mem. Amer. Acad., New Series, II. p. 310.
" " STORER, Synopsis, p. 58.
" " H. R. STORER, Bost. Journ. Nat. Hist., VI. p. 254.

Color. Body a dark reddish-brown tinged with violet. Abdomen and throat a dirty grayish-white. A row or two of moderate-sized dark-brown blotches above the lateral line, and another row immediately beneath it, extend throughout the greater part of its length to the tail. Tip and sides of head, snout, and anterior portion of under side of lower jaw, marked with smaller spots of the same color as those on the sides. Pupils black; irides golden.

Description. Length of head about one sixth the entire length; greatest breadth about one half the length of the head. On each side of top of head, two prominent bony ridges run directly back from posterior angle of eye to occiput. The posterior angles of operculum and preoperculum; the lower edge of preopercle; the scapular bones, — all seem like sharp points and edges concealed by the skin. The operculum is large and triangular, covered by the skin, as is also the preoperculum, which presents to the touch two sensible carinæ. Eyes circular, deeply sunk in the projecting orbits; diameter of orbit about equal to distance between eyes. Nostrils tubular, situated on the side of the prominent snout, just at the edge of the intermaxillary bones. Lips fleshy; lower jaw projecting beyond the upper; mouth slanting obliquely downwards; numerous teeth in jaws and upon the vomer and palatine bones, — those on the back part of the jaws recurved, while those in front are smaller and nearly straight. Gape of mouth moderate. Branchiostegal membrane extended along and connected with the sides for a short distance. Lateral line straight and interrupted.

The dorsal fin arises above the posterior half of the pectorals, and is continued to and united with the caudal; all its rays are spinous and strong, concealed by a stout and fleshy membrane; the first few rays are shortest.

The pectorals arise beneath the membrane of the branchiæ; they are fleshy, small, and rounded.

The anal arises upon the anterior half of body ; it is similar in its form and the character of its rays and their enveloping membrane to the dorsal, and is also, like that fin, connected with the caudal.

The caudal is rounded, and appears like the prolongation of the dorsal and anal fins.

D. 78. P. 15. A. 50. C. 15. Length three feet.

Remarks. This is a very rare species. I have known of only seven individuals being taken. One of these Mr. Jonathan Johnson, Jr. sent me from Nahant; one was found by Dr. Henry Bryant of this city, at Commercial Point, Dorchester; one I received from Captain Atwood of Provincetown ; three of the remainder were said to have been taken in Massachusetts Bay ; and the last was found by Horatio R. Storer on a beach in Nova Scotia. The finest specimen, taken by Captain Atwood, has served for the above description.

GENUS VIII. HEMITRIPTERUS, Cuv.

The head depressed ; two dorsals, as in Cottus ; no regular scales on the skin, but teeth in the palates. The head is bristly and spinous, and has several cutaneous appendages. The first dorsal is deeply emarginate, a circumstance which has led some authors to believe there were three dorsal fins.

Hemitripterus Acadianus, *Storer.*

The Deep-water Sculpin.

(Plate VII. Fig. 4.)

Cottus Acadianus, Acadian Bull-head, Penn., Arc. Zoöl., ii. p. 118.
Scorpæna flava, Yellow Scorpæna, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 382, pl. 2, fig. 8.
Scorpæna purpurea et *S. rufa*, Mitchill, Amer. Month. Mag., ii. p. 245.
L'Hemitriptère de l'Amérique, Hemitripterus Americanus, Cuv. et Val., iv. p. 268, pl. 84.
Hemitripterus Americanus, Rich., Fauna Boreal. Americ., iii. p. 50.
" " Règne Animal, ed. Val., pl. 22, fig. 1.
" " Griffith's Cuv., x. p. 141, pl. 53, fig. 3.
" " *Sea-Raven, Deep-water Sculpin*, Storer, Report, p. 23.
" " *American Sea-Raven*, Dekay, Report, p. 56, pl. 6, fig. 16.
" " Linsley, Cat. of Fishes of Conn.
" " Storer, Mem. Amer. Acad , New Series, ii. p. 310.
" " Storer, Synopsis, p. 58.

Color. Varies exceedingly. Some specimens are of a deep blood-red ; others of a pinkish-purple ; while others still are of a yellowish-brown, darker on the back ; each, however, variegated on the head, sides, and fins with irregularly defined markings. Abdomen yellow. A large female, weighing five pounds and measuring twenty-six inches in length, had the whole upper part of the body of a dark brown, elegantly variegated with white and dark-brown markings; this appearance most striking upon the head, about the eyes, and along the upper jaw; it is also observable beneath the chin and lower jaw. The branchial rays, as also the rays of the dorsal, pectoral, and caudal fins, marked with transverse white lines, and the intervening membranes very minutely dotted with black. Abdomen white. In still another specimen of a reddish-brown color, transverse broad bands of sub-quadrangular form were noticeable upon the back; one of these occupied the space between the first and fifth dorsal rays; a second commenced at the seventh ray, and was continued to the fourteenth; a third, between the fifteenth and sixteenth rays; a fourth, between the eighteenth and twenty-second; and a fifth, from the twenty-sixth to the twenty-eighth; in the intervening spaces was a whitish marking beautifully edged with black. The orbits of the eyes were marked with white vertical lines. Pupils black; irides yellowish-brown.

Description. Body oblong, cylindrical. Surface granulated, and studded with innumerable tubercles, which are quite large upon the back, and very small or almost entirely disappearing beneath the lateral line. Head large, spinous, hideous in appearance. The length of the head, measuring to the posterior extremity of the operculum, is about one fourth the entire length; width of head across opercula equal to its length. Twelve more or less prominent, blunted, spinous tubercles on each side of the median line of the head; the sharpest-pointed, which in some instances is naked, is just back of the nostril; the largest are at the posterior angles of the eyes, and just in front of the dorsal fin. From several of these prominences, such as those at the anterior and posterior angles of the eyes and about the snout, are suspended fleshy digitated cirrhi; those hanging over the eyes appear like a broad fringe. Orbitar cavity large. Eyes moderate in size; the distance between the posterior superior angles of the eyes rather less than one fourth the length of the head; space between them deeply depressed. The suborbitar bone presents an irregularly elevated ridge. The preoperculum at its posterior angle is armed with two strong spines; the upper curves upwards and backwards; the inferior is directed backwards and downwards. The operculum is small, triangular, with an elevated longitudinal ridge at its superior part. The jaws are of equal length; from the edge of the lower jaw are suspended about a dozen fleshy prolongations, similar to those attached to the prominences upon the head, but considerably larger. Mouth very large. The teeth in the jaws, pharynx, upon the vomer and palatine bones, numerous, sharp, and recurved like those of a card. The lateral line, which is tubercular, commences just above the posterior angle of the operculum, and, curving with the body, terminates at the base of the caudal rays.

The first dorsal fin arises just back of the posterior spines of the head. The first three rays of this fin are longest; the seventh, eighth, ninth, and tenth rays are next in length; from the extremities of the rays are suspended delicate tentacula.

Just back of the first dorsal arises the second, appearing as if connected with it; and hence described by Mitchill as *one* fin. It is of a somewhat quadrangular form, rounded above when expanded, and having the extremities of the rays projecting beyond the connecting membrane. Height of the fin one third of its length.

The pectorals are very large; when expanded resembling a wing. The rays are uncommonly distinct; the eight anterior are stout and unequal in their length, the anterior one being much the shorter; the ten posterior are rounded posteriorly when expanded; the four anterior of these latter, the larger. These fins arise from the entire lower edge of the branchial aperture; their height to their length is as four to two and a half.

The ventrals arise just back of the first rays of the pectorals. They are composed of three rays, the first of which is shorter and much stouter than the second. In some specimens, however, the first ray is the longest of the three.

The anal commences and terminates on the same plane with the second dorsal. The first nine rays of this fin are deeply divided at their extremities. This is much more marked in some specimens than in others. The length is to the height as three and a half to one and a half.

The length of the caudal is two thirds of its height.

The fin rays are as follows: — D. 16 – 13. P. 18. V. 3. A. 15. C. $12\frac{3}{3}$. Length two feet.

Remarks. This species is frequently taken by the cod-fishermen in deep water in the neighborhood of ledges in Massachusetts Bay.

Nova Scotia and Gulf of St. Lawrence, Cuvier, Richardson. Maine, Massachusetts, Storer. Connecticut, Linsley. New York, Mitchill, Dekay.

Inasmuch as authors generally suppose this to be the *Acadianus* of Pennant, I am compelled to assume his specific name. It is to be regretted, however, that his description should have been so meagre; and that, while he described well enough the dorsal fins, he should have utterly neglected mentioning the characteristic cirrhi of the head; this can only be accounted for upon the supposition that he never saw a recent specimen.

GENUS IX. SEBASTES, Cuv.

Body oblong, compressed, covered with scales; all the upper parts of the head also covered with scales. Eyes large; preoperculum and operculum ending in three or more spines; branchiostegous rays, seven; teeth small, numerous, equal in size, placed on both jaws, the vomer, and palatine bones; a single dorsal fin, partly spinous, partly flexible; inferior rays of the pectoral fin simple.

SEBASTES NORVEGICUS, *Cuv.*

The Norway Haddock.

(PLATE VII. FIG. 1.)

Perca Norvegica, FAB., Fauna Groenl., p. 167.
Perca marina, *Sea-Perch*, PENN., Brit. Zool., p. 226.
Serranus Norvegicus, FLEM., Brit. An., p. 212, sp. 140.
Scorpæna Norvegica, *Northern Sebastes*, JEN., Brit. Vert., p. 347.
Sebastes Norvegicus, GRIFFITH'S CUV., x. p. 144.
La Sébaste septentrionale, *Sebastes Norvegicus*, CUV. et VAL., IV. p. 327, pl. 87.
Scorpæna (Sebastes) Norvegica, *Northern Sebastes*, RICH., Fauna Boreal. Americ., III. p. 52.
Sebastes Norvegicus, *Bergylt*, *Norway Haddock*, YARRELL, Brit. Fishes (2d edit.), I. p. 87.
" " *Norway Haddock*, *Rose-fish*, *Hemdurgan Snopper*, STORER, Report, p. 26.
" " *Northern Sebastes*, DEKAY, Report, p. 60, pl. 4, fig. 11.
" " STORER, Mem. Amer. Acad., New Series, II. p. 312.
" " STORER, Synopsis, p. 60.

Color. In the recent fish the entire body, together with the fins, is of a beautiful bright red, with the exception of a black blotch upon the posterior portion of the operculum. After death the color partially disappears upon the throat and abdomen, and the space beneath the ventrals becomes nearly white; and at the posterior base of the soft portion of the dorsal a dull blotch is observed. Pupils black; irides yellow.

Description. Body oblong, compressed, covered with small rough scales. Length of the head, from the tip of lower jaws when closed, to the posterior angle of the operculum, about one third the entire length; head flattened above, between the eyes and upon the occiput. The operculum is armed with three spines; one pointing upwards and backwards at its posterior superior angle; a second beneath this, directed obliquely backwards and downwards; and a third, much smaller, at its inferior angle. The preoperculum is rounded at its edge, and furnished with five spinous processes; the three posterior of which are the larger. Two spines upon the scapular bones, and two upon the suborbitars. Four spinous projections upon the supra-orbitars, all of which are pointed backwards; one at the upper anterior angle of the eye; a second with its base continued along the greater portion of the ridge; and two smaller ones behind.

Two elevated sharp ridges upon the occiput, which bifurcate posteriorly into spinous points. Eyes circular, very large; the diameter of the orbit nearly equal to one third the length of the head, when the jaws are closed; the distance between the eyes equal to five eighths the diameter of the eye. The nostrils are just in front of the eyes; the posterior is much the larger. The jaws, pharynx, vomer, and palatine bones are armed with numerous minute, sharp teeth; the upper jaw is very protractile, and has an emargination at its centre, into which the extremity of the lower jaw shuts, when the mouth is closed. The chin is prominent. The lateral line arises above the operculum, and, taking the curve of the body, terminates at the caudal rays; about thirty-six tubes are seen in the course of the line, which are more nearly approximated at the posterior portion of the body.

The dorsal fin commences on a line with the upper opercular spine. Its anterior half is composed of spinous rays; the length of its highest rays is equal to about one third the length of the fin; the connecting membrane does not extend to the summit of the rays, and they are thus left naked and projecting. The posterior half of this fin is composed of membranous rays which are higher than the spinous ones; the length of this portion, which is rounded above and posteriorly, is less than one half the length of the spinous portion.

The pectorals commence on a line with the third dorsal ray; they are rounded when expanded. The rays project beyond the connecting membrane; the length of these fins is equal to one third their height; the middle rays are the longest.

The ventrals are fan-shaped, and situated just back of the pectorals; their first ray is a strong spine; the second membranous ray is the longest.

The anal has three strong spines; the posterior the longest. The first membranous ray is equal to the length of the fin.

The caudal is slightly emarginated at its tip; its length less than one third its height.

The fin rays are as follows: — D. 15 – 15. P. 18. V. 1 – 5. A. 3 – 7. C. 19. Length one foot.

In the specimens I have seen, the preopercular and opercular spines are much more developed than they appear in Cuvier's figure of this species. Yarrell's and Dekay's figures are copies from that of Cuvier.

Remarks. This species is known to our fishermen by the names of "Rose-fish," "Hemdurgan," and "Snapper." It is not common in Massachusetts Bay; it is occasionally taken during the winter, and rarely in the summer, while fishing for cod, near shoal ledges contiguous to deep water. It is not a marketable fish with us, although it is freely eaten by the Norwegians. Captain Atwood informs me that he never saw a specimen of this fish on the southern shore of Massachusetts Bay. The fishermen have an erroneous opinion that the spines of this species are very poisonous. It weighs from one to five pounds.

Greenland, FABRICIUS. Gulf of St. Lawrence, RICHARDSON. Maine, WOOD. Massachusetts, STORER. New York, DEKAY.

GENUS X. GASTEROSTEUS, Cuv.

Body without scales, more or less plated on the sides; one dorsal fin with free spines. Ventral fin with one strong spine, and no other rays; bones of the pelvis forming a shield, pointed behind; branchiostegous rays three.

GASTEROSTEUS BIACULEATUS, *Mitchill.*

The Two-spined Stickleback.

(PLATE VIII. FIG. 2, 3.)

Gasterosteus biaculeatus, Two-spined Stickleback, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 430, pl. 1, fig. 10.
" " " " DEKAY, Report, p. 65, pl. 3, fig. 8.
" " " " STORER, Mem. of Amer. Acad., New Series, II. p. 314.
" " " " STORER, Synopsis, p. 62.
" " " " H. R. STORER, Bost. Journ. Nat. Hist., VI. p. 260.

Color. The living fish is of an olive-green color above, lighter upon the sides, silvery beneath. Gill-covers silvery, spotted with fuliginous. Pupils black; irides silvery. Fins colorless; in the dead specimens yellowish.

Description. Body oblong, compressed, becoming abruptly very slender at the base of the tail. On each side of the body are about thirty transverse horny plates, the posterior of which are the narrower; these plates are indistinctly striated. The lateral line is situated high up on the back; it takes the curve of the body, and is lost in the carina on the side of the tail. The head is less than one fourth the length of the body; above it is bony and granulated, as in the *Prionoti*, and flattened. The mouth is protractile. The jaws are equal, and furnished with numerous minute teeth. The eyes are large and circular. The nostrils are large, and situated about half way between the eye and the snout. The opercula are covered with radiating striæ, as in the *Syngnathi.* A broad silvery plate bounds the branchial orifice posteriorly. On each side of the base of the tail is a distinct membranous carina. There are two distinct spines of about equal size situated upon the dorsum anterior to the dorsal fin; these spines are broad at their base, strongly serrated on their sides, very acute at their extremity, slightly recurved, and capable of being elevated or depressed at the will of the fish ; the anterior of these is situated over the silvery plate back of the branchial orifice ; the posterior is above the middle of the pectorals. Just anterior to the origin of the dorsal fin, and almost connected with it, is another very minute spine, which is naked throughout the greater portion of its extent.

The dorsal fin is longer than high ; its posterior rays are very short.

The pectorals are elongated, broad, and fan-shaped when expanded. In front of the pectorals two prominent, acute, serrated spines, with a bony process at their external base, are observed in place of the ventrals. Between these spines is situated a bony plate formed like the head of a lance, granulated upon its surface, serrated at its edges, with a central carina. (Plate VIII. Fig. 3.)

The anal commences posterior to the dorsal, and terminates on a line with that fin. Like the dorsal, it is preceded by an exceedingly minute spine.

The caudal is scarcely emarginated.

The fin rays are as follows: — D. 2 - 1 - 11. P. 10. V. 1. A. 1 - 6. C. 12. Length two inches to two and a half.

Remarks. Specimens of this species were brought me by my son, Horatio R. Storer, from small pools of water left at low tide on the rocks at Nahant, and also from the marshes at Brookline. Captain Atwood has likewise sent me individuals from Provincetown.

Massachusetts, STORER. New York, MITCHILL, DEKAY. Nova Scotia, H. R. STORER. New Brunswick, PERLEY.

This species may perhaps have been the one referred to by Forster and Pennant ; but it does not seem to be the Northern Two-spined Stickleback, which has been lately described by Girard from specimens brought from Labrador by my son, under the name of *G. Cuvieri.*

GASTEROSTEUS QUADRACUS, *Mitchill.*

The Four-spined Stickleback.

(PLATE VIII. FIG. 4.)

Gasterosteus quadracus, Four-spined Stickleback, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 430, pl. 1, fig. 11.
L'Epinoche à quatre aiguilles (*Gasterosteus quadracus*, MITCH.), CUV. et VAL., IV. p. 504.
L'Epinoche à bassin fendu (*Gasterosteus apeltes*, CUV.), CUV. et VAL., IV. p. 505.
Gasterosteus apeltes, Bloody Stickleback, STORER, Report, p. 31.
Gasterosteus quadracus, Four-spined Stickleback, DEKAY, Report, p. 67, pl. 6, fig. 18.
" " " " STORER, Mem. Amer. Acad., New Series, II. p. 315.
" " " " STORER, Synopsis, p. 63.

Color. When alive, greenish-brown above the lateral line; beneath this line, which is very perceptible, the color is darker, and is broken irregularly by the extension of the whiteness of the abdomen. In young specimens the color is distributed in four or five transverse bands, which are indistinct in the mature fish. The membranous portion attached to the posterior inferior part of the ventral spine is of a bright scarlet color, which causes this part to appear as if covered with blood, when the fish is suddenly darting through the water, with the spine projecting.

Description. Body slightly convex in front of the first dorsal spine. Length of the head equal to nearly one fifth the length of the body. Three or four movable spines are situated in front of the dorsal fin, with a membrane at their base. Directly before the dorsal fin, and connected with it by a membrane at its base, is a fifth spine, which is equal to about two thirds the height of the rays of this fin. Commencing at the base of the first spine, and terminating at the spine of the dorsal fin, is situated a groove, into which the larger spines are received when recumbent. The first and second spines are each equal in length to one third of the head; when erect, one or more of these spines frequently project outward from the straight line; the others are shorter; the fourth, when there are five, is the shortest.

The rays of the pectorals are very delicate.

The ventral spine is serrated on its anterior edge.

The os innominatum extends, on each side, almost to the anus. At the origin of the anal fin is situated a recurved spine, rather larger than that at the origin of the dorsal fin.

The first rays of the anal fin are the highest. This fin terminates opposite the dorsal fin.

The caudal fin is slightly rounded, when expanded.

The fin rays are as follows: — D. 3 or 4, 1 – 12. P. 11. V. 1. A. 10. C. 13.

Length one to two inches.

Remarks. This species, which Mitchill concisely described and badly figured in his paper on the Fishes of New York, is found in large numbers in creeks to which the sea has access, from Boston to Provincetown, and also in the mouths of rivers.

Massachusetts, STORER. New York, MITCHILL, CUVIER, DEKAY.

In this species, as in others of the genus, the number of dorsal spines varies. Cuvier's *Noveboracensis* is probably a variety with three spines, and my son has taken specimens with five spines in salt marshes at Cambridge.

Gasterosteus Dekayi, *Agassiz.*

The Many-spined Stickleback.

(Plate VIII. Fig. 5.)

Gasterosteus pungitius, Ten-spined Stickleback, Storer, Report, p. 32.
Gasterosteus occidentalis, Many-spined Stickleback, Dekay, Report, p. 68, pl. 42, fig. 135.
" " " " Storer, Mem. Amer. Acad., New Series, II. p. 315.
" " " " Storer, Synopsis, p. 63.
Gasterosteus Dekayi, Agassiz, Lake Superior, p. 311.

Color. When alive, this fish is of a grayish-yellow color, with from six to ten transverse dark bands upon its sides, which are very distinct in some specimens, while in others they are scarcely visible. In the same individual, these bands are much more apparent at some moments than at others, as the fish is excited by fear or other causes. The opercula and abdomen are silvery. Pupils black; irides metallic. After death the color of the fish is much lighter, and the bands, in a great measure, disappear.

Description. Body much elongated. Greatest depth of the fish rather more than one eighth of its length. Length of the head one fifth the length of the entire fish. The mouth opens obliquely downwards; the jaws are armed with great numbers of minute teeth. The eyes are circular; the diameter of the eye is equal to about one quarter the length of the head. The lateral line commences at the posterior superior angle of the operculum, and pursues a slightly declining course to a line over the anus, from which it passes in a straight line to the tail. A strongly marked carina upon each side of the tail, which is crossed by twelve or more plates.

Upon the dorsum are situated from eight to ten incurved spines, inclining to the right and left. The first of these spines arises on a line midway between the opercula and pectoral fin.

The dorsal fin arises on a line directly above the anal spine, and gradually diminishes in height, until its rays are scarcely perceptible.

The ventral spines are stout, sharp, somewhat incurved, serrated upon their upper edge, with a membrane at their base. A bony plate is situated between the ventral spines, which terminates posteriorly in a point.

The anal fin is similar in its form to the dorsal; its spine is recurved.

The caudal fin is rounded.

The fin rays are as follows: — D. 8 or 9 or 10. 1 – 7. P. 11. V. 1. A. 1 – 9. C. 13. Length one to two inches.

Remarks. This pretty species, which is less common than the *quadracus*, is found in the salt marshes along the sea-coast in company with that species and the different killifish.

Agassiz considers this species distinct from the *occidentalis* of Cuvier, and has accordingly named it for Dekay, who had previously expressed doubts of its identity.

Maine, H. R. Storer. Massachusetts, Storer. New York, Dekay.

FAMILY III. SCIÆNIDÆ.

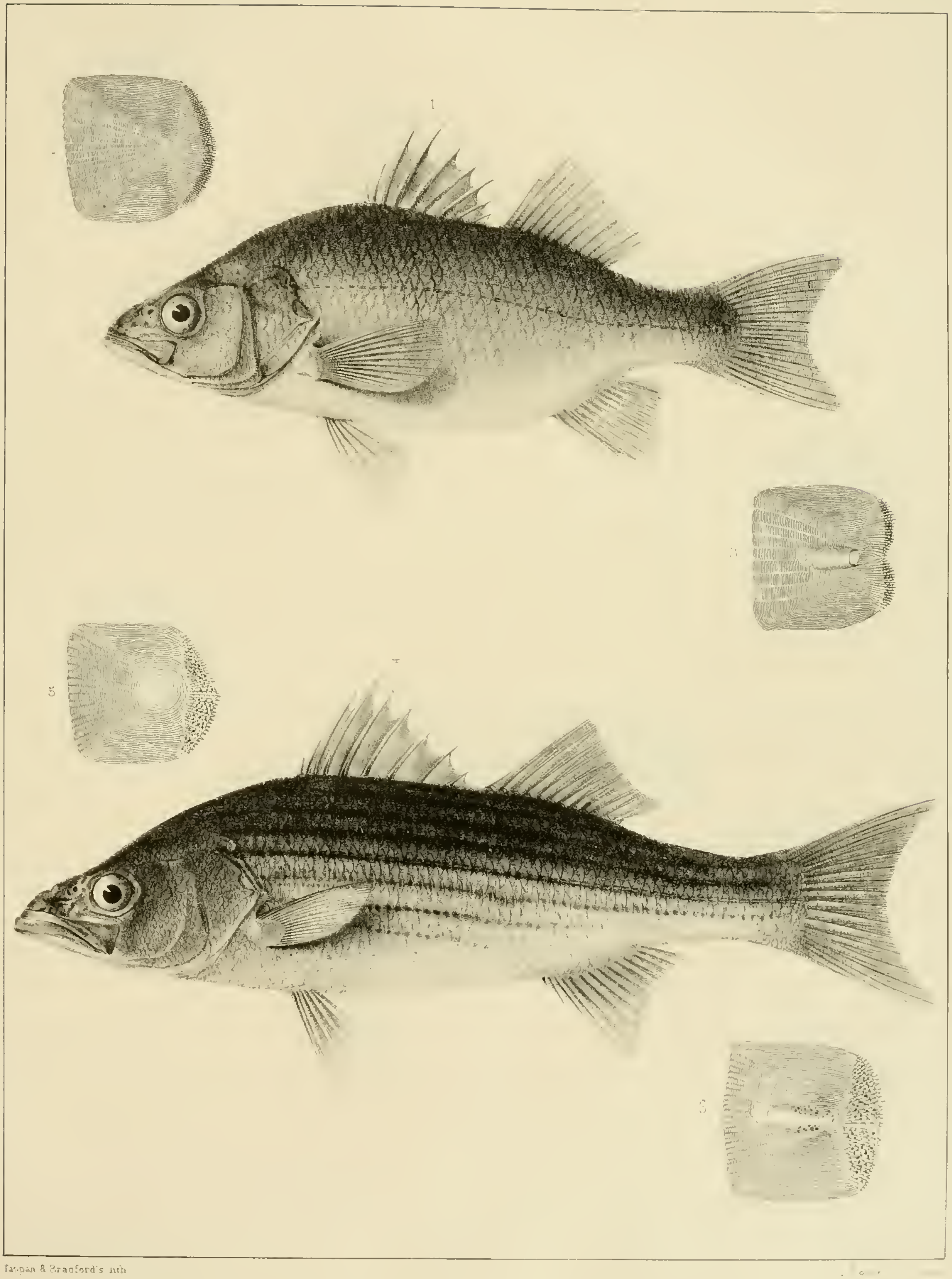
This family is very similar to that of the Percoids, and presents nearly all the same combinations of exterior characters, especially the denticulations of the preoperculum, and the spines of the operculum; but it has no teeth, either on the vomer or palatines; in general, the bones of the cranium and face are cavernous, and form a snout more or less rounded. It often occurs in this family that the vertical fins are rather scaly. Some of the genera have two dorsals, others but one.

GENUS I. OTOLITHUS, Cuv.

The bones of the anal fin are weak, and there are no barbels; some of the teeth terminate in elongated hooks, or are of the canine form. Their natatory bladder has a horn on each side, projecting forwards.

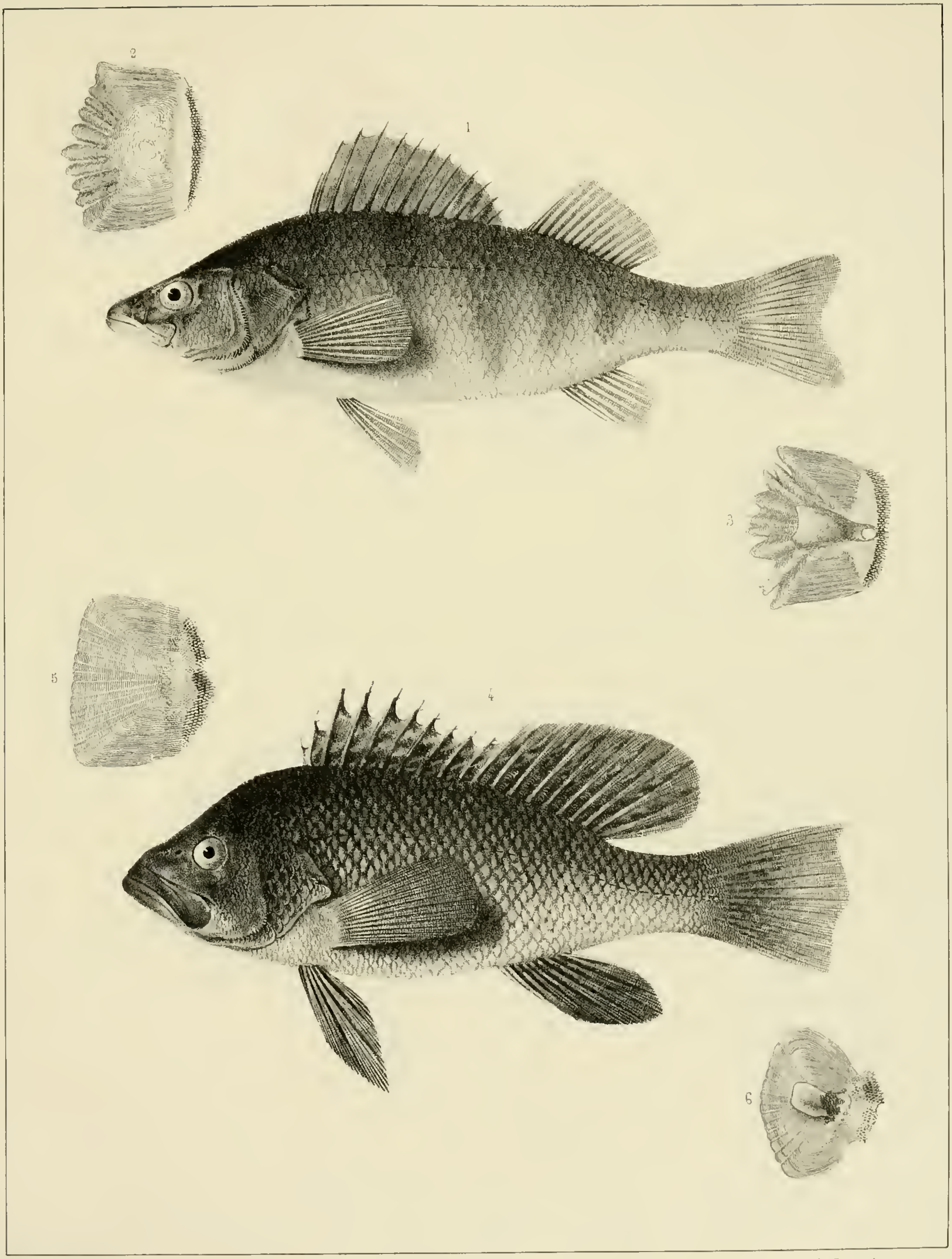
(*To be Continued.*)

Pl. 1



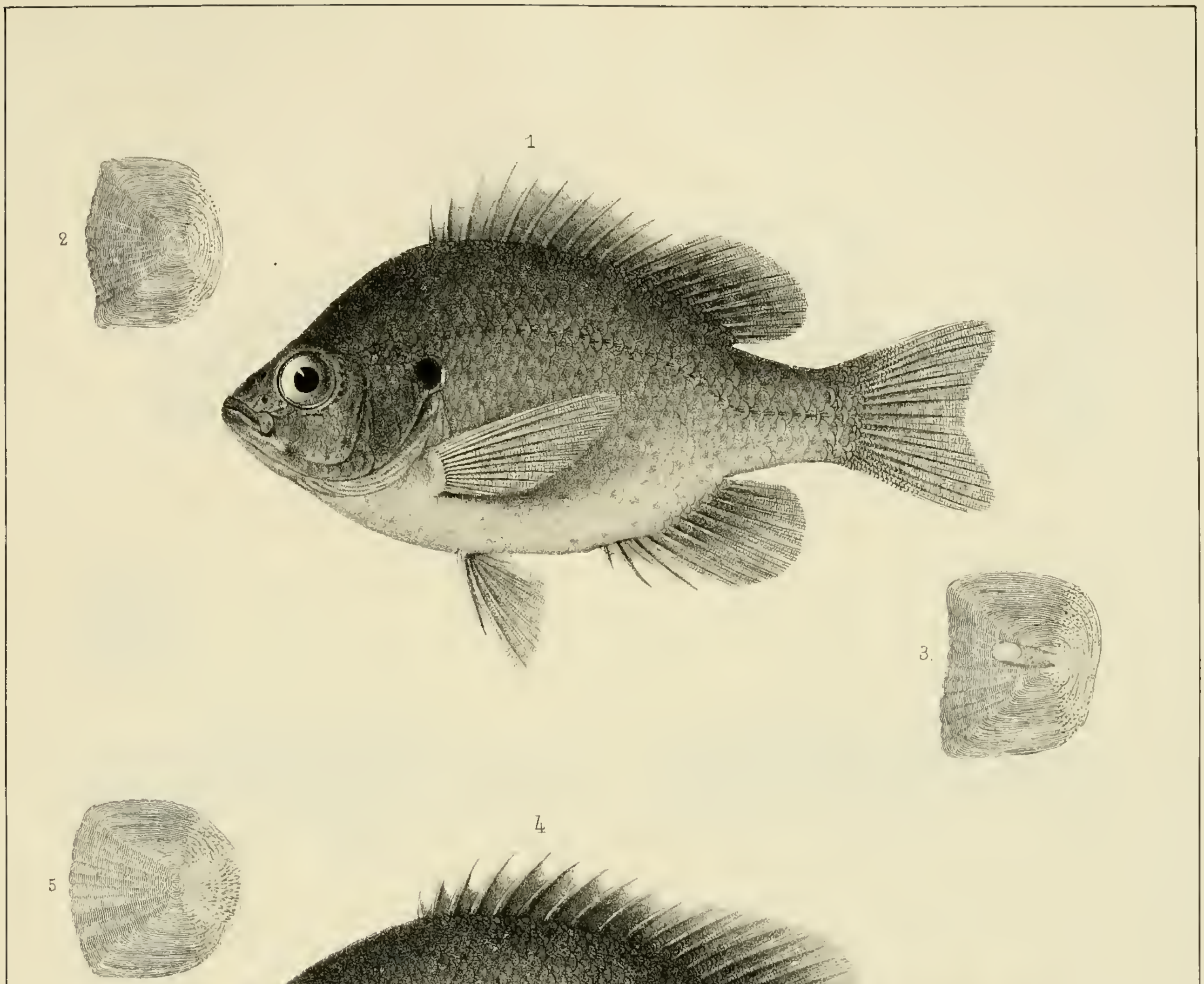
Tappan & Bradford's lith

1-3 LABRAX RUFUS. Dekay   4-6 LABRAX LINEATUS. Cuv



Tappan & Bradford's Lith. A. Sonrel on stone

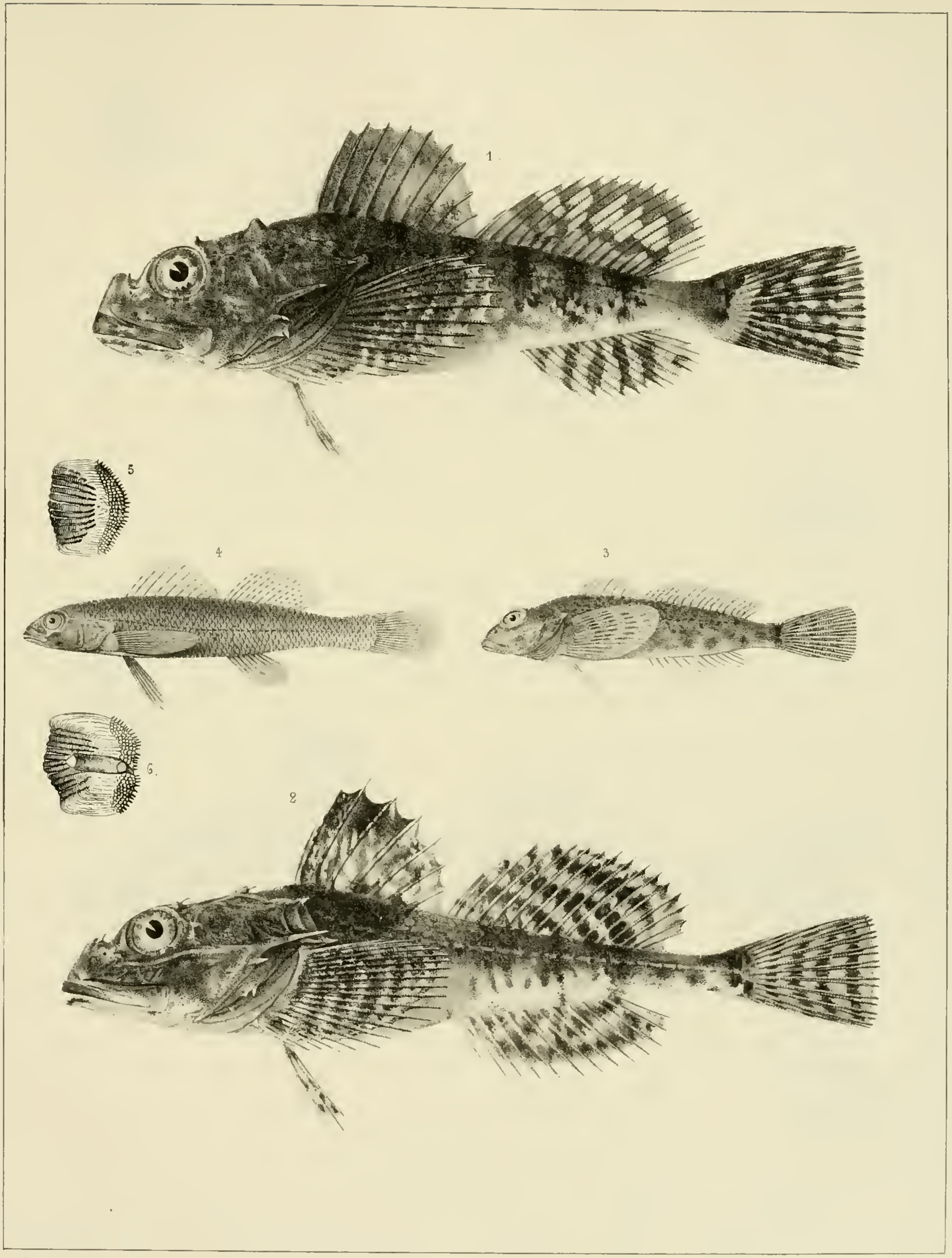
1-3. PERCA FLAVESCENS Cuv. 4-6 CENTROPRISTES VARIUS Storer



Tappan & Bradford's lith.y

A. Sonrel on stone

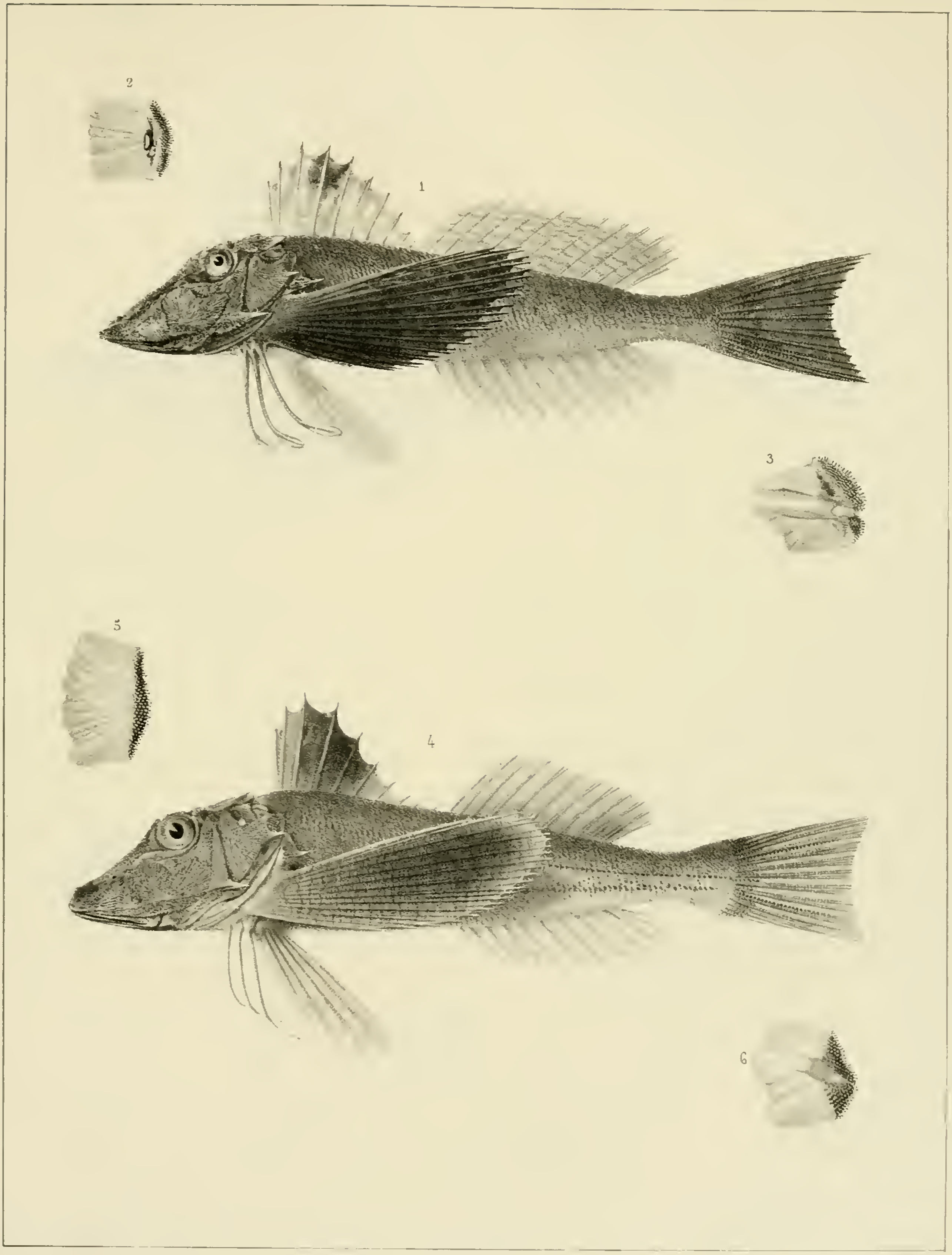
1-3. POMOTIS VULGARIS Cuv — 4-6 POMOTIS APPENDIX Dekay.



A Sonrel

Printed by Tappan & Bradford

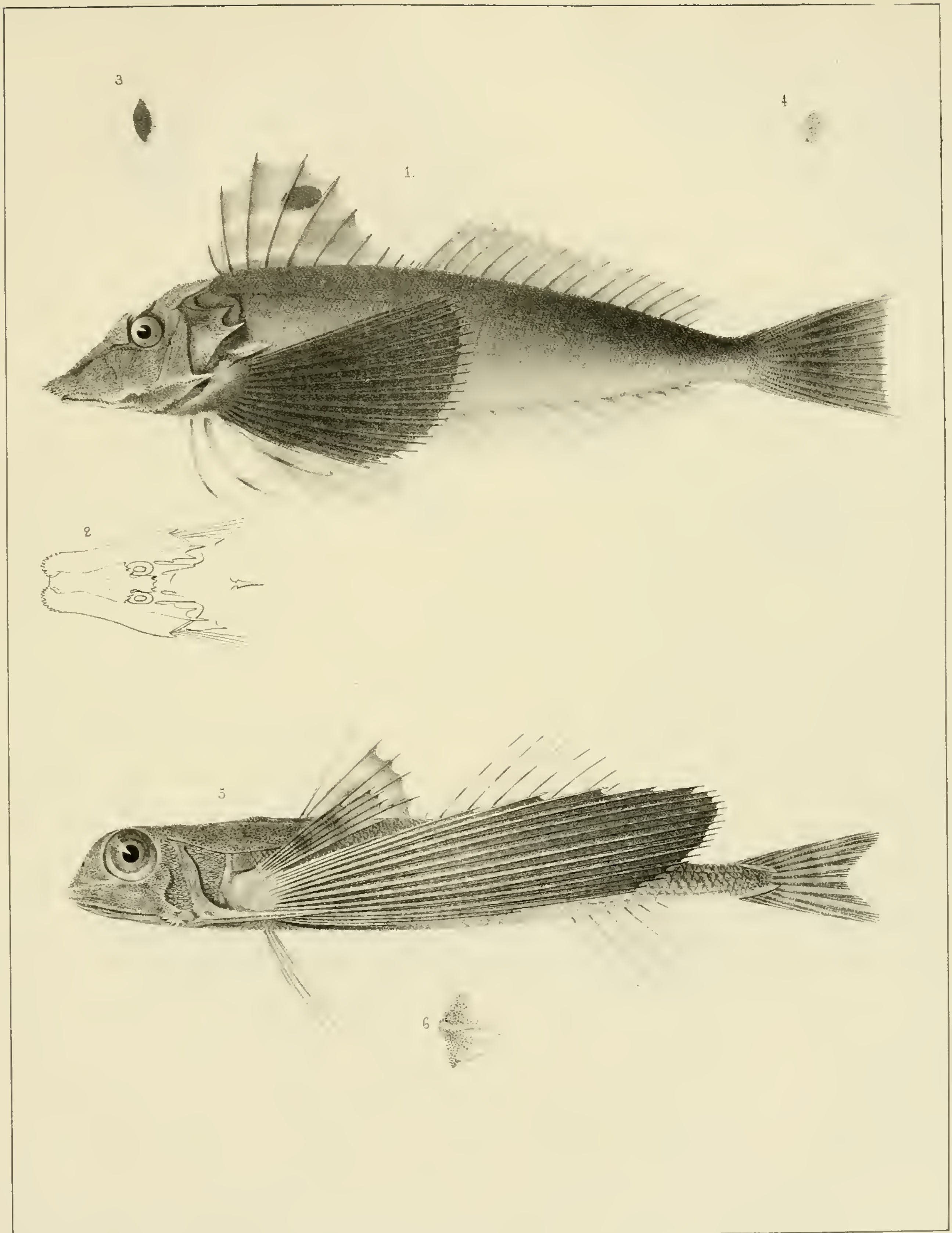
1. ACANTHOCOTTUS VARIABILIS Girard. — 2. A. VIRGINIANUS Girard.
3. COTTUS GRACILIS Heckel. — 4-6 BOLEOSOMA OLMSTEDI Ag.



A. Sonrel

Printed by Tappan et Bradford

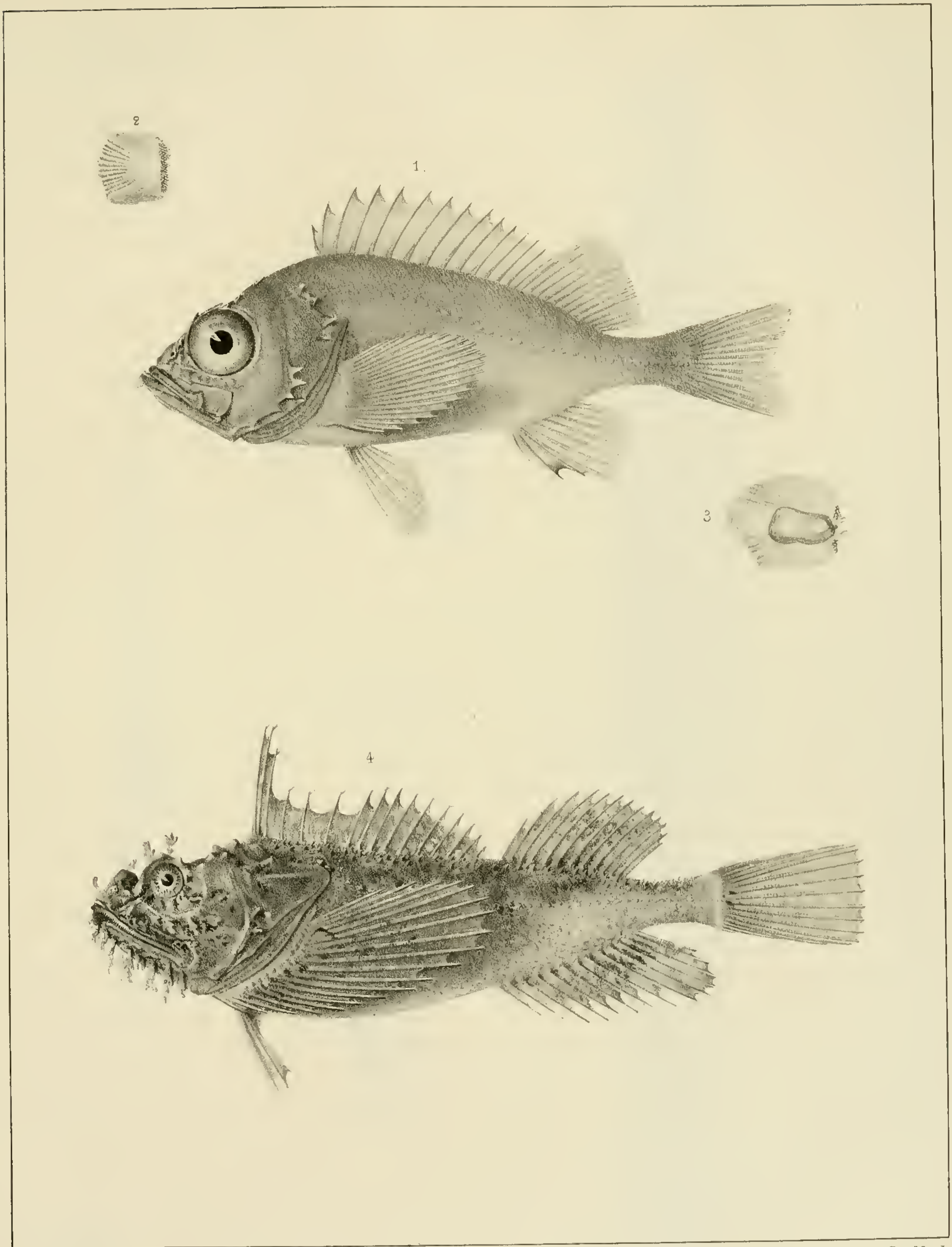
1-3 PRIONOTUS PALMIPES Storer.—4-6 PRIONOTUS LINEATUS Dekay



W.H. Tappan & A. Sonrel from nat.

Printed by Tappan & Bradford

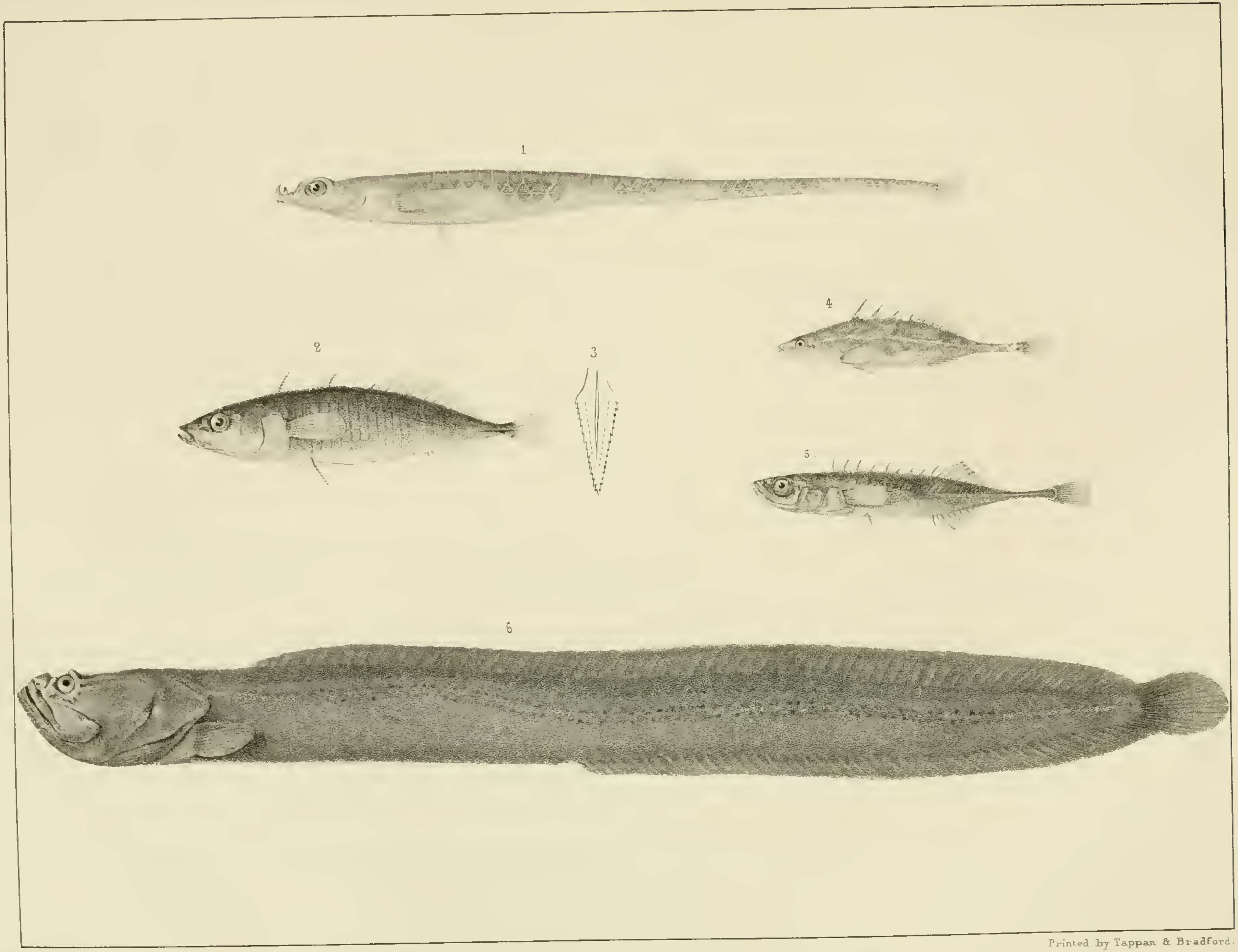
1-4. PRIONOTUS PILATUS Storer. — 5, 6. DACTYLOPTERUS VOLITANS Cuv.



A. Sonrel from nat:

Printed by Tappan & Bradford

1-3. SEBASTES NORVEGICUS Cuv. — 4. HEMITRIPTERUS ACADIANUS Storer.



W H Tappan & A Sonrel from nat.

Printed by Tappan & Bradford.

1. ASPIDOPHORUS MONOPTERYGIUS Cuv. — 2 3. GASTEROSTEUS BIACULEATUS Mitch. — 4. G. QUADRACUS Mitch
5. G. DEKAYI Ag. — 6. CRYPTACANTHODES MACULATUS Storer.

V.

A Scientific Account of the Inner Harbor of Boston, with a Synopsis of the General Principles to be observed in the Improvement of Tidal Harbors.

By CHARLES HENRY DAVIS, A. M., A. A. S., M. A. P. S., etc.,

LIEUTENANT U. S. NAVY.

(*Communicated April* 1, 1851.)

Whilst employed in executing the hydrographic portion of the survey of Boston Harbor, and since that time, I have been occasionally consulted as to certain proposed changes in the upper part of the harbor. These inquiries, my acquaintance with the subject and interest in it as a native Bostonian, have led me to make a particular examination for the purpose of ascertaining what alterations have taken place since the survey of Commodore Wadsworth in 1817. Some changes must necessarily have followed from the great diminution of the water receptacle above the channel, from the construction of wharves and piers, from neglect, and from the constant operation of those laws of tidal deposit which were the subject of a previous communication to the Academy.

The gradual deterioration of Boston Harbor is now generally admitted, and apprehensions are felt that the consequences of this deterioration may be, if it is suffered to continue, seriously injurious to the future prosperity of the city. The time seems, therefore, to have arrived, when it is expedient to inquire into the comparative condition of the harbor, using the most accurate means of investigation attainable; to state the active causes of change of which the present condition is the natural result; and to lay down those principles of hydraulic engineering which must be consulted in order that any future constructions, demanded either by the business of the city or the preservation of the channels, may prove beneficial, and answer the purposes for which they are designed. To make such an application of these principles as will form the safe basis of a plan for the general improvement and protection of the harbor may be the subject of a future communication.

In the preparation of this Memoir I have only consulted my associates in the Academy. I have no connection with any private enterprises of construction and improvement. I represent no parties concerned in them.

For the views here expressed I have no other responsibility than that which appertains to me as a member of this Academy; and this responsibility demands that I should make no statement of facts that do not appear to be well authenticated, present no general views except such as are authorized by a fair and reasonable induction, and advance no principles that are not admitted or easily proved.

The Comparative Condition of Boston Harbor.

The charts and surveys consulted or made known to me, in the course of the preparation of this memoir, are the following: —

1. *Carte du Port et Havre de Boston, avec les Côtes adjacentes. Par le Chevalier de Beaurain.* 1776. This is a military survey, and is based on an English survey.

2. *Part of Boston Harbor, by Henry Pelham.* 1777. This also is a military survey.

3. *Carte particulière du Havre de Boston, avec les Sands, les Bancs de Sable, les Roches, les Amaies, et les autres Directions utiles à la Navigation. Reduite de la Carte Anglaise de I. E. S. Des Barres, Ecuyer. Par le Marquis de Chabert.* 1780. This chart is topographical and hydrographical.

4. The chart of Des Barres in the second volume of the *Atlantic Neptune*, 1775, from which I imagine all the preceding have been taken, whether admitted or not; while Des Barres's own chart is partly composed of a survey of the harbor by Mr. Callender, a master in the Royal Navy, in 1659.

5. *The Chart of Boston Harbor, by Commodore Wadsworth.* 1817.

6. The chart made under the direction of commissioners appointed under the resolve of March, 1835.

7. The chart prepared by the Coast Survey, at the request of the commissioners appointed by the resolve of April 16, 1846.

8. To these might be added several others that are taken more or less from the preceding, and have but little original merit or value, with the exception perhaps of one in the possession of Mr. Thomas Richardson of Boston, entitled, *A Chart of the Harbor of Boston, with Soundings, Sailing-marks, &c. Taken from Holland's Surveys. Carefully revised and corrected by Osgood Carlton, Esq., Teacher of Mathematics, Boston. London, published by I. P. W. Des Barres, Esq. Boston, republished and sold by W. Newman, Book and Chart Seller.*

Of all the charts previous to that of Commodore Wadsworth, it may be said, at once, that they appear to be copied from the survey of Des Barres, or of each other more or less, and that, owing to a want of minuteness and of specific description, it is impossible to glean from them more than one or two facts of importance to be mentioned hereafter. This is not a matter of great regret, since it was not till after 1817 that the Milldam was built, the mill-pond filled up, and large portions of the flats inclosed in South Bay and elsewhere, all of which, together with the numerous constructions on the harbor front on both sides, have been the means of promoting, and of facilitating the natural causes of change in the channels.

If the means of accurate comparison were at hand, it would undoubtedly be seen that the alterations during the first thirty-four years after the close of the Revolutionary War were very much smaller than during the second period of the same duration. From 1783 to 1817, the circumstances, or state of things, remained nearly the same; with the year 1817 commenced those great enterprises which, while they mark the growth and prosperity of the city, have essentially affected the condition of the harbor. In the first period, whatever deterioration took place was due principally to the operation of natural causes unaided, or to the laws of tidal deposit controlled by the natural form of the shores. In the second, those causes, and the cases under them, have been multiplied and assisted by numerous artificial constructions.

The comparisons with the chart of Commodore Wadsworth, made in 1817, from an actual survey by himself, furnish very valuable information.

The life of this officer, every passage of which is stamped with honor and usefulness, having but just been brought to a close, his work ought not to be mentioned without a passing tribute to his memory. Having had the pleasure to sail under his command, and to be associated with him confidentially in important and interesting affairs, I knew him well. He was possessed of a simple uprightness of mind, and zeal and fidelity in the performance of his duty, which give a high authority to whatever came from his hands. In bearing testimony to these intrinsic qualities of his character I am performing a most grateful duty.

The most useful information obtained from the comparison of the Coast Survey chart of 1847 with the chart of Commodore Wadsworth, relates to the diminution in the breadth of the channel between Bird Island and Dorchester Flats.

On the chart of the Commissioners it will be seen that there are four cross-sections. The lines of these sections have been transferred to Wadsworth's chart, and the breadths measured between the six-foot and the fourteen-foot curves. The first of these curves, it may be observed, cannot be defined so accurately on the old as on the new chart; the precision and minuteness in details of the present mode of construction were not then practised. The *six*-foot curves have been traced on Wadsworth's chart from the soundings by myself, but the edge of the *dotted* surface is described on the chart itself as the *fourteen*-foot curve, and this last limit, therefore, is strictly exact. The following tables exhibit the breadths of the sections on both charts.

Between the six-foot curves: —

	Wadsworth.	Coast Survey.
Cross-section No. 1	4350	3333
" " " 2	3000	3104
" " " 3	3600	3104
" " " 4	2700	2167

Between the fourteen-foot curves: —

	Wadsworth.	Coast Survey.
Cross-section No. 1	3150	2500
" " " 2	2700	2650
" " " 3	3000	1833
" " " 4	1200	708

If these figures are summed up, it will be found that, in the first case, the mean loss of breadth in this part of the channel has been four hundred and eighty-five feet; and in the second case, five hundred and eighty-nine feet. The average of the two is five hundred and thirty-seven feet.

Section No. 4 crosses the harbor at the narrowest part of the entrance above Castle Island, that is, at the buoy of the Upper Middle, and here the loss is four hundred and ninety-two feet. Again, there is a point on the northwest part of South Boston Flats, where fourteen feet is marked on Wadsworth's chart; on the same spot four feet only is given by the Coast Survey chart, showing a loss of ten feet in thirty years.

The fourteen foot-depth has been carried out by the encroachments on the channel, if taken in the nearest direction, four hundred and fifty-eight feet; but much farther if measured on the line of the section, that being the direction in which the Flats have gained most rapidly at this point. On the opposite side, there was apparently nine feet in Wadsworth's time, where there is now four; the loss of breadth between these two depths appears by the same comparison to be three hundred feet.

The zero of reduction of the soundings on Commodore Wadsworth's chart, or the plane of reference, is said to be low water, by which is evidently to be understood mean low water. This is the common plane of reduction, and any departure from it would have been specially mentioned. The depths at Charlestown Bridge are known to be the same now that they were when the bridge was built; and the soundings in this vicinity agree with those on the Commissioners' chart, with which the comparisons have been made, the difference in the reduction of the two charts being taken into account.

The plane of reference adopted in the general chart of Boston Harbor, executed by the Coast Survey, but not yet published, is mean low water. The depth of water on some rocks in the lower harbor given in Wadsworth's chart coincides with the Coast Survey determinations. Finally, the mean rise and fall of common and spring tides, according to Wadsworth, harmonize better with the reduction to mean low water than to any other plane. This question of the reduction of the soundings is thus carefully considered on account of its important bearing upon the preceding measurements. Their strict accuracy depends upon the standard being correctly ascertained. If, however, contrary to all the evidence in the case (and the comparison of the depths on the rocks leaves but little room for doubt), the very lowest observed or recorded tide should have been used by the Commodore, the loss of capacity in the main ship-channel, though less than above stated, would still be alarmingly great.

The transfer of the sections of the Coast Survey chart to that of 1817 has been made by means of rectangular coördinates, the axis of abscissas being drawn through two distant points that had remained unchanged in the interval, and the centre being the draw of Charlestown Old Bridge. The measures taken on these sections harmonize with each other.. Others might have been added, but these are abundantly sufficient to answer the purpose in view.

To the foregoing facts is to be added another more conclusive proof of the deterioration of this part of the harbor, which results from a comparison of the chart of the Commissioners of 1835 with that of the Commissioners of 1846.

It is well known that the former survey was made with extraordinary minuteness and exactness. The precise form of the bottom is laid down in measures of depth below the coping of the dry dock, and the same plane of reference was adopted for the latter survey. The means of comparison, therefore, are strictly accurate, and the results are reliable. The survey of the Commissioners of 1835 extended so far below the wharves as to include the cross-section No. 1 of the Commissioners' survey of 1846.

The area of this section (at low water) is on the former seventy four thousand eight hundred square feet; on the latter, sixty two thousand one hundred feet; showing a loss of twelve thousand seven hundred feet in the water capacity of this place. The breadth of this section on the former is three thousand nine hundred and sixty feet; on the latter, three thousand five hundred and forty-six feet; showing a decrease of four hundred and fourteen feet. The profiles of these sections here presented exhibit the change in the form of the bottom.

It is worthy of notice, that the deposit is principally on the extreme sides of the channel, and that there is a slight increase in the depth in the *middle* of the channel, owing to the loss of capacity. The section under examination crosses the part most affected by the great changes and improvements on the East Boston side during the last fifteen years. And the influence of these changes has been increased by the filling up of the South Bay, and the great decrease of that reservoir in the same time. Another section made to the eastward of the former shows a loss of breadth of about five hundred feet, though the change in the form of the bottom is less marked.

But it is not necessary to multiply cases. The object in this part of this memoir is to communicate the evidences of deterioration, and enough has been adduced to prove the most interesting fact that can be stated with regard to Boston Harbor, and that is, the fact, that, at the inner threshold of approach to the upper anchorage, to the wharves and landing-places of the city and its environs, important changes have been for some time, and are now, in progress, which demand serious attention. And it must be remembered that this fact is the more worthy of consideration on account of the great increase in the size of vessels of commerce. To meet this alteration in the draught and capacity of steamers and merchant-ships, the channels and roadsteads of the harbor should be enlarged, and not diminished.

In this part of my subject it only remains to mention the filling up of the Fore Point Channel. And here the information contained in the old charts above mentioned appears to be satisfactory. Although nothing is known of their modes of reduction, and their statements concerning the tides conflict very much with our present knowledge, yet they concur so fully in assigning a much greater depth to this channel than now exists, that their combined authority cannot be slighted. It is strengthened, moreover, by Wadsworth; and it must be admitted without hesitation, that during the present century the average depths in the Fore Point Channel, below Summer Street wharf, have diminished one half. On the spot the most favorably situated for the accumulation of silt, the loss between the years 1836 and 1847 was more than two feet. This is authentically determined by means of the Commissioners' charts of those years. To all this is to be added the concurrent testimony of intelligent individuals, owning property or living in this part of the city, and having occasion to notice the changes in progress.

From the foregoing recital of the proofs of deterioration in the main ship-channel of the harbor, a deterioration slow and gradual, certainly, but which, if suffered to continue, must in course of time impair the commercial advantages of the city, I pass to the treatment of the natural causes, by the operation of which, assisted as they unavoidably are by artificial constructions, this injury is produced.

The subaqueous deposits in Boston Harbor may be separated into three classes, the *broad flats* attached to the dry land, from which they have been extended by gradual accumulation, of which the South Boston and Quincy flats are examples; the shoals and banks connected with the land, which make out in a more or less pointed form, being projected like *spits* into the channel, and having deep water on both sides of them, of which the spit to the eastward of Castle Island is an example; and detached shoals wholly disconnected with the land, and surrounded by deep water, of which the shoal in the Mystic Channel (on a small scale), and the Lower Middle, and the shoal to the north of Rainsford's Island, are examples.

These deposits consist of the silt of the rivers, or of the degraded materials of the neighboring lands, or of both. They are created by the action of the tidal currents, and this action varies under different circumstances, as these distinct forms indicate. The different forms also run into each other and unite under the combined influence of the various modes of action. The *broad flat*, or "bay deposit," as I have elsewhere named it, is the greatest in extent. It is a skirt of shoal ground, continuous with the beach, and running off some distance under the water, and is formed in those places which recede in the manner of a bay from the main passages of the harbor. The current carried towards the sides and bottom of the bay loses its velocity by degrees as it meets the resistance of the shore; and in bays of every dimension there will be more or less conflict of the tidal streams arising from their approaching each other at last from different sides of the bay. The quiet condition of the water produced by the first of these causes, and the eddying action following the second, are states in which the water drops its burden with facility. The external outline of the bay deposit will depend chiefly on the conflict of the tidal streams.

The *spit deposit*, running off from the land (whether an island or the main shore), is created by a twofold action of the tidal current. *First*, when a tidal current freighted with suspended matter presses on a point of land, beyond which it expands into a more open space, it falls into eddies beyond the point, and these eddies again are favorable to an accumulation of the suspended matter. The point or prominence serves as a nucleus to a shoal or bar joined to the land. The stream presses with accumulated force upon the point, eddies around it, and loses its velocity by diffusion. This is so common, that there is found on all alluvial shores, at every point and headland around which the tidal currents turn, a shoal of greater or less extent, joined to the land, and making a continuation of it. The precise position of this shoal with regard to the point, that is, whether inside or outside, or in a line with the point, depends upon the strength of the current, the depth of the water, and other circumstances. But, *second*, if the land in question is an island, there will not only be the eddying action just described, but a case of conflict will occur arising from a division of the stream by the island on the one side, and the meeting of the two branches approaching each other from opposite directions, on the other side. These counteracting forces create a space of still water. The combination of these two separate modes of action increases the amount of the deposit, and alters its form. Under these conditions it will have more of the character of a bank or flat. Boston Harbor, being filled with islands, abounds in examples of this kind of deposit. They are found on two or more sides of the islands, being formed, of course, by the currents of the ebb, as well as of the flood tide.

Lastly, the detached *shoals*, which are isolated deposits in deep water, result also from the tidal streams being arrested in their direct course, and being brought into that state of eddies and of rest in which, as has been said before, the suspended matter readily subsides. The place of these shoals may be decided by natural inequalities of the bottom, which, interrupting the stream, take up a portion of the matter and cause eddies; or it may be owing altogether to the meeting of two or more streams from different sources or directions in a central spot, around which they gyrate and fall into repose. The bottom in the lower part of the harbor is rocky, and, as there is a rock near the shoal north of Rainford's Island, we may assume that the position of that shoal has been determined by a nucleus, a natural unevenness in the bottom, as in the case first described. But the small shoal in the Mystic Channel is the simple result of the conflict of the stream of the channel on the ebb with that returning from Chelsea Creek. This shoal has been bored by Mr. Williams of Charlestown, and found to consist entirely of soft mud; that is, there is no perceptible nucleus. The Lower Middle probably belongs to the same class, although a single rock is found near the shoal.

Although pains has been taken to classify the deposits according to their characteristic forms, yet it is not to be understood that these precise forms can be distinctly traced in all, or even in many cases, because, as before said, the several modes of action of the tidal currents, or the causes of deposit, are combined in their effects, and produce complicated results. For example, the broad South Boston Flats have the general character of a bay deposit; but this character is modified by other causes. They have accumulated by means of the gradual and long continued deposits made by the currents of the ebb returning from the Charles and Mystic Rivers and from Fore Point Channel, and in a less degree by the current of the flood, divided by Castle Island into two branches, which meet above the island and bring in the muddy water of Dorchester and the neighboring flats and the discharges of the Neponset. Upon the surface of the flats generally the water is for a large part of the tide in a quiet state, the currents having no appreciable velocity or determinate direction. That part of the flats situated between Castle Island and South Boston Point has been built up by the action of both tides. As the ebb of the upper harbor meets that of Dorchester Bay in this space, so also there is a confluence here of the two branches of the flood, one of which passes to the north, and the other to the south of the island. The result of this double confluence is an excessive increase of the deposit in this place. Between Castle Island and the Point, some threadlike channels or drains are still preserved, but they are of no value to navigation. It is nearly, if not quite, possible to pass on foot from the island to the Point at extreme low water.

The increased amount of the deposit at the Upper Middle, where it takes a more pointed form, and projects far into the main channel, shows in a prominent manner the double action of the confluent divisions of the flood, and of the greater or less conflict of the concurring streams of the ebb that finally approach each other from different extremities of the bay in the manner previously described as characteristic of the bay deposit. And this feature of the bay deposit is strengthened by the opposition, as far as it goes, which the ebb current from Dorchester Bay presents to the easy course of that part of the ebb current which tends to drain the South Boston Flats by passing between Castle Island and South Boston Point.

But the conflict of the stream from South Bay, through the Fore Point Channel, with the ebb passing down from the upper harbor, and winding round on the South Boston Flats, gives rise to that other striking peculiarity of the deposit, its pointed and projecting shape on the borders of this channel. The water is diverted from its direct course to the bay, running almost at right angles to it, and the channel is constantly getting longer and shallower by means of this accumulation. It will be seen by an inspection of the map, that there is a remarkable correspondence between the outline of the flats and of the shore, the protuberance of the Upper Middle answering to that of the headland of the heights. On the opposite side of the channel there is a similarity in outline between the flats and Governor's Island, especially in the spot making off from the south point.

These flats immediately round Governor's Island have the twofold character of deposits such as, on alluvial shores, always attach to points and headlands, and of deposits resulting from the confluence of streams approaching each other from opposite di ections. The growth of the banks on both sides of the channel is probably now less rapid than it has been on the external borders; it will continue to diminish. And the reason of this diminution is pregnant with instruction; *it is the gradual narrowing* of the channel that lessens the accumulation, the water being made so much more rapid in its course by this contraction, that it carries its burden beyond this point to drop it in a more favorable place.

It is perhaps in this *narrowing* of the channel, and the greater tendency to deposit on the *sides*, that the explanation is to be found of the positive declaration of the late Mr. Winslow Lewis, that there is now, somewhere in this part of the channel, seventeen feet of water, where in 1814 there was twenty-one feet. It may be an instance similar to those made known by the comparisons with Wadsworth's chart. Still, this deterioration is going on; the *maximum* velocity on a bank of gradual slope must, in the highest parts, be insufficient to disturb the bottom.

Having pointed out the mode of operation according to which the tidal streams create deposits in Boston Harbor, it is worth while to turn for a moment to a consideration of the peculiar character of the harbor, and of the artificial changes which have assisted the working of natural causes. Of good tidal harbors on alluvial or other shores, possessing the means of self-preservation, there are several distinct kinds. There are those which are merely river-courses, as that of Philadelphia and that of Savannah; those which are bays forming the receptacles of rivers, as that of Hampton Roads; such again as are kept open by a double communication with the sea, as Edgartown; such as, having the bay form, not only receive a river, but have a double communication with the sea, as New York; and lastly, those which, like Boston, have large reservoirs or basins behind the port, receiving great quantities of tidal water, and keeping the channels of the port open by the scouring power of the ebb tide. Though the Charles and Mystic are called rivers, they are chiefly to be regarded as valuable reservoirs, the latter being a short drain for Mystic Pond, and the former being affected by the tide only as far up as Watertown. All harbors that have neither land-water nor back-water have a tendency to fill rapidly, and when not very deep, like Wellfleet and Plymouth, soon lose their usefulness; and, in the same manner, all tidal harbors like Boston have a constant tendency to deteriorate. The gradual diminution in capacity of the reservoir, or, in other words, the gradual growth by accretion of the flats and marshes above Boston, as the South Bay, the Back Bay, and the Mystic, is well known to every one who has occasion to observe them from time to time. The deposits by which this gradual increase of the land is finally effected, in the places here spoken of, occur principally on the flood tide. At "slack-water," as it is called, the sedimentary matter will subside in every part of the harbor; but it is not suffered to rest in those places where the *maximum* velocity of the current is sufficiently great to move it again on the returning tide. That part of the deposit of the ebb which is left on the borders of the flats will be carried farther up by the transporting power of the flood, increasing in strength as the tide rises; but if this matter be left during the period of still water between flood and ebb on the upper and inner edge of the flats, it will not be carried off again, because at these points the ebb stream, having no back-water to assist its momentum, never acquires velocity enough for that purpose. It soon, in fact, leaves these higher spots bare. A single illustration, which has been mentioned by Professor Treadwell, suffices to convey an idea of this gradual accumulation. When the Milldam was built, a barrel of tar in a good condition was found buried several feet in the soft mud.

In this manner the capacity of the reservoir is diminished by natural causes, of which alone I am now speaking; and as the reservoirs become smaller, the united sections, or capacity of the channels, by which the water is returned to the sea on the ebb, will necessarily undergo a similar reduction. A diminution of the reservoir occasions an injury to the harbor proportional to the space lost; it reduces the size of the channels simply because less water requires a smaller passage, and is not capable of keeping open the original passage.*

This description of the character of Boston Harbor opens the way to a brief enunciation of the leading principles which should govern any plan of improvement, either special or general.

The first fundamental principle to be observed is the preservation of the water receptacle, to its fullest extent; though not necessarily in any actual or particular form.† Tidal mud-lands may be occupied to advantage, provided compensation is made by deepening the reservoir, and adding to the quantity of the water in the reservoir. The velocity being, in general, proportional to the square root of the depth,‡ and the quantity of water proportional to the depth multiplied by the velocity, it follows that our reservoirs could be, at any time, improved for scouring purposes by excavating systematically the flats which are bare at low water. Owing to this law of velocity, fully established by

* The diminution in the reservoir caused by dikes, embankments, and made land, gradually produces of course the same effect. It is stated by William P. Parrot, Esq., Civil Engineer, that the area of the peninsula has been increased to three times its original size by this filling-up process. In this manner the action of the natural causes of deterioration is greatly promoted; but as the purpose here is only to lay down general views and principles, it is not necessary to dwell upon the significancy of this statement.

† The English engineers generally.

‡ Zendrini, and others.

experiment, and resting on the highest authority, a water receptacle of one hundred and eighty acres in area, having eight feet of water on it, which it receives, on the average, at every flow of the tide, would only be equal to one of eighty-four acres, receiving and having ten feet, that is, would only be equal to it in power to keep the channel clean and sweep away the loose deposits.

This question of the conservation of the reservoirs is to be treated relatively as well as absolutely. During an examination before a committee of the House of Commons, the following interrogatory was put to Mr. John Scott Russell by Mr. Hume: "Do you mean to say that a considerable portion of land might have been inclosed, provided compensation had been made by an addition of water by deepening the channel?" To which Mr. Russell replied, "Perfectly so!"

But the fact that the diminution of the reservoir leads to the diminution of the channels, a smaller quantity of water with less velocity requiring less water-passage, conducts, by an inverse process of reasoning, to the second principle: —

The contraction of the water-passage, or the union of the waters into one channel, and the cutting off of the secondary and lateral channels which conduct the water away from the main channel, and destroy its power and usefulness by wasteful diffusion.*

But while putting into practice the second principle, there are some subordinate principles, the effects of which are to be observed, and which lead to other fundamental principles.

1. When the waters flowing in several channels are united into one channel, the capacity of the latter will be less than the sum of the capacities of all the channels, before the union was made; that is to say, the union of the different passages into one will not lead to a corresponding augmentation in this single passage. This is established by experiment, and confirmed by observation in nature.

2. The apparent contradiction contained in the above statement is explained by the augmentation of the velocity in the main passage, which, under the most favorable circumstances, *might* be equal to the sum of the velocities in original channels.†

It has been found, for example, by experiment, that, if a stream equal to one half the water in the receiving or main channel was added, and afterwards another half, the quantities in the receiving channel being successively 1, $1\frac{1}{2}$, 2, the height in the latter was apparently the same, while the velocities and quantities of the fluid increased in the same proportion; namely, 1, $1\frac{1}{2}$, 2. Again, when the augmentations to the quantity in the receiving channel were in the ratios of 3, 4, 5, 6, and 7, the increase

* A. I. C. de Fontaine.

† Guglielmini.

in the height of water in this channel was only $\frac{1}{48}$, $\frac{1}{24}$, $\frac{1}{16}$, $\frac{1}{12}$, and $\frac{1}{9}$, respectively. And, by a contrary proceeding, if several tributary streams are successively let off, the dimensions in the height of water in the receiving channel are found to prevail in the same proportion as the augmentations.* Experiments by Genneté, Guglielmini, Pitot, and Bossut establish the same fact in nature; that is, that the effect of the affluent, especially where it seconds by its direction the thread of the receiving stream by making with it a very acute angle, is not to augment materially the section of the latter, but to give to the combined current a velocity approximating nearly to the sum of the velocities of the tributary and recipient.

3. This result from the union of several channels into one, or the concentration into one channel of a volume of water which has previously escaped through several channels, in producing an augmented velocity, leads to the statement of a third fundamental principle; which is, —

The limitation of the channels with a due regard to this: that the velocity be not increased to a degree that would be inconvenient to navigation.

4. And as, in the case of a tidal stream, the water that passes through all its sections in equal spaces of time will be equal for every part of the channel, or, in other words, as the medium velocities in the different sections of the channel will necessarily be proportional to the amplitude of the sections,† we arrive at the fourth fundamental principle; which is, —

That the volumes and mean and extreme velocities of the water passing through the narrowest part of the new or improved channels, at ordinary, extraordinary, and mean states of the tide, are to be calculated and used as strict guides in the projected plans of operation. And

5. As obstructions in the natural flow of the water lead to a destruction of that uniformity in the *mean* velocities in which the accelerating force is equal to the retardations, and consequently to sudden and violent states of the current, and as such obstructions create eddies which destroy a part of the moving force of the current on the borders of the channel, and give rise to conditions favorable to deposit, so we are led to a fifth fundamental principle; which is, —

The adoption of such forms for the channel as give an uninterrupted flow to the water; and these forms must be derived, and can only safely be derived, from observations.‡ And further, —

* Genneté's experiments, cited in the *Report on Hydraulics. Proceedings of British Association*, Vol. III.

† Abbé Mann, Castelli, &c.

‡ A. I. C. de Fontaine.

6. As, in a channel of irregular boundaries, the greatest strength of the current is found to be, according to circumstances, on one side or the other, leaving on the side opposite to it an eddy, or a space of still water, or even a current running in the inverse direction, and coming in conflict at the turning-point with the main stream, (a counter-current as it is called,) and as these conditions are favorable to deposit ;* and

7. As the deposits caused by such irregularities tend continually to divert the current from its proper channel, and may even, as in the well-known case of the Mystic, completely alter the channel, closing the old and opening a new one ; so we are led to observe a sixth fundamental principle ; which is, —

That the limit or boundary lines of the channel should be as regular as possible, coinciding with the natural course of the waters ; and it would even be desirable to have the sides of the channel steep, if practicable, because, —

8. The velocity of the current is very much diminished on sides of gradual slope, and the suspended matter, therefore, is carried there to be deposited.

The preceding statement of the importance of adopting such a form of channel as will allow a natural flow to the water, of making the bounding lines of the channel regular, and of avoiding obstructions to the current, however comprehensive it may seem to be, still leaves room for the introduction of another fundamental principle similar to those just stated, but derived from the following distinct considerations : —

9. It most commonly happens that, in tidal harbors, the channel or natural course of the water from the receptacle, or river-basin answering the purpose of the receptacle, is circuitous and indirect. Where the natural channel by which the back-water so passes to the sea is direct, as in the inner harbor of New York from the North River to the Narrows, it requires no artificial construction to *improve the form* of the channel, or to *change its direction.* But in the ordinary cases first mentioned, in which Boston Harbor is embraced, *improvement of form* and *change of direction* may be necessary.

10. Now, since the water does not rebound as a mass from an opposing wall or surface, like an elastic body, (a fact I should consider it wholly superfluous to mention, if the opposite opinion had not been maintained by respectable engineers,) but, on the contrary, its currents follow adhesively the changes in the form and direction of that surface;

11. And since we observe in nature, that, wherever one of the bounding sides of a channel retreats back from the former line of direction, there is invariably a deposit opposite the retreating point, we are conducted to a seventh fundamental principle ; which is, —

That, where one of the sides of a channel is altered by an artificial construction, the

* Abbé Mann.

line of this construction should be made uniform and continuous, complying at the same time with the principles previously laid down.

12. When the angle of meeting of two streams is a right angle, or approaches a right angle, a deposit will occur at the place of junction, broad at the base and narrowing towards the external termination, the effect of which is to make, *by a natural process*, the angle of meeting acute, as in the case of the deposit at the point of union of the Mystic with Chelsea Great Creek. Thence we derive from the observation of nature the eighth principle; which is, —

That, where lateral streams are diverted into the main channel, or flow into it, they must be made to enter in a direction coincident with that of the principal current to which they become auxiliary.*

The ninth principle directs that the effect of the contemplated alterations on the transmission of the tide-wave should be studied. The experiments of Mr. Russell show that the rate of transmission of the tide-wave depends on the form and depth of the channel; and he specifically states the numerical terms of this relation. Now it is evidently of importance that the tide-waves should reach, as soon as possible, the highest navigable point in the receptacle; partly because it will add to the height of the water, and still more because it lengthens the time during which the water will be sufficiently high for navigation. To solve this important problem, we are to make use of the numbers furnished us by Mr. Russell's experiments.

The last principle to be specified here is this; that, as all plans of alteration in the harbor should have for their first object its improvement for the purposes and conveniences of commerce, so they ought to be made with a careful regard to the wants of harbor accommodation, and to the best and most permanent interests of the owners and proprietors directly concerned in their execution.

It was my wish and expectation, when this memoir was begun, to be able to present with it a plan of improvement of the harbor, such as might serve at least as a general basis for the application of the foregoing principles. But any plan worthy of the consideration of the Academy, or entitled to public confidence, must be accompanied by observations and calculations, which I have not found leisure or opportunity to make. Plans made in the study, without observations in the field, and without calculations determining their consequences, may be very erroneous, and cannot safely be trusted. A reference to the principles laid down in this memoir shows the nature, importance, and objects of these observations and calculations. All the data upon which such a plan is

* Abbé Mann.

founded should be fully and distinctly communicated, in order that they may undergo strict examination and complete discussion. This part of the subject is of necessity, therefore, indefinitely postponed. I cannot, however, take leave of it for the present, without expressing the opinion that the plan of construction on South Boston Flats contained in the partial report of the present Commissioners, dated March 22, 1851, is not suited to accomplish the declared objects, — which are, "to improve the channel and at the same time to enlarge, in the best practicable way, the wharf and dock accommodations of the city, to meet the new demands of its growing commerce" (p. 14), — but that it will injure the main ship-channel in one of its weak places, by causing an increase of deposit on the side of the Bird Island Flats, by making it more crooked in this part, and by lessening its capacity; at the same time it affords no additional accommodations to commerce of permanent value and utility, and threatens to hasten the destruction of Fore Point Channel.

One of the purposes of this memoir has been, to impart the evidences of deterioration in the upper basin. Having these evidences, it was thought expedient, especially when my previous relation to the subject is considered, to make them known. But to prevent any unnecessary apprehension of the immediately fatal consequences of this deterioration, and to do justice to our admirable harbor, unsurpassed in its convenience, security, and ample dimensions, as it is rarely equalled in its beauty, it may be well to compare it with a few of the principal maritime ports of the world.

At New York (to begin at home) there are twenty and twenty-one feet of water on the bar, and the mean rise and fall of tides is five feet; the depth at the entrance of the inner harbor of Boston is eighteen feet, and the mean rise and fall of the tides ten feet; making the average depth in the two places about the same. Boston, however, enjoys this double superiority, — that, while at New York the bar is at the outer entrance, and ships must keep the sea until they are able to pass it, at Boston the bar is at the entrance of the inner basin, vessels are landlocked when they reach it, and, if compelled to wait for the tide, can lie in safety; and Boston, moreover, has several excellent roadsteads, in which New York is comparatively deficient.

At the entrance of the estuary of the Mersey, there are only eleven feet of water at low spring tides; but the rise of tide varies from twenty-one to thirty-one feet. The construction of a new harbor of refuge, at great cost, in this vicinity, is one of the splendid enterprises in which the British are now engaged. The harbors of Dublin are artificial; a bar prevents the entrance of large vessels into the river, and the navigation of the bay is very dangerous in stormy weather. The channel of the river Clyde above Greenwich is only three hundred feet wide, and at Glasgow there is now, after all the remarkably successful improvements made in the navigation of the river, only nine feet of water at low neap tides.

Hamburg, the greatest commercial city of Germany, perhaps of the Continent, can only be approached with safety at all times by vessels drawing fourteen feet of water, though vessels drawing eighteen feet can come up with the spring tides. Marseilles, the great emporium of the South of France, the centre of nine tenths of the commerce of France with the countries bordering on the Mediterranean, has for its port a basin three thousand feet long, and quite narrow, having only sixteen or eighteen feet of water at the entrance, with no perceptible tide, and kept open only by the incessant use of dredging-machines. The port of Havre is kept clear by artificial means.

But the best idea of the capacity of Boston Harbor, and of the most suitable mode of improving its conveniences for commerce, is obtained by comparing it with London in some particulars; and this comparison is suggested by the Report of the Commissioners of January, 1850. It is recommended in this report to excavate upon the flats wet docks, in imitation of London and Liverpool, and a plan is submitted in which the place of these docks is drawn, above low-water mark. This recommendation is founded upon a total misconception of the nature of the case, and ignorance of the actual condition of Boston Harbor. Wet docks have been constructed in London at an enormous cost, because they were absolutely indispensable. As the commerce enlarged, the ships that entered the river would have blocked it up, and intercepted all passage, had they not been drawn out on one side or the other. The maintenance of the commercial prosperity of the city depended on having some auxiliary space into which to take vessels that must unavoidably lie still a long time, while discharging, loading, repairing, &c. The natural room was too limited; artificial room was to be created. In the case of Liverpool, docks are required, whatever may be their expense, if a great trade is to be sustained, in consequence of the want of good anchoring-ground in the Mersey, and because it would not under any circumstances be either safe or commodious for vessels to load and discharge cargoes by the side of a pier, or by means of lighters, where the rise and fall of the tide is thirty feet. The cases, therefore, of Boston and London, or Liverpool, are essentially different.

Neither is it correct to speak of the Atlantic Dock at New York as belonging to the same system as the English docks. The Atlantic Dock is formed by the inclosure of a natural water area, deepened and improved undoubtedly. It is hardly worth while to say, that this is a very distinct thing from the construction of one of the London docks, occupying ground on which formerly stood a populous parish, with its dwellings and churches.

But while the London docks do not furnish us an example for imitation, we may copy with advantage the plan of the Atlantic Dock. The water area of the London docks is about one hundred and eighty-eight acres. Now the whole amount of the water area of the Fore Point Channel, including the space between the wharves, added to that of the two Mystic Channels, is about the same as the water area of the London docks. So far, then, from being called upon to excavate wet docks on the South Boston Flats at an incalculable cost, we have merely to inclose these channels suitably, and maintain them in a good state, to have at once a protected water area equal to that of the London docks, but having this remarkable superiority; that by far the greater portion of it is provided with natural reservoirs of back-water, which, if properly treated, will serve always to keep it open. And to all this is still to be added Chelsea Great Creek, the water area of which is in itself equal in amount to that of the London docks, and which, though it has no rear receptacle, possesses in its natural state every advantage of security that art could bestow.

It is painful to see opinions so erroneous, upon a subject of such vast importance as the preservation of Boston Harbor, and the improvement of its commercial accommodations, officially and formally laid before the Legislature of the State.

If the Fore Point Channel were appropriately walled in, (there being already sufficient wharf-room,) and if the proper accessories were provided, there is no reason why it should not, considering its convenience and proximity, take the place in Boston Harbor of the Atlantic Dock in New York. At present it exhibits a melancholy spectacle of resources wasted and opportunities unimproved.

Regret is sometimes expressed that so large a quantity of the tidal marshes and mudlands should have been filled during the present century. But this operation was the necessary concomitant of the growth of the city, and indeed the very mode of its prosperity and increase. The statesmen and political economists of the day would not have hesitated to sanction and encourage the schemes of aggrandizement of enterprising and sagacious projectors, even if they had foreseen that one of their results would be the loss of water capacity in the main channels of the harbor. Their part was to lay the foundations of our commercial greatness; one of the duties devolved upon us is to preserve and improve the instruments of commerce; and with prudent measures we shall always have it in our power to secure to Boston Harbor its present reputation of being one of the safest and most commodious in the world.

VI.

Observations on a New Ring of the Planet Saturn.

By W. C. BOND,

DIRECTOR OF THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE.

(*Communicated April* 15, 1851.)

In the remarks which follow, reference is made to the drawing accompanying this paper, which is lettered to correspond with the text.

"1850, November 11th, 7h. 30m. M. S. T. Saturn is seen this evening under very good definition. We notice to-night with full certainty the filling up of light inside of the inner ring at x and y. Also, where the ring crosses the ball from c to d, or apparently below its projection, is a dark band, no doubt the shadow of the ring upon the ball; but what is very singular, there is also a dark line from a to b, or *above* the ring, very plainly seen, so that there can be no question as to the line where the upper edge of the ring crosses the ball. The light which fills the spaces at x and y is suddenly terminated on the side towards the ball. It does not arise from any optical deception, for this would give a similar appearance to the outside of the ring, or indeed to the edge of any object we look at, which certainly is not the case.

"G. P. B. is very confident of having seen to-night a second division of the ring, near the inner edge of the inner ring."

"1850, November 15th, 7h. 30m. The definition of the rings of Saturn is the best we have ever had. Employed powers from 140 to 400, the latter to advantage. The new ring is sharply defined on the edge next to the ball. W. C. B. thinks he sees the new ring clear of connection with the old. But the side next to the old ring is not so definite as that next to the planet, so that it is not certain whether the new ring is connected with the old or not. Where the dusky ring crosses Saturn, it appears a little wider at the outside of the ball than in the centre. Where it crosses the ball, it is not quite so dark as the shadow of the ring."

"8h. P. M. Cannot be sure of a division between the new and old rings (other than their difference of light). Once or twice with the higher powers one was suspected.

"On further examination we agree that the dark ring is narrower than the outer ring. Its inner edge may be as far from the inner edge of the broad ring as two thirds of the breadth of the outer ring."

On the same evening the following notes were entered by Mr. C. W. Tuttle : —

"I notice a faint penumbral light on the inside of the interior (old) ring at its greatest apparent elongation from the ball as seen on previous nights. This light resembles that of the unilluminated part of the moon's disc, as it appears for a few days preceding and following conjunction with the sun. Its estimated width is about the same as that of the outer ring, or a little less, and it appears the same on either side of the ball. The greatest width of this dark ring is at the same point on each side where the bright rings appear broadest. Where it crosses between us and the ball, it appears as a *dark* line on the disc close to the inside edge of the bright ring. The inner edge is sharply defined, but I cannot see that it is detached from the old ring."

The appearances above described had been noticed on many occasions prior to the above dates, but their true explanation was first ascertained on the evening of November 15th. On that night an almost perfect tranquillity of the atmosphere afforded an invaluable opportunity of viewing the phenomena of the rings. The fact of the existence of a dusky ring hitherto unknown contained in the space between the old ring and the ball could no longer be questioned.

During the remainder of its apparition, Saturn was scrutinized on nearly every clear night, but up to the end of the year the state of the atmosphere was at no time equally fine with that on the 15th of November. The new ring was, however, always to be recognized when the definition was moderately good.

The concurring testimony of Messrs. Dawes and Lassell to the existence of this remarkable appendage to the old system of rings surrounding Saturn confirms the accuracy of our observations to their full extent. Whether or not the new ring is separated into two, as suggested by Mr. Dawes, or whether a division exists between it and the bright ring, its exact dimensions, &c. must remain as questions to be decided by future observations, for which, fortunately, the position of the planet is becoming every year more favorable.

In the engraving accompanying this paper, the outer ring is represented somewhat too narrow. As a consequence, the inner edge of the new ring should be brought nearer to the ball to preserve its correct proportion to the width of the outer ring. The width of the new ring being nearly two seconds of arc.

VII.

On the Rings of Saturn.

By G. P. BOND,

ASSISTANT AT THE ASTRONOMICAL OBSERVATORY OF HARVARD COLLEGE.

Communicated April 15, 1851.

The question of the multiple divisions of the ring of Saturn has engaged the attention of astronomers from an early period. Cassini appears to have been the first to notice the primary division, though he has placed it midway between the inner and the outer edges.

This interval is always visible with a good telescope, but much nearer to the outer edge than Cassini describes it to be. Short, next, with a telescope of twelve feet focus, probably a reflector, saw two or three divisions outside of the centre of the ring ; a figure is given in Lalande's Astronomy. In June, 1780, Sir W. Herschel noticed, on four different nights, a division near the inner edge. From its never, either previously or subsequently, having been seen by him, it is probable that the subdivisions are not permanent ; otherwise they could scarcely have escaped detection under the scrutiny to which he subjected every thing appertaining to the system of Saturn for thirty or forty years. This inner division is figured and described in the *Philosophical Transactions* for 1792. In Gruithuisen's *Astron. Jahrbuch*, for 1840, pp. 103 – 105, mention is made of lines seen on both rings in 1813 and 1814. Quetelet, at Paris, with an achromatic of ten inches' aperture, saw the outer ring divided in December, 1823.

On the 17th of December, 1825, and on the 16th and 17th of January, 1826, at least three divisions were seen on the outer ring by Captain Kater. A full account, illustrated with engravings, has been published in Vol. IV. Part II. of the Memoirs of the Royal Astronomical Society. This contains also a collection of the accounts of previous observers. Two reflectors of the Newtonian form were used, of between six and seven inches' aperture.

At Berlin, on the 25th of April, 1837, the outer ring was seen by Professor Encke, with perfect distinctness, divided into two nearly equal parts, and several divisions were recognized on the inner edge of the inner ring. The great equatorial of the Berlin Observatory was used with an achromatic eye-piece.

On the 28th of May, the place of the outer secondary interval was determined. The great optical capacity of the telescope, and the eminence of Professor Encke as an observer, gives the highest value to these observations. They are found in the *Astronomische Nachrichten*, No. 338. No. 357 of the same volume has a notice of several divisions on both rings, seen by De Vico, at Rome, with the equatorial of the Roman College, the object-glass of six inches, by Cauchoix. A letter from M. Decuppis, *Comptes Rendus*, Vol. VII., gives a description of several divisions seen at Rome, in May, June, and July, 1838.

On the 7th of September, 1843, a division of the outer ring was detected by Messrs. Lassell and Dawes, at Starfield. They employed a Newtonian reflector of nine inches' aperture ; the details are to be found in Vol. VI. of the Monthly Notices of the Royal Astronomical Society.

The newly discovered inner ring of Saturn cannot properly be classed with the subdivisions of the old ring, as it lies within its inner edge.

We have, then, the best assurance, in the number and reputation of those who have described the phenomena in question, that to set aside these appearances by referring them to some optical deception on the part of the observer, or to some defect in his instrument, is an explanation altogether insufficient and unsatisfactory. On the other hand, we know that some of the best telescopes in the world, in the hands of Struve, Bessel, Sir John Herschel, and others, have given no indication of more than one division, when the planet has appeared under the most perfect definition. The fact, also, that the divisions on both rings have not usually been visible together, and that the telescopes which have shown distinctly several intervals in the old ring have failed to reveal the new inner ring, while the latter is now seen, but not the former, may be taken as some evidence that the difference is not probably owing to any extraordinary tranquillity or purity of the atmosphere, nor to any peculiarly favorable condition of the eye or instrument, but rather to some real alterations in the disposition of the material of the rings.

Admitting this, the idea that they are in a fluid state, and within certain limits change their form and position in obedience to the laws of equilibrium of rotating bodies, naturally suggests itself. There are considerations to be drawn from the state of the forces acting on the rings which favor this hypothesis. For instance, on the assumption that the matter of which the ring is composed is in a solid state, we may compute for any point on its surface the sum of the attractions of the whole ring and of Saturn. The centrifugal force, generated by its rotation, may then be determined from the condition that the particle must remain on the surface. Now in the case of a solid ring, particles on the inner and outer edges must have the same period of rotation. This condition limits the breadth of the ring, for if it be found necessary for the inner and outer edges to have different times of rotation, this can be accomplished only by a division of the ring into two or more parts. In this way Laplace has inferred the necessity of there being several rings. From a more exact analysis, M. Plana, in the *Mem. Acad. Turin*, Vol. XXIV., concludes that more than one ring is not essential. The data which he assumed we now know to have been very wide of the truth, as regards the mass and thickness of the ring.

Bessel's last determination of the mass, derived from the progressive motion of the line of apsides of the satellite Titan, which amounts to a very sensible quantity, makes that assumed by Plana at least thirty times too large. If Bessel's mass be received, the necessity of numerous rings can scarcely be questioned.

If the density of the ring be the same with that of Saturn, and its matter uniformly distributed, with Bessel's mass $= \frac{1}{118}$ of Saturn's, its thickness, seen from the earth, would only subtend an angle of $\frac{1}{29}$ of a second of arc. It is a confirmation of the mass adopted, that this does not vary more from that derived from observation, than we can attribute without improbability to a difference of density between the ring and Saturn. Sir John Herschel states, *Outlines of Astronomy*, p. 315, that it cannot be so large as one twentieth of a second. In the *Astronomical Journal* for January, 1850, I have given as the result of observations with the great refractor at Cambridge, during the disappearance of the ring in 1848 – 49, a thickness not exceeding one hundredth of a second. We cannot suppose the mass to be greater than that assigned by Bessel, without also admitting a density much greater than that of Saturn, the smallest observed thickness already requiring a density more than three times that of the planet.

In the calculations which follow, I have supposed the mass of the ring not greatly to exceed $\frac{1}{118}$ of Saturn, and its thickness $\frac{1}{45}$ of a second. For the other elements I have used Struve's measurements.

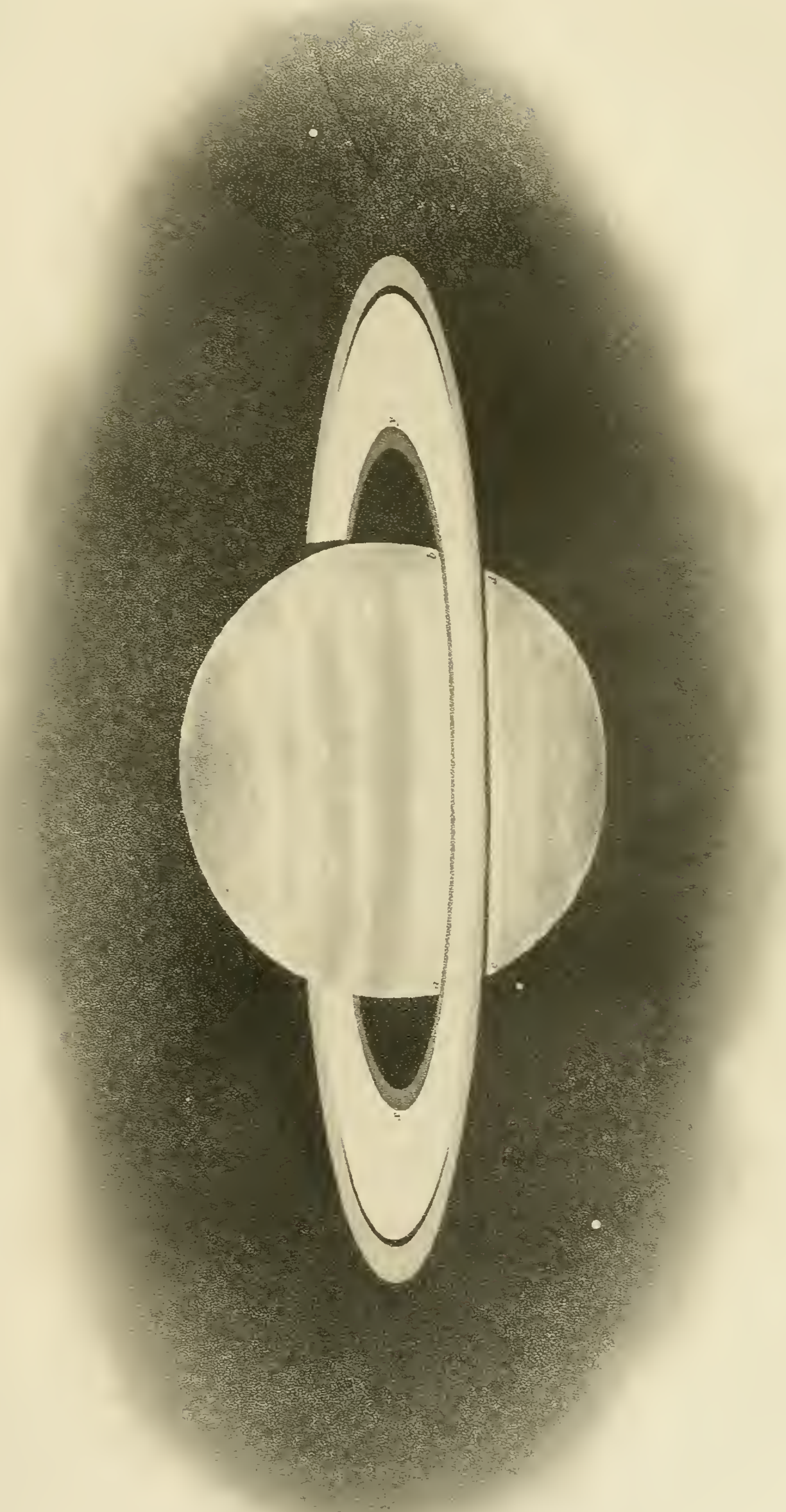
The analysis of the attraction of the ring presents great difficulties. Laplace has taken as an approximation for a very narrow ring the attraction of a cylinder of infinite length, having for its base an ellipse. Plana takes account of the curvature, by assuming the breadth to be very small compared with its radius. But if more than the first term is taken into account, the numerical calculations become very complicated. These difficulties may in part be avoided by taking account of the form of the surface only in the immediate neighborhood of the point attracted. In all the parts distant compared with the thickness, it is sufficient to suppose the whole mass collected in the plane of the centre of the rings. This plane, considered as made up of parallel straight lines, attracts the particle by the sum of the attractions of its elements. The attraction of each line parallel to its length, y being its perpendicular distance from the radius joining the attracted particle with the centre, and r and r' the distances of its extremities from the the same point, will be $\left(\frac{1}{r} - \frac{1}{r'}\right) d\, y$.

From which the attraction of a plane surface is easily computed by quadratures. For the ring on the surface of which the attracted particle is, and for the two next adjacent, I have used Laplace's formula, *Mécanique Céleste*, Vol. II. [2092]. This assumes the figure of the surface to be elliptical; in the absence of any certain knowledge of its form, this has the recommendation of simplicity, and of satisfying also, to some extent, the conditions of equilibrium. The hypothesis of any other figure would not materially affect the conclusions arrived at, provided the mass and density be not altered. The numbers thus obtained are only approximations to the truth, but are sufficient for the object in view.

If we adopt for unity the radius of the outer edge of the outer ring, we have from observation the thickness of the ring $= 2\, b < \frac{1}{900}$. Let r and r' be the radii of the inner and outer edges, and i the interval between the two adjacent rings,

$$r_0 = \frac{r + r'}{2},\ 2\, a = r' - r.$$

Any intervals permanently existing so large as one half, or even one third, of that usually seen, could not escape observation. Moreover, if the subdivisions are numerous, the width of the intervals must be proportionally diminished, because the whole area occupied by them goes to diminish the amount of light reflected, and to increase the density of each ring, both of which are already large. The light of the ring being sensibly brighter than that from an equal area on the ball, it is not probable that any considerable part of the light of the sun is transmitted through intervals. And to preserve the same mass, if the intervals are large, the matter must be compressed, as it is not allowable to give a thickness greater than is indicated by observation. To avoid the hypothesis of a reflective power, and a density greater than we are warranted in assuming, we must, therefore, consider the intervals to be very narrow. We may take, then, the width of all but the known interval as certainly less than 0.01, which is one half of the width of the known interval. From the blackness of the shadow of the ring upon the ball, which would be diminished in intensity were a considerable part of the sun's rays transmitted,



we may then infer that the intervals, which reflect no light at all, cannot occupy an area so large as one fourth of the average breadth of the rings; that is, $r' - r > 0.04$.

The above are very liberal allowances, but it is important to assume the intervals as large as possible, so as to diminish the chances of a collision, which at best is almost inevitable.

We come now to consider the forces acting on the rings.

Let f' be the force with which a particle at the outer extremity of the major axis of a ring is attracted to its surface by the sum of the attractions of all the rings, f the same force for the inner edge, s the mass of Saturn, and t the time of revolution of any ring in days, the centrifugal force at the distance r will be $= \frac{k\,r}{t^2}$, log. $k = 9.1207$.

Then, in order that the particle should remain on the surface, we must have

$$f > \frac{s}{r^2} - \frac{k\,r}{t^2};\; f' > \frac{k\,r'}{t^2} - \frac{s}{r'^2}.$$

Therefore,

$$r' - r < \frac{r_0^3}{3\,s}\,(f + f').$$

If we put $F = \frac{s}{r_0^2} =$ the attraction of Saturn on the middle of any ring, we obtain the relation,

$$\frac{f + f'}{F} > 3\,\frac{r' - r}{r_0}.$$

From the smallness of the mass of the ring, as well as from its unfavorable distribution, it is easy to see that $r' - r$ must be very small compared with r_0.

To obtain f and f', I have computed from Laplace's formula the following values: f_0 is the attraction of a single ring upon a particle on its surface, at the extremity of the major axis of its base; f_1 and f_2 are the attractions of the two next adjacent. The interval between $= 0.01$, $2\,b = \frac{1}{900}$. The radius of the outer edge of the outer ring being $= 1$.

Attractions of Three Narrow Rings.

	f_0	$\frac{f_1}{f_0}$	$\frac{f_2}{f_0}$
$a = 0.01$	+0.00661	−0.284	+0.134
.02	679	.393	.150
.03	685	.460	.154
.04	689	.507	.157
.05	691	.543	.160
.06	692	.571	.162
.07	693	.594	.164
.08	693	.614	.165
.09	694	.631	.166
.10	+0.00694	−0.646	+0.166

The attraction of the whole system, considering its mass to be uniformly distributed, I have next computed by quadratures. Breadth of whole system = 0.335. Radius of outer edge = 1.

Distance of	particle	within the	outer edge =	0.0075	Attraction =	+4.52 × mass of ring.
"	"	"	"	.0474	"	2.42
"	"	"	"	.0875	"	1.70
"	"	"	"	.1275	"	1.16
"	"	"	"	.1675	"	0.61
"	"	"	"	.2075	"	+0.04
"	"	"	"	.2475	"	—0.52
"	"	"	"	.2875	"	1.32
"	"	"	"	.3275	"	—3.53

These two tables give the means of finding f and f' with sufficient exactness. For Saturn we have

$$s = \tfrac{4}{3}\pi\left(\frac{17''.7}{40''.095}\right)^3; \text{ log. } s = 9.5567\text{ ; log. mass of ring} = 7.4848.$$

The density of a ring, for f_0, f_1, and f_2, is assumed = Saturn's, unless it be otherwise stated. A change in the density affects only that part of the ring's attraction depending on f_0, f_1, and f_2. But $f + f'$ will be changed very nearly in the direct ratio of the differen densities when the rings are narrow.

We will first suppose the case of but one ring without division.

$$r = 0.665$$
$$r' = 1.000$$
$$r_0 = 0.8325$$
$$r' - r = 0.335$$

Upon a particle at a distance within the outer edge = 0.21, the attraction of the whole ring becomes = 0. This gives for the time of rotation $t = 0.43$. The excess of Saturn's attraction over the centrifugal force at the inner edge = 0.37. At the outer edge the centrifugal force is in excess by 0.33. We must therefore have, —

$f > 0.37$ and $f' > 0.33$

But $f = 0.0040$ and $f' = 0.0070$

Assumed value of $r' - r = 0.335$

Required " < 0.0058

If there be but one ring, it will be necessary to increase its attractive force by sixty times its probable value, in order to retain its particles on its surface.

With a single division into two equal rings, we have for the inner of the two, giving such a time of rotation as will retain particles on the middle from leaving their place,

$t = 0.39$ $r = 0.665$ $f > 0.25$ $f' > 0.19$

$r' = 0.8325$ $f = 0.0050$ $f' = 0.0042$

$r' - r = 0.1675$ $r' - r$ computed $= 0.0036$

For the outer ring,

$$f = 0.0012 \qquad f' = 0.0081$$
$$r' - r < 0.0066 \text{ computed.}$$
$$r' - r = 0.1675 \text{ assumed.}$$

As no change of mass or density within the limits of probability will account for so large differences, we must therefore still further reduce the width of the rings.

By trying different values, it will be found necessary to diminish $r' - r$ so far, that the intervals occupy nearly as much area as the reflecting surface, which cannot be admitted, for reasons before given.

We will take $r' - r = 0.02$, which corresponds to eleven equal rings distant from each other by 0.01.

For the outside ring,

$$t = 0.59 \qquad f > 0.0023 \qquad f' > 0.0202$$
$$f = -0.0036, \text{ tendency is from the surface.}$$
$$f' = \quad 0.0144$$
$$r' - r < 0.0097 \text{ computed.}$$
$$r' - r = 0.0200 \text{ assumed.}$$

For the middle ring,

$$f > 0.0172 \qquad f' > 0.0205 \qquad t = 0.46$$
$$f = 0.0046 \qquad f' = 0.0095$$
$$r' - r < 0.0064 \text{ computed.}$$
$$r' - r = 0.0200 \text{ assumed.}$$

For the inner ring,

$$f > 0.0415 \qquad f' > \quad 0.0288 \qquad t = 0.34$$
$$f = \ .0113 \qquad f' = -0.0004$$
$$r' - r < \quad 0.0031 \text{ computed.}$$
$$r' - r = \quad 0.0200 \text{ assumed.}$$

In order to preserve the mass as previously adopted, we must suppose an average density about three times that of Saturn. By recomputing f and f' for the inner ring with a density $= 3$, we obtain,

$$f = +0.0263 \qquad f' = +0.0091$$
$$r' - r < 0.0101$$
$$r' - r = 0.0200$$

A density six times that of Saturn would just suffice to retain the particles on the surface of the inner ring. To effect this without changing the mass, we must diminish b in the same proportion. But the attraction of a thin and narrow ring upon a particle at the extremity of its major axis varies nearly as $b \times$ density. *Mécanique Céleste*, Vol. II. [2095]. Therefore f is not increased when we increase the density by diminishing b.

If a further diminution of width is attempted, a difficulty is encountered in the width of the intervals.

In the last case supposed, the area occupied by the intervals is already double the limit previously assigned. If we lessen the space occupied by the intervals, by bringing the adjacent rings nearer together, f decreases instead of increasing.

But there are still stronger objections to a large number of small rings near to each other.

It is known in the case of a single ring, that, if it were perfectly uniform in every part of its circumference, the slightest exterior disturbance would precipitate it upon the body of the planet. To avoid this catastrophe, we must suppose each ring to be an irregular solid, its centre of gravity not coinciding with its centre of figure, but having a motion of rotation about the body of Saturn. In addition to this, a number of regular concentric rings are in a position of unstable equilibrium, by virtue of their own mutual attractions. The slightest inequality in the intervals would have the effect of throwing the whole system into confusion.

Let us suppose, for instance, that the inner ring deviate by ever so small an amount from an exact central position with reference to the ring outside of it. The nearest sides commence moving together, until they come in contact. All the others must follow. The consequence of such a conflict of these masses, each urged by different velocities, corresponding to the different times of rotation of the several rings, must be fatal to the whole structure. It is therefore again necessary that the rings be not of regular figure or density.

But if these irregularities are small, there will be only a feeble resistance opposed to their tendency to fall upon the body of the planet. On the other hand, if they be large, they will become the source of mutual disturbances, which must end in their destruction, by causing them to fall upon each other. The smallness of the intervals between them, and the near equality in the period of rotation of two adjacent rings, will make the danger of the latter event imminent, if not wholly unavoidable. The nearness of the rings will in any case render it impossible that they can assume a figure of equilibrium permanent or nearly so.

The hypothesis that the whole ring is in a fluid state, or at least does not cohere strongly, presents fewer difficulties.

There being no longer an unyielding coherence between the particles of the inner and outer edges, they have not necessarily the same period of rotation about Saturn. A continual flow of the inner particles past the outer may be supposed, by which the centrifugal force will be brought into equilibrium with the other forces. And even should an accumulation of disturbances, of which the absence of inequalities lessens the probability, bring the rings together, the velocities at the point of contact will be very nearly equal, and the two will coalesce without disastrous consequences.

If in its normal condition the ring has but one division, as is commonly seen, under peculiar circumstances it might be anticipated that the preservation of their equilibrium would require a separation in some regions of either the inner or outer ring; this would explain the fact of occasional subdivisions being seen. Their being visible for but a short time, and then disappearing, to the most powerful telescopes, is accounted for by the removal of the sources of disturbance, when the parts thrown off would reunite.

Finally, for a fluid ring, symmetrical in its dimensions, there is not the same necessity for a state of unstable equilibrium, with reference either to Saturn or to the other rings, which obtains in the case of a rigid coherence of its particles.

VIII.

A History of the Fishes of Massachusetts.

By DAVID HUMPHREYS STORER, M. D., A. A. S.

Continued from page 92.

Otolithus regalis, *Cuv.*

The Weak-fish.

(Plate IX. Fig. 1.)

Johnius regalis, Schn.
Labrus squeteague, *Weak-fish*, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 396, pl. 2, fig. 6.
L'Otolithe royal (*Otolithus regalis*, Cuv., *Johnius regalis*, Schn., *Labrus squeteague*, Mitch.), Cuv. et Val., v. p. 67.
Sciæna (*Otolithus*) *regalis*, *Squeteague*, Rich., Faun. Boreal. Americ., iii. p. 68.
Otolithus regalis, *Weak-fish*, Storer, Report, p. 33.
" " " Ayres, Bost. Journ. Nat. Hist., iv. p. 259.
" " " Dekay, Report, p. 71, pl. 8, fig. 24.
" " " Linsley, Cat. of Fishes of Conn.
" " " Storer, Mem. Amer. Acad., New Series, ii. p. 318.
" " " Storer, Synopsis, p. 66.

Color. The upper part of the body is of a bluish color, with irregularly distributed brownish spots. Sides silvery. Abdomen white. Pupils black; irides yellow. Dorsals, pectorals, and caudal fin brownish. Ventrals and anal orange.

Description. Body elongated, compressed. The length of the head is equal to one fourth the whole length of the fish; it is flattened between the eyes, and slightly convex back of them. The eyes are large and horizontally oblong, and about one seventh the length of the head. The nostrils are situated directly in front of the superior anterior angle of the eye; — the posterior the larger, a vertical slit; the anterior circular. Mouth large. The lower jaw the longer, with a single row of separated, sharp teeth upon its sides, and several rows of smaller teeth at its centre. The sides of the upper jaw are armed with very minute teeth; somewhat larger teeth are observed at its centre, in the midst of which are situated two strong, incurved fangs. Minute teeth in the pharynx.

The lateral line arches backwards until opposite the posterior termination of the second dorsal fin, whence it pursues a straight course to the extremities of the caudal rays.

The triangular first dorsal fin commences just back of the origin of the pectorals; its third and fourth rays are longest.

The second dorsal is elongated, and diminishes in height posteriorly; it terminates on a line with the anal fin.

The pectoral fins arise just beneath the posterior angle of the operculum, and extend beyond the middle of the first dorsal.

The ventral fins commence posterior to the base of the pectorals, and terminate on a line with the tips of those fins.

The anal fin is short and quadrangular.

The caudal fin is somewhat emarginated.

The fin rays are as follows: — D. 8-1-28. P. 15. V. 6. A. 13. C. 17. Length one to two feet.

Remarks. Many years since, this species was found in abundance about Nantucket and Martha's Vineyard, but of late it has disappeared. Dr. Yale wrote me, in October, 1837, "The *squeteague* has deserted these waters; there has not been one taken for three or four years about here; they left about the time that the *blue-fish* came." Hon. Hezekiah Barnard, of Nantucket, in a letter to me, dated July, 1838, remarked, "The *squeteague* or *weak-fish* have disappeared since the return of the *blue-fish*, who are their avowed enemy. I have conversed with our fishermen; they say they have scarce seen one for six years."

On the 23d of June, 1847, a squeteague was taken at Provincetown, the first known to have been taken there for twenty years.

Bay of Chaleur, Lieut.-Col. Hamilton Smith. Massachusetts, Storer. New York, Mitchill, Dekay. Caribbean Sea, Cuvier.

GENUS II. UMBRINA, Cuv.

Distinguished from the Scienoids by a cirrhus under the symphysis of the lower jaw.

UMBRINA NEBULOSA, *Storer.*

The King-fish.

(PLATE IX. FIG. 4.)

Sciæna nebulosa, King-fish, MITCHILL, Trans. Lit. and Phil. Soc. of N.Y., I. p. 408. pl. 3, fig. 5.
L'Ombrine des Etats Unis (*Umbrina alburnus,* CUV., *Sciæna nebulosa,* MITCH., *Perca alburnus,* LIN., *Centropomus alburnus,* LACEP.), CUV. et VAL., Hist. Nat. des Poiss., V. p. 180.
Umbrina nebulosa, King-fish, STORER, Report, p. 35.
" " " AYRES, Bost. Journ. Nat. Hist., IV. p. 259.
" " " LINSLEY, Cat. of Fishes of Conn.
Umbrina alburnus, King-fish, DEKAY, Report, p. 78, pl. 7, fig. 20.
" " " STORER, Mem. Amer. Acad., New Series, II. p. 323.
" " " STORER, Synopsis, p. 71.

Color. Of a dull gray color, with silvery reflections upon sides, ornamented with irregularly disposed dark bars; some passing obliquely forwards from the dorsal fin; others passing obliquely backwards from nape of neck; and one broader one pursues a straight course backwards through the middle of the body, from extremity of pectorals to the tail. Body beneath, yellowish. Extremities of first dorsal, pectorals, and tips of ventrals, white; rays black; second dorsal and base of pectorals and ventrals color of abdomen.

Description. Body elongated, slightly arched over pectorals, gradually tapering towards tail. Length of head, which is the same as the greatest depth of the body, equal to one fifth the entire length of the fish. Scales upon the head smaller than those upon the body; head slightly flattened between eyes; rounded upon occiput; somewhat depressed back of snout. Snout blunted, projecting slightly beyond upper jaw. Eyes of moderate size; the greatest diameter equal to half the distance between eyes. Nostrils directly in front of eyes; the posterior larger, situated obliquely beneath and in front of the anterior inferior angle of eye; at the anterior inferior angle of this orifice is situated the anterior nostril, which is very small and circular. Mouth of moderate size, projectile; lips fleshy; jaws filled with numerous very small card-like teeth, the front row in the upper jaw the longest; upper jaw the longer; a small fleshy cirrhus is suspended from the chin. Preoperculum serrated at its posterior margin; more sparsely so beneath. A small, concealed, delicate spinous point is observed at posterior portion of operculum. Lateral line very distinct, curving with the body.

The triangular dorsal fin arises just back of the pectorals; its first ray is a minute spine; the third ray is much the longest of all; this ray is nearly twice as high as the length of the fin, and nearly three tenths the length of the fish. The extremities of the rays are free, like those of the other fins.

The height of the second dorsal, which is equal throughout, is one sixth of its length.

The length of the pectorals is less than one third their height.

The ventrals arise in front of the posterior half of the pectorals; extremities multifid; first ray stoutest.

The caudal is deeply emarginated; the upper lobe pointed, the lower broad and rounded at extremities; about as high as long.

The fin rays are D. 10 – 26. P. 21. V. 5. A. 10. C. 18.
or D. 9 – 26. P. 19. V. 5. A. 10. C. 17.

Length sixteen and a half inches.

Remarks. In my "Report on the Fishes of Massachusetts," published in 1839, I admitted this species under the name of *Umbrina nebulosa.* As Dekay, in his "Report on the Fishes of New York," published in 1842, accepted the opinion of Cuvier, that it was identical with the *Perca alburnus* of Linnæus, I felt in a measure compelled to coincide; and consequently in my "Synopsis of the Fishes of North America" I introduced it as the *Umbrina alburnus.* Convinced that our species is distinct from the Southern fish, I have resumed my former opinion.

This species must be very rare in our waters. The specimen belonging to the Natural History Society of this city was captured in a lobster-pot at the Boston light-house, previous to the year 1833. In 1840, a specimen was taken at Lynn, and was referred to by me in the Journal of the Natural History Society. In July, 1846, Captain Atwood caught one at Provincetown; and in November, 1847, a second specimen at the same place. Both of these latter specimens were taken in nets, while fishing for mackerel. These are all of which I have any knowledge.

Massachusetts, Storer. Connecticut, Ayres, Linsley. New York, Mitchill, Dekay.

FAMILY IV. SPARIDÆ.

This family is characterized by the opercular pieces being unarmed; the palate toothless; the jaws not protractile; scales large. Branchial rays not exceeding six.

GENUS I. SARGUS, Cuv.

Trenchant incisors in front of the jaws, almost similar to those of man; molars rounded.

Sargus ovis, *Cuv.*

The Sheep's-head.

(Plate X. Fig. 1.)

Sparus ovis, Sheep's-head, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 392, pl. 2, fig. 5.
Le Sargue tête-de-mouton (*Sargus ovis,* Cuv., *Sparus ovis,* Mitch.), Cuv. et Val., Hist. Nat. des Poiss , vi. p. 53.
Sargus ovis, Sheep's-head, Storer. Report, p. 36.
" " " Dekay, Report. p. 89, pl. 8, fig. 23.
" " " Ayres. Bost. Journ. Nat. Hist., iv. p. 260.
" " " Storer. Mem. Amer. Acad., New Series, ii. p. 332.
" " " Storer. Synopsis, p. 80.

Color. Light gray, with six quite distinct, dark-brown, transverse bands, broad and nearly equidistant from each other; another band across neck, over shoulders. Head above darker; orbits greenish; gill-covers with silvery and golden reflections. Throat somewhat reddish. Pupils black, irides golden. Scales throughout body margined with darker than their centre. Fin membranes dark brown or black, save that of pectorals, which is nearly colorless.

Description. Body short, stout. Back rounded, slightly elliptical. Head hardly projecting, about one fourth the length of fish; its depth about five sevenths its greatest depth; its width between eyes about two fifths its length. Posterior and upper part of head scaled, the rest naked. Lips large and fleshy; jaws equal, armed in front with large, stout, quadrangular teeth, the outer of which are somewhat curved inward; these teeth in the upper jaw slightly overlap those of the lower; within and behind these are several rows of teeth, rounded or obtusely conical. Eyes large, their diameter nearly equal to half the distance between them; just above and in front of them the orbitar ridge is quite prominent. Nostrils high up in head, anterior to eye, double, the posterior an elongated slit opening backwards. Head anteriorly abounding in mucous pores. Posterior opercular margin sinuous. Scales upon body generally very large, although in some places their size is greatly diminished, as upon top of head, the throat, and the bases of all the fins save the anterior three quarters of the dorsal. Lateral line commences high over pectorals, and, curving upwards at first rather more than the line of body, gradually becomes parallel to it until it reaches a line with termination of dorsal and anal, whence it runs straight to middle of caudal; its scales present dark ramifications, which appearance is also found upon the scales bordering a triangular space on top of head.

The first twelve rays of dorsal fin are strongly spinous; of these the alternate rays are much larger than their neighbors. The first five of these rays gradually increase in length; the remaining seven are about equal. The rest of the fin increases in height, giving its termination a peculiar truncated appearance. Behind and beneath the base of the fin, as well as at termination of anal, is a deep emargination.

Pectorals very much elongated; the rays of first half are simple, the others branched.

Ventrals stout, subtriangular; at their base a strong spinous process, covered with scales, connected along its edge by several membranous attachments. The first ray is spinous.

The anal shuts anteriorly into a deep groove, as does also the dorsal. Its first three rays are spinous; the second is much the largest.

Caudal slightly truncated; the interspaces between its rays are well scaled at first.

D. 12 – 12. P. 16. V. 1 – 6. A. 3 – 2. C. 22. Length twenty inches.

Remarks. This delicious fish, which has been so minutely described and so highly eulogized by Mitchill, in his "History of the Fishes of New York," is occasionally taken in the waters of Massachusetts south of Cape Cod. Thomas A. Greene, Esq. of New Bedford, informs me it is sometimes sold in that market from the above-noticed locality. Dr. Mitchill speaks of it "as the most esteemed of the New York fishes, and fetching a higher price than any, excepting, perhaps, fresh salmon and trout"; and Dekay remarks, "The sheep's-head holds the same rank with American gastronomes that the turbot holds in Europe. I have frequently eaten of both, under equally favorable conditions, that is to say, within an hour after having been taken from the water, and can assert that the sheep's-head is the more delicate and savory fish."

Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Cuvier, Dekay. Lake Pontchartrain, Louisiana, Lesueur.

GENUS II. PAGRUS, Cuv.

But two rows of small, rounded molar teeth in each jaw.

Pagrus argyrops, *Cuv.*

The Scapaug.

(Plate X. Fig. 4.)

Sparus argyrops. Lin., Syst. Nat., Gmel., p. 1277.
" " *Silver-eyed Sparus,* Shaw, Gen. Zoöl., iv. p. 426.
Labrus versicolor, Big Porgee of New York, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 404, pl. 3, fig. 7.
Le Pagre œil-d'argent, Pagrus argyrops, Cuv. et Val., vi. p. 164.
" " *Big Porgee, Scapaug, Scup,* Storer, Report, p. 38.
" " " Dekay, Report, p. 95, pl. 9, fig. 25.
" " Linsley, Cat. of Fishes of Conn.
" " *Porgee,* Ayres, Bost. Journ. Nat. Hist., iv. p. 260.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 334.
" " Storer, Synopsis, p. 82.

Color. When just caught, this fish is of a beautiful pinkish tinge or flesh-color upon the upper portion of the sides; abdomen silvery. The naked portion of the head, between, anterior, and posterior to the eyes, reddish. At the base of the dorsal fin on each side is a narrow green ridge; also a similar ridge just back of the eyes. Pupils black; irides silvery, with the exception of the upper middle portion, which is brown or cupreous. The dorsal fin is reddish, with the bodies of the anterior rays silvery white. Pectorals with a slight tinge of red, greenish at their base beneath. Ventrals of a greenish tinge. Anal brownish, margined with blue. Caudal reddish.

Description. The length of this species is from eight to twelve inches; the length of the head is about one fourth the length of the entire fish; the depth of the body across from the base of the pectorals is equal to rather more than one third its length; the width of the body at the base of the tail is equal to one tenth its length. Body very much compressed towards the back; back gibbous, gradually curving towards the tail. The eyes are large and circular. The jaws when closed are equal. In the back of the jaws are two rows of blunt teeth; those in front of the jaws are sharp and prominent. The lips are large and loose. The nostrils are double; the anterior is smaller and circular, the posterior larger and vertical. The head is destitute of scales. The preoperculum and operculum are covered with scales. A large semicircular scale is observed at the commencement of the lateral line; between this scale and the outer angle of the naked space at the posterior angle of the eye, a band of smaller scales than those of the body passes obliquely upwards to the anterior portion of the dorsal ridge. The lateral line, commencing back of the upper angle of the operculum, and passing obliquely up to a point on a line with the fifth or sixth spine of the dorsal fin, curves with the body to the base of the tail.

The dorsal fin is received into a deep groove at its base; when this fin is not erect, the spines are scarcely visible, so completely do they shut into this groove. The third spine is the longest; from the extremities of the first three spines are suspended delicate filaments. Just anterior to the dorsal fin is situated a strong horizontal spine, almost entirely enveloped by the skin, which projects forwards.

The pectoral fins commence on a line beneath the origin of the dorsal fin; they are one fourth the length of the body.

The ventrals are just back of the pectorals; their second and third rays are the longest. A large subsidiary scale exists at the anterior edge.

The anal fin is shorter than the dorsal, and terminates on the same plane with that fin, and like the dorsal is received into a groove at its base.

The caudal fin is quite deeply forked.

The fin rays are as follows: — D. 12 – 12. P. 15. V. 6. A. 3 – 11. C. $16\frac{3}{3}$.

Length about a foot.

Remarks. This pretty species, which is known as the Scup, Porgee, and Scapaug, is taken in large quantities in Buzzard's Bay and the Vineyard Sound; and at New Bedford, Holmes's Hole, and Gay Head it is one of the most common fishes, and in a fresh state is used more than any other. At Holmes's Hole it is taken from the first of June until the middle of October with the hook; after that date, in the ponds, with spears and nets. Within a few years, small numbers have appeared north of Cape Cod, and are now yearly captured at Wellfleet and Sandwich.

In the year 1834 or 1835, Captain William C. Downes, of Holmes's Hole, carried a smack-load of this species from the Vineyard Sound, and threw them overboard in Plymouth Harbor.

Mr. James Newcomb, fishmonger in the Boston Market, informs me that in the year 1831 or 1832 a smack-load of scapaugs arrived in Boston Harbor. A portion of them were purchased by subscription among the fishermen in the market, and thrown into the harbor. The next season two specimens were caught from our wharves; in the summer of 1835, one individual was taken at Nahant, and was considered a very strange fish, no specimen having been known to have been seen there before; in 1836, still another was captured at Nahant. As no specimen had ever been taken so far north before, and as the few taken would lead to the inference that those which had been transplanted from Buzzard's Bay had not bred in the cold waters of this portion of Massachusetts Bay, we are led to believe the individuals taken immediately around Boston were of the number of those originally brought from the South.

Massachusetts, STORER. Connecticut, AYRES. New York, MITCHILL, CUVIER, DEKAY. South Carolina, LINNÆUS.

FAMILY V. SCOMBRIDÆ.

The fishes of this family have small scales, so that the greater part of the skin appears as if entirely smooth. The ventral fins are destitute of scales; the opercula are without spines or denticulations; in most of them the caudal fin is large and powerful, and generally they are furnished with numerous cœca.

GENUS I. SCOMBER, Cuv.

Body fusiform, covered by scales which are uniformly small; sides of the tail not carinated, but merely raised into two small cutaneous crests; dorsal fins widely separated; some of the posterior rays of the second dorsal and anal free, forming finlets; one row of small conical teeth in each jaw.

Scomber Dekayi, *Storer.*

The Spanish Mackerel.

(Plate XI. Fig. 1.)

Scomber colias, The Spanish Mackerel, Storer, Report, p. 45.
" " " " Dekay, Report, p. 104, pl. 11, fig. 23.
" " " " Storer, Mem. Amer. Acad., New Series, II. p. 341.
" " " " Storer, Synopsis, p. 89.

Color. The upper part of the body is of a light-green color, with numerous contiguous beautifully undulating lines of a darker green passing down the sides and just crossing the lateral line. Beneath the lateral line is an interrupted dull-brown band, arising beneath the pectorals and continued in a straight course to the tail; below this band the sides are silvery, with numerous irregularly marked blotches, circular, oval, and oblong. The abdominal ridge is immaculate; the entire sides exhibit cupreous reflections. The upper portion of the operculum is greenish, with cupreous reflections; the inferior portion, as well as the preoperculum and jaws, is silvery. The first dorsal fin is transparent, slightly dusky; the pectorals have a small black blotch at their base, within, which is scarcely perceptible unless the fins are raised; their outer base is silvery. The ventrals are of a reddish white. The caudal fin is of a yellowish green. The pupils are black; the irides silvery. The mouth is fuliginous; the tongue is greenish, with a metallic tint.

Description. The body is cylindrical, very plump, tapering towards the tail, at the origin of which it is very small. The greatest depth of the body is equal to rather more than one sixth its length. The length of the head is less than one fourth the length of the body; it is flattened upon its top, compressed upon its sides; the snout is rather pointed. The eyes are large and circular; the diameter of the eyes is less than the distance between them. The nostrils are double; the anterior is circular, in front of posterior a distance equal to that between the posterior and the eye; the posterior is vertical, just in front of the eyes. The jaws are equal, crowded by a single row of very minute teeth.

The first dorsal fin arises opposite the middle of the pectoral fins; its first ray upon its outer edge is margined, as well as the spaces between the tips of the rays, with black; the second ray is the longest; the most posterior ray is exceedingly minute. The tips of all the rays project slightly beyond the membrane.

The second dorsal fin commences back of the first, at a greater distance than the length of the first dorsal. This fin is shorter than the preceding; its rays are short, and enveloped in a thick membrane emarginated above; the extremities of the rays project slightly beyond the membrane. There are five finlets back of the second dorsal fin; the fifth is deeply divided, making it appear like two finlets.

The pectorals are just beneath the origin of the lateral line; they are triangular, and their length is equal to the height of the first dorsal ray.

The ventrals are fan-shaped; they are situated just in front of the first dorsal fin: their rays are multifid.

The anal fin arises back of the second dorsal fin, and like it is emarginated above, and has five finlets posterior to it. A small spine, projecting backwards, is situated at the origin of the anal fin.

The caudal fin is deeply forked, and has at its base two lateral carinæ.

The fin rays are as follows: — D. 9 – 11 or 12. P. 19. V. 5. A. 12 or 13. C. $18\frac{6}{6}$.

Length, one to two feet.

Remarks. The many points of resemblance to the *Scomber colias*, Gmel. presented by this fish, caused me to consider it as identical with that species, and thus I described it in my "Report on the Fishes of Massachusetts." With this opinion Dekay coincided in his "Report on the Fishes of New York"; although we might infer that he was not perfectly convinced of our species being the foreign fish, from the following sentence at the conclusion of his description: "If this species is identical with the *S. colias* of Europe, it has a wide geographical range," &c. Subsequent investigation has convinced me that the species under consideration is indigenous to the American coast. It differs from the *S. colias* in its more robust figure, its markings, and the number of rays in the first dorsal fin. I know of no other species for which it can be mistaken. With a melancholy pleasure I would dedicate it to the memory of the lamented naturalist who has accomplished so much for the science of our country.

This fish is of late years found more rarely along our coast than formerly. Captain Blanchard, of Lynn, informs me, that during some seasons but two or three individuals are taken by the fishermen. Captain Atwood has seen but a single specimen during the last four or five years; many years since, it was abundant at Provincetown, and would run up the small creeks, and be left by the tide. This fish usually weighs about three quarters of a pound; generally speaking, it is as fat as the *Scomber vernalis*, but it is not considered so good to eat; by epicures, however, it is thought to be excellent, even preferable to the common mackerel. Dekay states that he has seen specimens nearly two feet in length in the New York market.

Massachusetts, STORER. Connecticut, LINSLEY. New York to Carolina, DEKAY.

SCOMBER VERNALIS, *Mitchill.*

(PLATE XI. FIG. 2.)

Scomber vernalis, Spring Mackerel, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 423.
Scomber grex, Thimble-eyed, Bull-eyed, or Chub Mackerel, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 422.
Le Maquereau printanier (Scomber vernalis, MITCH.), CUV. et VAL., VIII. p. 48.
Le petit Maquereau de l'Atlantique (Scomber grex, MITCH.), CUV. et VAL., VIII. p. 45.
Scomber grex et vernalis, Chub and Spring Mackerel, RICH., Fauna Boreal. Americ., III. p. 81.
" " " " " " STORER, Report, p. 41.
Scomber vernalis, Spring Mackerel, DEKAY, Report, p. 101.
Scomber grex, Fall Mackerel, DEKAY, Report, p. 103, pl. 11, fig. 32.
Scomber vernalis et grex, STORER, Mem. Amer. Acad., New Series, II. p. 342.
" " " STORER, Synopsis, p. 90.

Color. Upper part of the body of a dark-green color, marked throughout its whole extent from the occiput to the tail with beautiful transverse, more or less undulating, broken bands, of a deeper hue, commencing on the sides of the dorsal ridge, and extending downward below the lateral line. Top of head of a dark, almost black color, produced by longitudinal, broad, broken bands, passing backwards from the snout, and a large black blotch extending backwards from the occiput towards the gill-covers. The portion of the head directly back of the eyes cupreous. Gill-covers and maxillary bones silvery. Intermaxillary bones dark-fuliginous, as well as the tongue and inside of the jaws; angle of jaws dusky. Sides white, with cupreous reflections. Abdomen white. Beneath the lateral line, on each side, is a fuliginous, oftentimes interrupted line, much wider than the lateral line, arising beneath the pectoral fin, and traversing the length of the fish; the space between these two lines is of a duller color than the side beneath.

Description. Body elongated. Length of head almost equal to one sixth of the length of entire fish. Eyes large, circular, their diameter equal to one half the distance between them; pupils black; irides silvery. Eyes protected by a nictitating membrane. Nostrils circular. Inferior margin of preoperculum marked by a row of minute mucous pores, and a few are also seen on the posterior margin. Gape of mouth moderate. Jaws and palatine bones armed with a single row of very minute teeth.

The very narrow lateral line commences directly back of the humeral bone, on a line above the origin of the pectoral fin, and pursues a gently undulatory course to the base of the tail: this line, being slightly prominent, is very distinct.

The first dorsal fin, composed of strong rays, of which the second and third are the longest, arises on a line opposite the posterior half of the pectoral fins; in some specimens the membrane in this fin reaches to the top of the rays, in others the extremities project as in the figure; the length of this fin is hardly greater than its height. When unexpanded, it is entirely concealed in a groove at its base.

The second dorsal, situated upon the posterior half of the head, is of a fuliginous color, margined with white ; it is nearly three times as long as high ; back of this second dorsal, occupying the space between it and the tail, are five finlets, the fifth of which is usually the largest.

The pectoral fins, of a dark color, having at their base beneath, a black blotch, arise back of the upper third of the operculum. Their length is equal to about one third their height.

The ventrals arise back of the pectorals, and likewise have beneath them a black spot at their base ; save the tinge given them by this spot, they are of a flesh color in the fresh fish, but soon become the color of the abdomen after death. The first ray is very strong. All the rays are subdivided at their middle, and again divided into smaller portions at their extremities.

The anal fin arises directly back of the anus, which is situated opposite the origin of the second dorsal. At the commencement of this fin is a short spine ; this fin is slightly shorter than the second dorsal, and is of the same color as the abdomen. Back of this fin are six finlets ; that next the anal fin appearing at first sight to be a portion of the fin.

At the base of the caudal fin are situated two longitudinal carinæ, extending the whole length of the fleshy portion of the tail ; the outer rays of the caudal fin are much the larger ; their articulations are very direct ; the fin is deeply forked ; its extremities are margined with white ; the distance between the extremities of the caudal rays, when expanded, is equal to the length of the head.

The fin rays are as follows : — D. 10 – 12. P. 17. V. 5. A. 12. C. 20.

Remarks. Mitchill described the mackerel which visit our shores in the spring, and those which are taken in the autumn, as distinct species. Dekay coincides with him in his opinion. In my "Report" I considered them as one species, agreeing with Richardson, who observes : "The only differences between *S. grex* and *vernalis* seem to be in their size and color, and they are very probably different ages of the same species." In my "Synopsis" I reluctantly yielded my opinion to that of Dekay, and described the two species. Satisfied that my early impressions were correct, I again unite them, remarking, as in my "Report," that "I have examined with much care the mackerel which are brought to our market, and the differences are too slight between them to constitute distinct species."

This beautiful species is one of the most valuable fishes which frequents our waters. From the 10th of May to the 15th of June, they appear at the entrance of Massachusetts Bay, having been a few days previous at Nantucket and Vineyard Sound. Nine tenths of those which are first seen are *males*, and they are all large, but poor, weighing from one pound to a pound and a half each. After they have been cured, and made ready for inspection, and are packed for the third quality, one hundred and fifty-four, fifty-five, or fifty-six constitute a barrel. At their first appearance they will not take the hook, and are therefore captured in nets. The fishermen of Provincetown are the only persons in the State who thus take them. Their nets are about eighty yards long and eighteen feet deep, with the meshes three and a quarter inches long, of a size intermediate between a herring net and a menhaden net, the one being too large and the other too small. These nets are suspended vertically in the water, so that when the mackerel, as they swim along, endeavor to pass through, they are caught by the gills; or should they be smaller than usual, they pass their heads through, and are caught by the body.

Most of the fishermen engaged in this method of catching mackerel reside at that portion of Provincetown called Long Point, north of the town; and it is exceedingly interesting to watch them in their laborious and successful avocation. The following notes I took upon the spot, June 26, 1847: — "Now all the male inhabitants of the Point are engaged in the mackerel fishery; from twenty to thirty boats, each of about three or four tons burden, sail at four or five o'clock in the afternoon, having all their nets, varying from ten to fifteen in number, carefully dried and rolled up for their night's fishing. Each boat has two persons on board, one to manage the boat while the other takes charge of the nets. As the boats sail from the harbor, the scene is very exciting, all leaving at about the same time, and doubling the point upon which the light-house is situated nearly together. (Occasionally a boat arrives late in the morning from its night's fishing, or is detained until an unusually late hour in the afternoon, by its nets being injured, or by the unusually large quantity of fish taken the previous night, and then it does not leave the harbor, but anchors within the Point; this, however, is seldom done, as but few mackerel, comparatively, are taken here, except when the fish first arrive upon the coast.) When the extremity of the Point is cleared, the boats separate from each other, and each skipper fixes upon his own locality. Some of the boats sail but a few miles, perhaps to the extremity of Race Point, which is distant four or five miles; while others go nearly to Plymouth, and others scatter all over the bay. The farther the boat sails, the later will the nets be thrown overboard; because, should the boats go, as they frequently do, nearly a fourth the distance to Boston, the crew will not be able to get them overboard until late in the evening, or even until midnight; and then, wishing to return as early in the morning as the other boats, they will necessarily keep them out but a few hours. Having thrown over their nets, the fishermen lie down in their little cabins, and get what sleep they can, having first fixed to one of the masts of their boat a light, to prevent their being run down by any vessel which may be passing; and some of the fishermen, in stormy nights, hang up a bell in their rigging, which is kept ringing by the motion of the boat. About daylight in the morning the fishermen draw their nets, and one man continues to free them of the fishes they contain, during the whole time the boat is sailing homeward, while the other manages the boat. Frequently but small numbers of other species are taken besides the mackerel, while at other times the nets will contain three or four times as many whiting as mackerel, and, as the former are worthless, the duty of the fisherman is very laborious and irksome. The boats arrive early in the morning at the Point, and all is life and excitement. 'How many fish have you caught?' is the universal salutation; and, before they sail again in the afternoon, every boat's crew knows exactly how many have been taken by each boat during the previous night. As soon as the boats arrive, the fishermen at once draw their nets upon the shore, free them of the fish caught, unless it has already been done, and, spreading them upon the sand, or winding them upon a reel, leave them until the latter part of the afternoon to dry, when they again roll them up carefully and put them on board of their boats. Such quantities of whiting are sometimes contained in the nets that they cannot be freed for hours, not even until the middle of the day. Should only a few mackerel be taken during a night, they are sent at once to Boston in some one of the fishing-smacks which are in waiting to take them, and the carriers receive a part of the proceeds of the sale; or they are sold outright, for from three fourths of a cent to a cent and a half apiece, to the smacks. If many are caught, only a few are sent, and the rest are split and salted, and sold afterwards, to be sent in various directions. On the 26th, from twenty to twenty-three boats returned, while I was on the Point, from the previous night's fishing, and averaged about one thousand mackerel apiece; such a quantity could not be disposed of, fresh. Captain Atwood sold only one hundred of the largest, for two cents apiece, and was obliged to salt the remainder. It is very exciting to be on the shore and watch the fishermen as they empty their nets, — throwing out whiting, menhaden, sheep's-head, grunters, kiucks, blue-backs, goose-fish, and dog-fish."

To give an idea of this seining of mackerel, which continues only from a month to six weeks, I subjoin the following tables, furnished me by Captain Nathaniel E. Atwood, of his two years' fishing, including the seasons of 1846 and 1847, assisted by one person, in his beautiful little boat, the "Scomber vernalis."

Number of Mackerel caught in 1846.

Date.	Whole Number.	Sold Large.	Sold Small.	Stock.	Number Salted.
May 20,	39	34	5	$ 3.18	
" 21,					
" 22,	68	68		4.11	
" 23,	69	69		4.30	
Sunday.					
" 25,	85	63	22	2.27	
" 26,	355				355
" 27,	352				352
" 28,	315	260		14.30	55
" 29,	200	170	30	9.00	
" 30,					
Sunday.					
June 1,	179	113	66	6.57	
" 2,	453	275	178	15.47	
" 3,	352	291	61	11.78	
" 4,	1,117	100		3.12	1,017
" 5,					
" 6,	426				426
Sunday.					
" 8,	463	322	141	16.66	
" 9,	223	178		8.01	45
" 10,	282	208	74	11.02	
" 11,	206	156	50	7.25	
" 12,	296	188	108	9.85	
" 13,					
Sunday.					
" 15,	273	150	123	9.51	
" 16,	340	222	118	11.94	
" 17,					
" 18,	110	15	95	1.84	
" 19,					
" 20,					
Sunday.					
" 22,	70	18	52	2.02	
" 23,					
" 24,	242	172	70	10.39	
" 25,	142	87	55	4.16	
" 26,	123	87	36	4.72	
" 27,					
Sunday.					
" 29,	242	131	111	10.39	
" 30,	98	55	43	3.54	
July 1,	20	10	10	.76	
	7,140	3,442	1,448	$ 187.16	2,250 = 13 bbls. packed.

Number of Mackerel caught in 1847.

Date.	Whole Number.	Sold Fresh.		Stock.	Number Salted.
		Large.	Small.		
June 1,	442	245	197	$ 13.39	
" 2,	189	66	123	4.95	
" 3,	268	111	157	7.12	
" 4,	262	180	82	8.84	
" 5,					
Sunday.					
" 7,	368	176	192	10.55	
" 8,	326	163	163	8.80	
" 9,	261	90	171	7.09	
" 10,					
" 11,	18	9	9	.94	
" 12,					
Sunday.					
" 14,	654	263	391	20.17	
" 15,	410				410
" 16,	1,172	384	788	27.60	
" 17,	271	70	201	3.08	
" 18,	346	75	271	4.10	
" 19,	460				460
Sunday.					
" 21,	426	92	334	10.64	
" 22,					
" 23,	262	53	209	6.30	
" 24,					
" 25,	888	100		2.10	788
" 26,	242				242
Sunday.					
" 28,	14			Price not named.	
" 29,	102	18	84	"	

By small mackerel in the table is meant those about half the size of the largest; they are culled out by the fishermen, and sold for about half the price of the largest. The salted mackerel are generally contracted for by some purchaser for a certain price (in Captain Atwood's case, for $5 per barrel), to be delivered at his wharf within a month or two from the time they are taken.

This species revisits our shores again in the autumn, but is not taken in such quantities as in the spring of the year. Thus in the months of October and November, 1847, there were taken, by thirty-five fishermen who followed this business, 1,076 barrels full, which were packed; and $783.73 worth, which were sold fresh.

These mackerel are inspected at the wharf, before they are barrelled, and are of four distinct qualities.

The first must be 13 inches long, from the tip of the snout to the notch of the caudal fin. The second is under 13 inches in length, but fat. The third comprises those which are 13 inches long, but are poor. And the fourth contains those which are under 13 inches and poor.

After the 1st of July, the fishermen at Provincetown cease to catch this species in nets; it now readily takes the hook, and is captured along our coast in immense quantities. Captain Atwood informs me, that in 1845 the mackerel-fishery yielded the fishermen at Long Point two thousand dollars.

It is calculated that from six to eight thousand barrels of mackerel are annually sold fresh in Boston market alone. But their great value arises from the employment afforded by them to such a number of persons, in the process of salting and packing, requiring mechanics of various descriptions, and seamen to manage the vessels which transport them from place to place.

The number of barrels of mackerel *inspected* in Massachusetts from the years 1831 to 1847 was as follows: —

1831,	383,559	1839,	73,018
1832,	224,000	1840,	50,992
1833,	225,000	1841,	55,537
1834,	253,000	1842,	75,543
1835,	197,000	1843,	64,451
1836,	180,616	1844,	86,181
1837,	138,157	1845,	202,303
1838,	108,358	1846,	174,064

Those packed in 1836 were furnished by the following towns: —

	Barrels.		Barrels.
Boston,	40,559	Scituate,	3,782
Gloucester and Manchester,	43,937	Yarmouth,	2,446
Newburyport and Newbury,	21,463	Salem and Beverly,	2,394
Wellfleet,	17,500	Plymouth,	1,477
Provincetown,	14,139	Lynn,	1,400
Hingham,	13,882	Duxbury,	1,000
Cohasset,	11,700	Charlestown,	822
Barnstable,	4,115		

At the prices these fish were worth in November, 1836, the value of the year's fishing amounted to $ 1,264,012 dollars.

Mr. Solomon Lincoln, of Hingham, wrote me that the number of barrels of mackerel taken at that place in 1837 was 17,134½; and that he estimated the gross proceeds of the mackerel fishery of that place for that year at $ 115,000.

By the "Statistical Tables" drawn up by the Secretary of State, from the reports upon the various branches of industry, by the assessors of the different towns, it appears that the number of barrels of mackerel taken in the year 1837, with their prices, were as follows: — Whole number of barrels, 234,059; value, $ 1,639,042. Taken by the following counties: Barnstable Co., 76,036; valued at $ 490,638. Essex Co., 69,599 = $ 518,663. Suffolk Co., 43,266 = $ 320,165. Plymouth Co., 25,258 = $ 179,748. Norfolk Co., 18,450 = $ 120,528. Middlesex Co., 1,000 = $ 6,000. Bristol Co., 450 = $ 3,300.

From the same source, for the year ending April 1st, 1845, we collect the following facts: — Whole number of barrels of mackerel taken, 86,628; value, $ 637,052. Taken by the following counties: Essex Co., 30,247; valued at $ 234,385. Barnstable Co., 29,407 = $ 207,145. Plymouth Co., 10,388 = $ 74,191. Norfolk Co., 8,859 = $ 56,583. Suffolk Co., 7,455 = $ 63,118. Dukes Co., 217 = $ 1,300. Middlesex Co., 55 = $ 330.

I have not been able to ascertain with accuracy the number of vessels engaged exclusively in this fishery. In many towns, the same vessels are used, at different seasons of the year, for the cod as well as the mackerel fishery. I have ascertained, however, that there were two hundred and two vessels employed in this fishery in 1836 in the county of Barnstable, and that of this number ninety-eight belonged to Provincetown, which were valued at $ 147,000.

It might be inferred, from an examination of the above table of the numbers of mackerel inspected in different years, that in some seasons fewer vessels were engaged in the business, or that it was considered at such periods of less importance than at others; this, however, is not a correct conclusion. In some seasons immense shoals of these fish are readily met with, and the vessels return in a few weeks with full cargoes; while the same localities may be visited at other seasons and the efforts of the fisherman prove fruitless, and his fare meagre.

So peculiar are the habits of this species, that oftentimes weeks may pass, the fishing-smacks be surrounded by millions sporting upon the surface of the ocean, and scarce one allow itself to be taken; while, again, the success of a few days will nearly retrieve the disappointments of a season.

Thus a fisherman informed me that, in the year 1837, having been to the Bay of Chaleur, and taken but few fish, the vessel to which he belonged was returning home, when, off Cape Cod, the fish were so numerous and voracious, that the crew, consisting of ten men, captured in two hours nearly thirty barrels of them. At this time about two hundred smacks were together, and they were all equally successful, some of them taking even forty barrels of fish in the same period.

Occasionally this fish visits the very harbors along both shores of Massachusetts Bay, and is taken in great numbers. When they first enter the Bay, immense quantities are captured in the harbor of Provincetown. By the following extract from the Boston Atlas of July 12, 1845, copied from the Gloucester Telegraph, it appears that that place had received a visit from this species: — "For a few days past our harbor has been filled with mackerel; and on Monday about four hundred barrels, it is estimated, were taken in seines, vessels, boats, and from the wharves. Upwards of a hundred barrels were taken in a seine at one haul." The following, which I extract from a "Statement presented to the Members of the House of Representatives, by Mr. Caleb Cushing," in reference to a "Bill in Addition to an Act to authorize the Licensing of Vessels to be employed in the Mackerel Fishery," exhibits the peculiarities of this fish in an interesting manner: — "Their movements and haunts are very precarious, and their habits are more versatile than those of almost any other fish of commercial importance. So true is this, that fishermen who have pursued the business for a long period have but little advantage over those recently engaged in it, in judging, with any degree of certainty, which may be the best spot of fishing-ground at any particular season of the year. It is oftentimes the case, that vessels in extreme parts of the Bay, and in nearly all intermediate stations, will have good fishing for a few days, and for many succeeding days no mackerel will be visible; after which they will appear to rise simultaneously in nearly all parts of the Bay; and in moderate weather large tracts of the surface of the sea will seem to be covered with shoals of the fish, swimming with one side of the gill out of water. At times, the fishermen can take only a few from a shoal, as it passes directly in contact with their vessel, without being induced to stop by bait, or altering its course in the least degree. It occasionally happens, that late in the year the fishermen will reap a rich harvest, when the whole previous season had been comparatively unproductive. Thus it was in the autumn of 1831. In October of that year the mackerel struck in very near to Cape Ann. Large fleets of vessels collected in such close order as to be continually coming in contact. The sea being smooth, and great quantities of bait thrown out, the fish collected in such quantities that some vessels took nearly one hundred barrels in a single day. At the same time they were very abundant off Cape Cod and on Jeffries' Ledge; and it was computed that more than 70,000 barrels were taken in a single week."

Several of our most intelligent fishermen inform me that the difficulty of taking mackerel is yearly increasing, from the barbarous custom prevailing of "gaffing" them; that is, of collecting them around vessels by throwing out bait, and then suddenly drawing up an instrument armed with numerous sharp iron points, by which many are captured, and greater numbers are cruelly maimed without being taken.

After being carefully inspected, a ready market is found for these fish, as is shown by the following notice, copied from Mr. Cushing's "Statement," above referred to: — "A small portion of the mackerel, consisting chiefly of the poorest quality, No. 3, is exported to foreign countries. It is not easy to ascertain the precise quantity exported, as the Annual Statement printed by order of Congress embraces all kinds of pickled fish under one head; probably the amount does not exceed 40,000 barrels. They are sent to the West Indies, to South America, to some ports of the Mediterranean, and to the East Indies. But the principal market for this fish is in the United States. Philadelphia, New York, Baltimore, and New Orleans have taken the largest quantities hitherto; but more or less is shipped to most of the chief ports along the seaboard from New York to New Orleans. Thus far Philadelphia, by its rapid and steady increase of demand, has held the lead of other ports. From 1820 to 1825 that city required from 30,000 to 40,000 barrels, as its yearly supply for its own consumption, its interior trade, and its foreign or domestic export. It now receives three times that quantity, and about one third part of the whole product of the fishery. In the Southern States, also, the demand increases with the increased facilities of interior transportation, and must continue to be enlarged, as the interior of the country goes on acquiring access to markets and added population and prosperity. It is understood, also, that this fish, owing to its good qualities as an article of food, and its convenient form for subdivision and distribution among the slaves, is gaining favor in the estimation of the planters of the South. As evidence of which fact, it may be stated, by way of example, that, with a colored population of 210,000 persons, the State of Georgia consumed, the last year (1835), 37,000 barrels, of all qualities, valued there at $286,750. Doubtless the consumption is proportionably great in all the other planting States."

Labrador, H. R. Storer. The whole of the Atlantic Coast, Richardson. Maine, Massachusetts, Storer. Connecticut, Linsley, Ayres. New York, Mitchill, Dekay.

GENUS II. PELAMYS, Cuv.

The teeth strong, separate, and pointed.

Pelamys Sarda, *Cuvier.*

The Striped Bonito.

(Plate XI. Fig. 5.)

Scomber sarda, Bloch, Systema, p. 22, pl. 334.
" " *Bonetta*, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 428.
La Pélamide commune, ou Bonite à dos rayé (*Pelamys sarda*, Cuv., *Scomber sarda*, Bl.), Cuv. et Val., viii. p. 149, pl. 217.

Pelamys sarda, *Skip-Jack*, STORER, Report, p. 49.
" " *Striped Bonito*, DEKAY, Report, p. 106, pl. 9, fig. 27.
" " STORER, Mem. Amer. Acad., New Series, II. p. 343.
" " STORER, Synopsis, p. 91.

Color. The head and the upper part of the body are of a greenish-brown color; the sides are lighter, the abdomen of a silvery white. From ten to twenty dark-bluish bands pass obliquely downwards and forwards from the dorsum towards the abdomen; the first of these bands commences at the posterior extremity of the first dorsal fin; the last arises at the commencement of the caudal fin; several of these bands pass very low down upon the sides, almost reaching the abdomen. Besides these, several indistinct lighter-colored bands cross the body transversely. The gill-covers are silvery, marked with fuliginous. The pupils are black; the irides silvery. The first dorsal fin is of a light color, with dull patches. The pectorals are of a dark color above, and lighter beneath. The anal fin is white, with fuliginous. The caudal fin is of a dirty bluish color.

Description. The body is oblong, compressed, perfectly smooth. The scales are exceedingly minute, with the exception of a large triangular patch of larger scales, situated back of the opercles, in the middle of which are the pectoral fins. Several series of longitudinally arranged scales are situated on each side of the dorsum, running the whole length of the first do rsal fin.

The lateral line arises high up on the back, and pursues an undulatory course till it reaches a line opposite the anterior third of the anal fin, whence it is continued in a straight line to the tail.

The length of the head, which is destitute of scales, is less than one fifth the whole length of the fish. The jaws are equal. The jaws and palatine bones have each a single row of sharp, recurved, prominent teeth; upon the middle of the lower jaw are four teeth, the anterior two quite small, the posterior two the largest in the jaws; the palatine bones are very small. The gape of the mouth is large. Eyes circular. Diameter of eye about a sixth the length of the head.

The first dorsal fin commences on a line over the origin of the pectorals; its second and third rays are longest; the posterior rays are very short; the whole fin, when unexpanded, is concealed in a groove at its base. It is continued almost to the origin of the second dorsal.

The second dorsal is nearly triangular, emarginated posteriorly; its posterior portion is slightly tufted like the commencement of finlets; back of this fin are eight finlets, the posterior of which are the smallest.

The pectoral fins arise just back of the operculum. The fan-shaped ventrals are just back of the origin of the pectorals; when unexpanded, these fins shut into a depression on the abdomen.

The anal fin arises on a line with the posterior extremity of the second dorsal, and is shaped like that fin. Seven finlets are situated back of the anal fin.

The anus is small, and situated directly in front of the anal fin. A stout fleshy carina is situated on each side of the fleshy portion of the tail; on each side of the posterior part of this carina two quite small obtuse carinæ run directly backward across the middle of the caudal fin, causing quite a depression between them.

The caudal fin is lunated. Length of the exterior rays, compared with distance between the extremities when expanded, as 3 to $5\frac{1}{2}$.

About twenty inches in length.

The fin rays are as follows: — D. 20 – 14 + VIII. P. 24 or 26. V. 6. A. 14 + VII. C. 24 or $26\frac{9}{9}$.

Remarks. This species, called by the fishermen in Boston Market the *Skip-Jack*, and by those at the extremity of Cape Cod the *Bonito*, is very rarely met with in Massachusetts Bay; it is occasionally taken at Provincetown, and even at Lynn. South of the Cape, at some seasons, it is frequently caught at Martha's Vineyard, with trailing bait. Dekay remarks that it is but an "occasional visitor" to the coast of New York.

Massachusetts, STORER. Connecticut, LINSLEY. New York, MITCHILL, DEKAY.

GENUS III. THYNNUS, Cuv.

Form of the body like that of Scomber, but less compressed. A kind of corselet round the thorax, formed by scales larger and coarser than those of the rest of the body; a long, elevated crest on each side of the tail. The anterior dorsal reaching almost to the posterior one. Numerous finlets behind the dorsal and anal fins. A single row of small, pointed, crowded teeth in each jaw.

THYNNUS SECUNDO-DORSALIS, *Storer*.

The American Tunny.

(PLATE XII. FIG. 4.)

Thynnus vulgaris, CUV., *Common Tunny*, STORER, Report, p. 47.
" " DEKAY, Report, p. 105, pl. 110, fig. 28.
" " STORER, Mem. Amer. Acad., New Series, II. p. 343.
" " STORER, Synopsis, p. 91.

Color. Nearly black above. Silvery upon sides; beneath white. Gill-covers a silvery gray. Pupils black; irides golden, with greenish reflections. Rays of first dorsal fuliginous; connecting membrane nearly black. Second dorsal of a reddish-brown color. Pectorals silvery gray. Ventrals black above; beneath white. Anal finlets, like those on the dorsum, of a bright yellow color; dark at base and upon anterior edge.

Description. Form elongated, gradually sloping from commencement of dorsal to extremity of snout, and tapering from dorsal to tail. Length of head about one fourth length of fish. Depth across base of pectorals, two ninths of entire length ; across base of anal, about one seventh ; at base of caudal, one twenty-eighth, and in another specimen, one thirty-fourth. Eyes circular ; distance between them less than half the length of head. Opercula very large, perfectly smooth. Jaws equal when closed. Tongue large. Inside of mouth blackish. Gape of mouth very large. Entire body covered by large scales, which are almost hidden by superjacent smaller ones, and a thickened membrane. Patches of still larger scales, or bony plates, in front of first dorsal, around pectoral, between it and lateral line.

First dorsal commences just over pectorals. Its rays are very strong, gradually decreasing in length until hardly perceptible ; the first the longer. The fin, when unexpanded, shuts out of sight into a deep groove, deepest of course at its origin.

The height of the second dorsal is much greater than that of the first, and more than twice its own length. Followed by ten finlets.

Pectorals falciform. About one seventh of length of fish.

Ventrals, just beneath pectorals ; stout, and shutting, like dorsal, into a groove.

Anal commences some distance back of a line from termination of second dorsal. Behind it nine finlets, the middle ones the longer, as is also the case with those of the dorsal.

Caudal lunated. Measured across the extremities of its lobes, it is equal to one third the entire fish. At its base a stout lateral carina of considerable length. Above and below its posterior third are two smaller carinæ.

Owing to the denseness of the membrane which connects them, it is with great difficulty that the fin rays can be counted. As accurately as they could be ascertained, they are as follows : — D. 14 – 1 – 13 + X. P. 34. V. 1 – 5. A. 2 – 12 + IX. C. 19.

Length of two specimens which I have examined, 8 feet 6 inches and 9 feet 3 inches. Weight, over 1,000 lbs.

Remarks. In the year 1838 I had an opportunity to examine a specimen of this fish, which was taken near Cape Ann, and concluded that it must be the *vulgaris* of Cuvier. Dr. Dekay, in his Report, not having seen an entire specimen, adopted my description and conclusion. During the last spring, a second specimen was examined at Provincetown, and carefully figured by Mr. Sonrel ; and I have satisfied myself that it differs from all the species of the genus contained in the *Histoire Naturelle des Poissons.* The following are the differential marks from the *vulgaris*, which it most nearly resembles : —

1st. In the *vulgaris* the height of the second dorsal is about that of the first. In our fish it is much greater, and also as compared with its own length.

2d. In the *vulgaris*, the anal arises on a line with the termination of the second dorsal. In ours, it is several inches behind it.

3d. In the *vulgaris*, the length of the tail, from the point of one lobe to that of the other, is shorter than the length of the head. In ours, it is much longer.

4th. In the *vulgaris*, the length of the pectorals is about one fifth the entire length. In both the specimens here examined, their length was one seventh the entire fish. It, however, differs in all other important respects from the *brachypterus* of the Mediterranean, which, indeed, seems identical with the *brevipinnis* of the same waters ; and in this respect, as also in the greater height of its second dorsal, from the *Coretta* of the West Indies.

This species, which is known along our coast as the *Horse-Mackerel* and *Albicore*, comes into Massachusetts Bay about the middle of June, and remains until early in October. At the entrance of the Bay, they are met with in greater quantities than in any other part of it ; thus, while a few stragglers are occasionally seen by the fishermen who supply the Boston market daily with cod and haddock, it is not an uncommon circumstance to observe fifty or more in a day at Provincetown. When this fish first appears, it is exceedingly poor, and is perfectly useless. By the first of September it becomes quite fat, and is frequently taken at Provincetown for its oil. This is not extracted from the liver, as in many other fishes, but is obtained from the head and belly by boiling. Sometimes twenty gallons of oil are procured from a single specimen. It is rarely caught with the hook, but is generally taken with the harpoon, in the same manner that whales are captured. Within a few years past, this species seems to have become more shy and distant. I learn from fishermen of veracity, that instances have occurred in which food has been taken by them from the hand when held to them from the boat. It feeds upon menhaden and other small species, which it drives near, and frequently upon, the shore. The fishermen are oftentimes much annoyed by having their nets injured by them. Its flesh is occasionally used for mackerel-bait, but not with us as an article of food, although Dekay states that it is met with in the New York market every season.

GENUS IV. CYBIUM, Cuv.

An elongated body without a corselet ; and large, compressed, sharp teeth. The palatines have only short and even teeth.

Cybium maculatum, *Cuv.*

The Spotted Mackerel.

(Plate XIII. Fig. 1.)

Scomber maculatus, Spanish mackerel, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 426, pl. 6, fig. 8.
Le Taassard tacheté (*Cybium maculatum,* Cuv., *Scomber maculatus,* Mitch.), Cuv. et Val., viii. p. 181.
Cybium maculatum, Spotted Mackerel, Storer, Bost. Journ. Nat. Hist., iv. p. 179.
" " Ayres, Bost. Journ. Nat. Hist., iv. p. 261.
" " *Spotted Cybium,* Dekay, Report, p. 108, pl. 73, fig. 232.
" " Storer, Mem. Amer. Acad., New Series, ii. 344.
" " Storer, Synopsis, p. 92.

Color. The top of the head and the upper part of the sides of the body are of a dark leaden color; the sides are lighter; the jaws, opercula, and abdomen are of a beautiful clear white, presenting a satin-like appearance; the dorsal ridge throughout its whole extent is of a beautiful dark-green color; twenty or more circular or oblong spots, situated above and beneath the lateral line, ornament its sides; the most anterior of these spots is beneath the pectoral fins; the largest number of the spots is anterior to the dorsal fin. The membrane connecting the first eight rays of the dorsal fin is black; the second dorsal fin is of a lead-color; the pectorals are black beneath, light above; the ventrals are white.

Description. In its figure it resembles the *S. colias.* Its greatest depth, measured from the origin of the first dorsal fin, is equal to nearly one fourth its entire length.

The length of the head is equal to about one seventh the entire fish, and terminates anteriorly in a sharp point. The eyes are circular. The anterior nostril is the smaller, and is semicircular; the posterior nostril, which is situated directly in front of the centre of the eye, is a transverse slit. The upper jaw terminates in a point; the prominent tip of the lower jaw projects slightly beyond the upper: both of the jaws are furnished with a single row of prominent, sharp, somewhat conical teeth; those situated towards the angle of the jaws are the largest.

The lateral line, which is raised above the general surface of the fish, arises half an inch above the origin of the pectoral fins, and, in the language of Mitchill, "does not travel straight, but crooks and meanders along prettily towards the tail."

The first dorsal fin, when unexpanded, shuts almost completely into a groove at its base; its anterior portion is much higher than the posterior; the second and third rays are the highest; all the rays project beyond their connecting membrane, and are furnished with delicate filaments.

The second dorsal fin is triangular, emarginated posteriorly; its first two rays are simple; posterior to this fin are eight or nine finlets, of the same color as the fin.

The pectoral fins are falciform, and arise directly back of the angle of the operculum.

The ventral fins are quite small.

The anal fin arises opposite the middle of the second dorsal, and is of the same length as that fin ; eight or nine finlets are posterior to it, similar in their appearance to those back of the second dorsal fin.

The caudal fin is large and lunated. At its base is a lateral carina, upon which the lateral line terminates ; and on each side of this are two smaller carinæ running the entire length of the fleshy portion of the tail.

Length, about twenty inches.

The fin rays are as follows : — D. 18 – 17 + VIII. P. 20. V. 4. A. 18 + VIII. C. 26.

Remarks. This species, which is found on the coast of South America, and which Dekay speaks of as occurring sparingly in the waters of New York, must be exceedingly rare on the shores of Massachusetts. I have known but five specimens to be taken here ; one of these was captured at Lynn, July 24th, 1841, in a seine, in company with several *blue-fish*, and the others were taken at Provincetown, August, 1847. The former measured twenty-one inches in length, the latter but fifteen inches. It roams even farther north than Massachusetts, Captain Atwood having captured a specimen at Mohegan, on the coast of Maine.

Maine, Captain ATWOOD. Massachusetts, STORER. Connecticut, LINSLEY, AYRES. New York, MITCHILL, DEKAY. South America, CUVIER.

GENUS V. TRICHIURUS, LIN.

Head pointed ; body without scales, elongated, compressed, thin, ribbon-shaped. No ventral fins, nor scales instead ; no anal fin ; a single continuous dorsal fin ; tail without rays, ending in a single elongated hair-like filament, from which the generic name is derived. A single row of compressed, cutting, and pointed teeth. Branchiostegous rays, seven.

TRICHIURUS LEPTURUS, *Lin.*

The Silvery Hair-tail.

(PLATE XII. FIG. 1.)

Trichiurus lepturus, LIN., Syst. Nat., p. 409.
Gymnogaster argenteus compressus, cauda attenuata impinna, BROWNE, Jamaica, p. 444, pl. 45, fig. 4.
Trichiurus lepturus, BLOCH, Ichth., v. p. 55, pl. 158.
Trichiurus argenteus, Silver Trichiure, SHAW, Gen. Zoöl., IV. p. 1, pt. 90, fig. 12.
Trichiurus lepturus, STRACK'S Plates, XX. fig. 1.
Trichiurus argenteus, Silvery Hair-tail, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 364
Le Trichiure de l'Atlantique (*Trichiurus lepturus*, LIN.), CUV. et VAL., VIII. p. 237.

Trichiurus lepturus, YARRELL, Brit Fishes (2d edit.), I. p. 204.
" " STORER, Bost. Journ. Nat. Hist., IV. p. 181.
" " DEKAY, Report, p. 109, pl 12, fig. 35.
" " STORER, Mem. Amer. Acad., New Series, p. 346.
" " " Synopsis, p. 94.

Color. Of a uniform silver color throughout. Pupils black; irides golden. Lateral line of a greenish-yellow color. The dorsal fin is greenish-yellow at its base; fuliginous above. The pectorals are yellowish at their base, and more or less fuliginous above.

Description. Body without scales; long, very much compressed, tapering to a point. The abdomen is full, rounded, and smooth on its edge; the inferior portion of the body back of the anus forms an acute edge, which is marked throughout with sharp serrations. The length of my specimen is thirty-nine and a half inches; the length of the head is six inches, or nearly one seventh of its whole length. The head is compressed upon its sides, flattened between the eyes; a protuberance exists upon the top of the occiput, and two similar projections directly back of the eyes. The operculum is large, margined with a very delicate membrane, and presenting numerous very delicate striæ upon its surface; similar striæ are noticeable upon the posterior portion of the superior maxillary bone. The eyes are large and circular; their diameter nearly equal to an eighth the length of the head; the nostrils are large, vertically oval, situated in front of the anterior superior angle of the eye. The gape of the mouth is large. The lower jaw is the longer, with a prominent chin; both jaws have numerous acute, lancet-shaped teeth. At the extremity of the upper jaw are two large, much-incurved, barbed teeth; and back of these, two other similarly formed, rather larger teeth, separated from the former by one or two very minute ones; posterior to these are about a dozen acute unarmed teeth, the posterior ones the largest. At the tip of the lower jaw, on each side, is a large tooth similar to those above them in the upper jaw; when the jaws are closed, these project beyond the upper jaw; and the two anterior teeth of the upper jaw shut into a cavity of the lower, just back of the chin; back of these prominent teeth, in the lower jaw, are from fifteen to seventeen other smaller ones; of these, three, which are the larger, on each side, in about the middle of the jaw, are barbed. The palatine bones are armed with very minute teeth. The tongue is of moderate size, and smooth. A portion of the roof of the mouth is covered by a loose membrane.

The lateral line arises upon the shoulder, at the superior angle of the operculum, curves backwards and downwards to the inferior third of the body, until opposite the fourteenth or fifteenth dorsal ray, when it pursues a straight course to the tip of the tail.

The dorsal fin, which is composed of flexible rays, commences upon a ridge just back of the occipital protuberance, and gradually increases in height towards its middle, then diminishes, and is lost in the naked tail.

The fan-shaped pectoral fins arise from under the posterior inferior angle of the operculum, being partly crossed by that angle; the first rays, which are highest, are nearly equal to one third the length of the head.

The fin rays are as follows: — D. 133 – 135. P. 12. Length, from two to three feet.

Remarks. This beautiful fish is a Southern species, and is very rarely found in our waters. During twenty years' attention to the fishes of Massachusetts, I have known but two individuals to be taken. One of these was cast ashore, during the summer of 1840, upon the beach at Buttermilk Bay, in the northern corner of Buzzard's Bay; the other was captured at Wellfleet in the summer of 1845. From this latter specimen, received in a perfectly fresh condition, my figure and description have been prepared.

Dekay states that it is known by the fishermen of New York by the name of *Ribbon-fish.* According to Browne, it is called *Sword-fish* at Jamaica.

Massachusetts, Storer. New York, Mitchill, Dekay. Gulf of Mexico, Caribbean Sea, South America, Cuvier.

GENUS VI. XIPHIAS, Lin.

Body fusiform, covered with minute scales; a single elongated dorsal fin; ventral fins wanting; tail strongly carinated; upper jaw elongated, forming a sword. Mouth without teeth. Branchiostegous rays, seven.

Xiphias gladius, *Lin.*

The Sword-fish.

(Plate XIII. Fig. 2.)

Xiphias gladius, Lin., Syst. Nat., p. 432.
" " *Common Sword-fish*, Shaw, Gen. Zoöl., iv. p. 99, fig. 14.
" " " " Strack's Plates, xxi. fig. 1.
" " " " Pennant, Arc. Zoöl., ii. p. 113.
" " " " Griffith's Cuv., x. p. 187, pl. 27, fig. 1, and Supplement to the Acanthopterygii, p. 349.
L'Espadon épée (*Xiphias gladius*, Lin.), Cuv. et Val., viii. p. 255, pl. 225 and 226.
Xiphias gladius, Wilson, Encyclopædia Brit, Art. Ichth., p. 184, pl. 202.
" " Jenyns, Brit. Vert., p. 364.
" " Yarrell, Brit. Fishes (2d edit.), i. p. 164, fig.
" " Storer, Report, p. 51.
" " Dekay, Report, p. 111, pl. 26, fig. 79.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 347.
" " " Synopsis, p. 95.

Color. In the fresh fish, the back and upper parts of the sides are almost black; this color changes to a bluish after death. The abdomen is of a dirty-white color, which afterwards is changed into a silvery gray. The gill-covers are silvery brown, and present on their surface an arborescent appearance.

Description. The surface of the body is smooth. The length of the head from the posterior edge of the operculum to the angle of the jaws equal to one twelfth the entire length of the fish. The length of the lower jaw, from the angle to the chin, equal to one ninth the length of the fish. The length of the sword, from the anterior angle of the eye to its extremity, equal to one third the length of the fish. Upper part of the sword dark brown, almost black, with a groove extending throughout its whole extent. Under portion of the sword lighter colored, and having a velvety feel. The edges of the sword have a bony, shining, perfectly smooth edge. The widest portion of the upper jaw equal to about one twelfth the length of the sword. This upper jaw gradually terminates to a point. Jaws, without teeth; a velvety feel, to the finger, upon the lower jaw. Eyes large and very movable in their orbits; the orbit horizontally oval, the eye itself circular. Branchiæ composed of four pairs of large parallel laminæ, and one smaller one. Branchial membrane composed of eight rays.

The dorsal fin commences nearly on a line above the posterior edge of the operculum. It is strongly falciform, four times as high as the upper jaw is wide; its length is equal to three fourths its height. In the specimen described in my Report, eighteen rays were obvious in the anterior portion of the dorsal; in the specimen from which my present description is written, twenty-one rays may be counted, although the former specimen measured twelve feet five inches, while the present one measures only seven feet three inches. In this specimen, as well as that, the whole dorsal ridge between these rays, and within a few inches of the base of the tail, has no vestige of a ray above the surface, but in their place is a shallow groove throughout the whole extent, supporting a slight membrane; the bases of a few rays are seen, however, upon dissection, beneath the skin. A few inches in front of the base of the tail is situated the extremity of the dorsal fin, composed of three rays in both of the specimens I have seen, slightly emarginated above and terminating posteriorly in a point, and looking like the adipose fin of the *Salmonides*, or the finlets of many of the *Scomberoides*.

The pectoral fins are also falciform, less high than the dorsal; their length a little more than one fourth the height.

The anal fin is formed like the dorsal, and is three fifths its height. The extremity of this fin terminates on the same plane with the dorsal, and is formed much like that. This portion in the former specimen contained three rays, in the present two. This small posterior portion is one eighth the height of the longest rays. At the base of the tail is situated a transverse furrow. On each side of the base of the tail is situated a carina about the height of the posterior extremity of the dorsal fin, and about as long again as high, extending on to the caudal fin.

The caudal fin is very deeply forked.

The fin rays are as follows: — D. 18 – 3. P. 15. A. 11 – 2 – 3. C. 17.

Remarks. This species is seldom seen in Massachusetts Bay, but is a common fish at some seasons of the year from Nantucket to Block Island, and has become quite an article of commerce. It is generally discovered by the fishermen by the projection of its dorsal fin above the surface of the water, as it is pursuing shoals of mackerel and menhaden, upon which it feeds. It is occasionally taken with a hook baited with one of these fishes, but almost always it is captured with an instrument called a "lily-iron," from the form of its shafts or wings, which resemble the leaves of a lily. This instrument is thrown, like a harpoon, with great force, into the fish, the attempt always being made to wound the animal in front of the origin of the dorsal fin. When wounded, it sometimes frees itself from the iron by its struggles; and has been known to dive with so much force towards the bottom of the sea, as to bury the sword its whole extent into the sand or mud, which was proved by its appearance when taken. When unmolested, it is observed, not unfrequently, to spring several times its length forwards, some feet above the surface of the water. It appears at Gay Head about the first of June, and remains there until into September. Fifteen to twenty boats are employed from Martha's Vineyard and Noman's Land in this fishery. At Noman's Land, two men in a boat not unfrequently take eight in a day. When caught, their heads and fins are cut off, and they are carried fresh to New Bedford market, where they are sold like the halibut, cut into slices, or cut into slices and pickled or salted, and kept for sale in that state throughout the year. In the first part of the season they sell fresh for four cents per pound, but late in the season they do not bring more than two cents per pound. When salted, the flesh is worth $6 per barrel. About one third of the quantity taken is sold fresh. About two hundred barrels of this species are yearly captured at Martha's Vineyard. Very rarely is the flesh of this species offered for sale in Boston market, although when salted it is preferred by many to that of several other species.

The largest individuals weigh about three hundred and fifty pounds.

Massachusetts, Storer. Connecticut, Linsley. New York, Mitchill, Dekay.

GENUS VII. PALINURUS, Dekay.

Preopercle serrated, with spines on its margin. Opercle with one or more flat spines, more or less distinctly serrated beneath. Anal with one or more spines in front. Teeth small, pointed, subequal. Body compressed, oblong. The anterior portion of the single dorsal spinous.

PALINURUS PERCIFORMIS, *Dekay*.

The Black Pilot.

(PLATE XIII. FIG. 3.)

Rudder-fish, or Perch Coryphene, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. pl. 6, fig. 7. No description.
" " " *Coryphæna perciformis*, MITCHILL, Amer. Month. Mag., II. p. 244.
Trachinotus argenteus, STORER, Report, p. 53.
Palinurus perciformis, Black Pilot, DEKAY, Report, p. 118, pl. 24, fig. 25.
" " STORER, Mem. Amer. Acad., New Series, II. p. 351.
" " " Synopsis, p. 99.

Color. Of a bluish-white color upon the sides, covered with minute black punctures, the lower portion of the sides and abdomen of a lighter color; the top of the head and back mottled with black blotches. In the immature fish the color is a dark brown, variegated with yellow patches.

Description. The body of this fish is oblong. The head in length is equal to one fourth that of the body; a bony ridge is observed over the eyes; the diameter of the eyes is rather more than one fourth the length of the head. The operculum is large, naked, of a horny texture, margined by a membrane. The preoperculum is strongly serrated throughout, more conspicuously posteriorly. A depression exists upon the top of the head between the eyes. The distance between the eyes is equal to twice the diameter of the eyes. The nostrils are situated directly in front of the anterior superior angle of the eyes; the posterior is much the larger. The jaws are of equal length, with small, sharp teeth; the upper jaw descends abruptly.

The lateral line commences high above the operculum, and, curving over the pectorals to their extremities, pursues a straight course to the tail.

The dorsal fin, whose fleshy portion is preceded by eight spinous rays, commences back of a line opposite the posterior angle of the operculum, and is continued to the fleshy portion of the tail.

The pectorals are just beneath the posterior angle of the operculum; they are as long again as high.

The ventrals are more than half the length of the pectorals; their outer ray is spinous.

The anal fin arises just in the middle of the body, and is as long again as high; this fin is preceded by three spinous rays.

The caudal fin is quite deeply lunated.

Length, about twelve inches.

The fin rays are as follows: — D. 8 – 22. P. 19 to 21. V. 1 – 5. A. 3 – 17. C. $16\frac{2}{2}$.

Remarks. This species, which, while preparing my Report, I considered to be the *Trachinotus argenteus* of Cuvier, is occasionally found in New York, according to Dekay, and is not unfrequently met with at Holmes's Hole. Dr. Yale writes me, from the latter place: "It follows vessels, or keeps near old casks or planks that are floating, and sometimes is found about the wharf-logs in our harbor." The only specimen I have known to be captured north of Cape Cod was taken at one of the wharves in this city, September 12, 1846.

It is known by the fishermen at Martha's Vineyard as the *Rudder-fish.*

Massachusetts, Storer. New York, Mitchill, Dekay.

GENUS VIII. CARANX, Cuv.

Body covered with small scales, with the exception of the lateral line, which is armed with a series of broad scales, those on the posterior half of the body having an elevated horizontal keel in the centre, forming a continuous ridge, each scale ending in a point directed backwards. Two distinct dorsal fins; free spines before the anal fin; teeth exceedingly minute; branchiostegous rays, seven.

Caranx chrysos, *Cuv.*

The Yellow Mackerel.

(Plate XIV. Fig. 1.)

Scomber chrysos, Yellow Mackerel, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 424.
Le Carangue jaune (*Scomber chrysos*, Mitch.; *Scomber hippos*, Lin.), Cuv. et Val., ix. p. 98.
Caranx chrysos, Yellow Caranx, Dekay, Report, p. 121, pl. 27, fig. 85.
" " " " Storer, Proceedings of Bost. Soc. Nat. Hist., i. p. 148.
" " " " " Mem. Amer. Acad., New Series, ii. p. 353.
" " " " " Synopsis, p. 301.

Color. Of a greenish-blue color upon the back and upper portions of its sides; the greater portion of the sides of a bright yellow. An obscure dark-brown blotch is observed at the posterior superior angle of the operculum. The abdomen is yellowish-white. The pupils are black; the irides golden. The dorsal and pectoral fins are yellowish-brown. The caudal fin is yellowish throughout its greatest extent. The ventrals and the anal are of the color of the sides.

Description. The length of the head is less than one fourth the length of the entire fish. The top of the head and the gill-covers are smooth, and destitute of scales; the top of the head is arched; upon its top is a distinct ridge, which passes from above and between the nostrils to the spine before the first dorsal fin. The eyes are large and circular; the portion at the superior anterior angle of the eyes is translucent; at the anterior extremity of this space the nostrils are situated, and are obliquely oval, the posterior being the larger. The jaws are about equal in length, armed with numerous very minute teeth, which are also observed on the vomer and palatine bones. The tongue is rounded and single.

The lateral line commences just back of the blotch upon the opercula, and passes (slightly obliquely) upwards opposite the posterior half of the pectorals, then courses downwards to near the extremities of the pectorals, whence it proceeds in a straight line to the extremity of the fleshy portion of the tail. The lateral line is smooth until it assumes a straight course; thence it is armed with horny plates, about forty-eight in number; these plates at first are scarcely observable; they become gradually larger, and are most prominent upon the fleshy portion of the tail; they are most crowded at its termination. These plates terminate posteriorly in an acute angle, rendering the line a sharp ridge.

Just in front of the first dorsal fin is a naked recumbent spine, which projects forwards.

The rays of the first dorsal fin are so broken in my specimen that I am obliged to use the words of Dekay respecting it, and also to copy this portion of his figure: — "The first dorsal fin is triangular. This fin is composed of eight spinous rays; the first short, slender, and closely attached to the second, which is shorter than the third; the fourth longest, and all received into a deep groove."

The second dorsal arises on a line just before the termination of the pectoral fins; its rays are connected by a dense membrane; the first ray is shorter than the second; the first half-dozen rays much the highest; the posterior rays are very short. This fin shuts into a fleshy groove when unexpanded; the fin is continued to the fleshy portion of the tail.

The pectoral fins commence just beneath the posterior angle of the operculum; they are long, falciform, articulated.

The ventral fins are situated just back of the pectorals; when closed, they are received into a concavity of the abdomen, to which they are attached by a membrane connected to their inferior rays.

The anal fin is of a similar form with the second dorsal, and, like that fin, shuts into a groove at its base. Two strong spines are situated before this fin.

The caudal fin is deeply forked; two carinæ are seen on each side of its base.

Length, seven and a half inches.

The fin rays are as follows: — D. 8 – 24. P. 21. V. 1 – 4. A. 2 – 1 – 20. C. 19¼.

Remarks. I have seen a single specimen only of this species, which was taken from one of the bridges connecting Charlestown with this city. According to Dekay, it is found in great abundance at New York in the autumn.

Massachusetts, Storer. New York, Mitchill, Cuvier, Dekay.

GENUS IX. ARGYREIOSUS, Lacep.

Body much compressed. Spines between the dorsal fins. Dorsal, ventral, and anal rays filamentous.

Argyreiosus capillaris, *Dekay.*

The Hair-finned Dory.

(Plate XIV. Fig. 3.)

Zeus capillaris. Hair-finned Dory, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 383, pl. 2, fig. 2.
Argyreiosus capillaris, Hair-finned Argyreiose, Dekay, Report, p. 125, pl. 27, fig. 82.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 356.
" " " Synopsis, p. 104.

Color. Of a beautiful silvery color, with several dark, almost black, transverse bands crossing the upper part of the sides; these bands disappear in the dead fish. The dorsal and ventral filaments are black.

Description. The body, which is perfectly smooth, is of an irregular rhomboidal form, exceedingly compressed laterally. The forehead is high, and gradually slopes to the snout, which is very prominent.

The length of my specimen is two inches and five eighths; its depth from the base of the first dorsal across to the pectorals is about two inches; its greatest thickness is less than one quarter of an inch. The length of the head is seven eighths of an inch. The jaws are equal when closed. The eyes are circular, and are a little more than an eighth of an inch in diameter. The nasal orifices are directly in front of the eyes. The branchial rays are exposed. A slightly raised line passes upward from the upper portion of the operculum, curving backward before reaching the base of the first dorsal. Just back of this commences the lateral line, which at its origin rises immediately, makes a semicircle of an inch in height, and is then continued in a straight line to the tail. Three slight protuberances are situated anterior to the first dorsal fin.

The first dorsal fin is composed of eight rays, the first of which is a minute spine; the second is a membranous ray prolonged into a filament, measuring in its whole extent four and a half inches; the third ray is about half an inch long; the remaining five rays are small, naked spines.

The second dorsal fin, which appears to be almost a continuation of the first dorsal fin, is continued nearly to the tail. The first ray is spinous; the second ray is nearly an inch long; the fifteen posterior rays are of equal height.

The pectoral fins are situated directly on a line with the base of the first dorsal.

The ventral fins are an inch and five eighths in length. Anterior to the anal fin are two small spines. The first ray of the anal fin is spinous; the first four membranous rays are longer than the remainder; the first membranous ray is half an inch long; the posterior rays are as high as the corresponding ones of the second dorsal fin. This fin terminates opposite the termination of the second dorsal.

The caudal fin is deeply forked; the depth of its fleshy portion is less than the eighth of an inch; the length of its rays is half an inch.

The fin rays are as follows: — D. 8 – 1 – 22. P. 17. V. 1 – 5. A. 2 – 1 – 18. C. 17.

Length, five and a half inches.

Remarks. The only individual of this species I have known to be taken on our coast, was captured in a seine at New Bedford, in August, 1842, and sent to me by Mr. William H. Taylor of that place. I received it in fine condition, and from it the accompanying figure was made. Dekay observes that this fish is taken in the month of August "in very inconsiderable numbers" in gill-nets.

Massachusetts, Storer. New York, Mitchill, Dekay.

Argyreiosus unimaculatus, *Batchelder.*

The One-spotted Dory.

(Plate XIV. Fig. 2.)

Argyreiosus unimaculatus, Batchelder, Proceed. Bost. Soc. Nat. Hist., II. p. 78.
" " Storer, Mem. Amer. Acad., New Series, II. p. 523.
" " " Synopsis, p. 271.

Color. Above, light bluish-slate; on sides and belly, silvery; an ill-defined fuliginous band passing upwards, slightly backward, from superior angle of eye. On sides, over vertebral column, but not reached by pectorals, a single darkish oblong spot, of moderate size.

Description. Outline of body semicircular beneath, semioval above; truncated and inclined in front; its depth five eighths its length, of which its greatest thickness is about one eleventh, it being very much compressed. Head large, gibbous above, thence inclined forwards. Mouth and throat greatly projecting. Length of head about one third the length of body; its depth through eyes about three fifths the greatest depth. Eyes rather large, situated about midway between top of head and throat; their diameter about three fifths of the distance above them. Nostrils double, in front of eye; the anterior nearly beneath the posterior. Jaws about equal. Scales wanting. Lateral line with an abrupt curve over pectorals to lateral spot; thence straight to tail.

First dorsal commences slightly in front of pectorals. Second ray strongly filamentous; others somewhat so. Between this and the second dorsal four short but well-defined spines.

The first ray of the second dorsal is short and spinous; the next four much longer than the rest, which are of nearly equal length.

Pectorals quite large, of an elongated oval shape.

Ventrals somewhat filamentous, with an almost concealed spine at base.

Anal preceded at some distance by two spines, of which the anterior is the smaller; another spine at origin of the fin. Along its base, as at that of the dorsal, are spines corresponding in number to the rays, their points directed backward.

Caudal fan-shaped and deeply emarginate.

Length, two inches.

The fin rays are as follows: — D. 8 - 1 - 22. P. 9. V. 4. A. 2 - 1 - 17. C. 20.

Remarks. Although in many respects this fish resembles the *A. capillaris*, I think it must be distinct, and if so, the *unimaculatus* of Batchelder. His specimen was taken at Saco, Maine. The only specimen I have seen was caught in a scoop-net at one of the bridges leading to South Boston, in October, 1847, and sent to Dr. Gould, who kindly transmitted it to me.

Maine, Batchelder. Massachusetts, Storer.

GENUS X. SERIOLA, Cuv.

Lateral line with scales not larger than those on the rest of the body. First dorsal fin with a continuous membrane. No finlets.

Seriola zonata, *Cuvier.*

The Banded Mackerel.

(Plate XV. Fig. 5.)

Scomber zonatus, Banded Mackerel, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 427, pl. 4, fig. 3.
La Seriole à ceintures, Seriola zonata, Cuv. et Val., ix. p. 213.

Seriola zonata, DEKAY, Report, p. 128, pl. 9, fig. 26.
" " STORER, Mem. Amer. Acad., New Series, II. p. 357.
" " " Synopsis, p. 105.

Color. Of a silvery-brown color ; lighter upon the sides, with a yellowish tint, which is also observable upon the opercula and along the lower jaw. Five well-marked dark-brown transverse bands, upon the sides, passing from the dorsum to the abdomen, are continued upon the dorsal fin.

The first dorsal fin is black. The second dorsal fin has a yellowish tinge ; its first rays are tipped with white. The ventrals are fuliginous beneath, with their extremities yellowish-white. The centre of the anal fin is of a greenish brown ; its base and tips are white. The caudal fin is yellowish-green, with a dusky tinge at its base and posterior portion ; its extremity is white.

Description. Body elongated, compressed, with very minute scales. Its greatest depth is more than the length of its head. The length of the head is less than one third the length of the body ; the top of the head and the opercula are destitute of scales. The eyes are circular, and of moderate size. The nostrils are double, oval, just anterior to the edge of the superior orbitar bone. The gape of the mouth is large ; the jaws are armed with several rows of minute card-like teeth. The tongue, pharnyx, palatine, and vomer roughened by slight asperities.

The lateral line, which is a mere thread, commences at the superior angle of the operculum, and slants downwards in an undulatory manner to about opposite the middle of the second dorsal fin, whence it pursues a straight course to the tail, being elevated into a ridge upon its fleshy portion, forming a well-marked carina.

Just in front of the dorsal fin is a small distinct truncated spine, pointing forwards.

The first dorsal fin, which is composed of seven spinous rays, is quite small and triangular ; it arises just back of the pectorals, and is united by a prolongation of its connecting membrane to the base of the first ray of the second dorsal fin ; its third and fourth rays are highest ; the first ray and last two rays are very short.

The second dorsal fin arises opposite the extremity of the ventrals, and is continued until within a short distance of the tail ; it is high at its origin, diminishes in height until about the fourteenth or fifteenth ray, and the remainder of the rays are about the same height ; the rays are bifid at their extremities, all of which slightly project above the connecting membrane.

The pectoral fins are subtriangular, and are situated directly beneath the posterior angle of the operculum.

The ventral fins are just beneath the origin of the pectorals, and are composed of five strong multifid rays.

Just anterior to the origin of the anal fin are two very minute naked spines, the anterior of which is the smaller.

The anal fin is similar in form to the second dorsal, and terminates on a plane with it.

The caudal fin is very deeply forked; its rays are articulated, and its two extremities terminate in sharp points.

Length, about ten inches.

The fin rays are as follows: — D. 1 – 7 – 38. P. 20. V. 6. A. 2 – 20. C. $15\frac{5}{5}$.

Remarks. I have seen but two specimens of this fish. Both of these were caught in the harbor of Wellfleet, one in August, 1844, and the other in November, 1849. Dekay speaks of it as not being uncommon in Long Island Sound.

Massachusetts, Storer. New York, Mitchill, Dekay.

GENUS XI. TEMNODON, Cuv.

The tail unarmed; the little fins or the detached spines before the anal, as in Seriola. The first dorsal fragile and low, the second and the anal covered with small scales; but the principal character consists in a row of separated, pointed, and cutting teeth in each jaw; behind the upper ones is a row of smaller teeth, and there are some fine as velvet on the vomer, palate, and tongue. The operculum terminates in two points, and there are seven branchiostegous rays.

Temnodon saltator, *Cuv.*

The Blue-fish.

(Plate XV. Fig. 1.)

Saltatrix, Skipjack, Green-fish, Lin., Catesby's Carolina, ii. pl. 14.
Gasterosteus saltatrix, Lin., 12 edit., p. 491.
" " *Skipping Stickleback,* Shaw, Gen. Zoöl., iv. p. 609.
Pomatome Skip, Lacepede, iv. p. 436.
Scomber plumbeus, Horse-Mackerel, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 424, pl. 4, fig. 1.
Le Temnodon sauteur (*Temnodon saltator,* Cuv.; *Perca saltatrix,* Lin.; *Cheilodiptere poptucanthe,* Lacep.), Cuv. et Val., ix. p. 225, pl. 260.
Temnodon saltator, Blue-fish, Storer, Report, p. 57.
" " " Ayres, Bost. Journ. Nat. Hist., iv. p. 261.
" " " Dekay, Report, p. 130, pl. 26, fig. 81.
" " " Storer, Mem. Amer. Acad., New Series, ii. p. 360.
" " " " Synopsis, p. 108.

Color. The upper part of the body is bluish; a greenish tinge upon the sides and abdomen. The irides are yellow. The pectorals are of a greenish-brown color, with a deep black blotch at their base beneath. The second dorsal and caudal fin are likewise of a greenish-brown color. The ventral and anal fins are of a bluish-white color.

Description. Body oblong, compressed, becoming suddenly narrower at the base of the tail. Length of the head not quite equal to one fourth the length of the fish; head above naked. Preoperculum naked beneath, finely denticulated upon its inferior edge, and terminated inferiorly and posteriorly in an obtuse angle. Eyes circular, and moderate in their size. Operculum terminating in two membranous points superiorly and posteriorly, which do not amount to spines. Nostrils double, terminating in the same cavity; the anterior orifice is perpendicularly ovate, and situated directly in front of the posterior, which is larger and crescent-shaped. Gape of the mouth large. Jaws armed with prominent, sharp, lancinated teeth; the lower jaw has but one row of these, ten or twelve in number; the upper, besides a similar row to that in the under, has a row of very small teeth back of these. A row of very minute teeth at the base of the tongue; also small teeth upon the vomer. The lateral line commences just above the posterior angle of the operculum, and, curving slightly at its commencement, pursues nearly a straight course to the caudal rays.

The first dorsal fin, commencing on a line with the anterior half of the pectorals, is composed of seven spinous rays, the second, third, and fourth of which are longest; the rays of this fin are connected by a membrane, which proceeds obliquely backwards from the posterior tip of one to the anterior centre of the succeeding ray. This fin, when not expanded, is received into a groove at its base.

Just back of the first dorsal commences the second, which is nearly as long as the head; it is composed of a very dense membrane, which envelops all the rays, the second, third, fourth, fifth, and sixth of which are longest; this fin is slightly emarginated above, and its posterior termination resembles a finlet.

The pectorals are triangular.

The ventrals are beneath the pectorals, and are fan-shaped.

The anal fin, similar in its structure and form to the second dorsal, arises just back of the origin of that fin, and terminates nearly on a line with the termination of it.

The caudal fin is large, and deeply forked.

Length, about eighteen inches.

The fin rays are as follows: — D. 7 – 26. P. 17. V. 6. A. 28. C. 20.

Remarks. On some parts of our coast this is a common species. Many years since, it was held in high estimation by the aborigines of our country. For a long series of years it disappeared from our waters, as may be learned from a journal of the first settlement of the island of Nantucket, written by Zaccheus Macey, in 1792, and contained in the third volume of the *Massachusetts Historical Collections.* In this account, notice is taken of a great pestilence which attacked the

Indians of that island in 1763 and 1764, with such mortality that, of 358, the whole number, 222 died. He adds: "Before this period, and from the first coming of the English to Nantucket, a large fat fish, called a *blue-fish*, twenty of which would fill a barrel, was caught in great plenty all round the island, from the 1st of the 6th till the middle of the 9th month. But it is remarkable that in the year 1764, the very year in which the sickness ended, they all disappeared, and that none have been taken since." Occasionally, for the last thirty years, a few straggling specimens, very small, have been taken, but they were rarely seen until within the last fifteen years. During this latter period, they have gradually increased in numbers, and, generally speaking, have been of much larger size than when they were first observed. Now they visit the coast south of the Cape, at Buzzard's Bay, the Vineyard Sound, and Nantucket, in large numbers; and also Massachusetts Bay as far as Boston, from the wharves of which city I have observed specimens to be taken yearly since September, 1844. This species occasionally weighs fourteen pounds. In its flavor it resembles the mackerel, and is highly esteemed by many as an article of food; but it is excessively fat, and cannot always be borne by the stomach. In the early part of summer it is very lean; towards the latter part of summer and the commencement of autumn, it is in a state of perfection for the epicure. Its food is herring and mackerel, and when it appears these fisheries are destroyed. Thus, in March, 1846, the *herring fishery* on the south side of Falmouth was spoiled by the ravages of this species. On the night of the 27th of June, 1847, Captain Atwood caught in his mackerel-nets two large blue-fish. He fished but two nights more that season; — the blue-fish had driven the mackerel entirely from the coast. From that time until now, 1853, the mackerel fishery at Provincetown has been ruined. It is usually caught from the shore at Nantucket by throwing a drail, — a hook fixed into a piece of bone or ivory, and sometimes pewter, somewhat in the form of a fish, with brass wire around the line near it, to prevent its being bitten off by the strong jaws of the fish. It is also caught from a boat under sail with a good breeze, the line dragging behind; and they have been taken with a seine. In a number of the Nantucket Enquirer, July 8th, 1837, I find the following: "A few days since, there were caught at one haul, 241 blue-fish, 108 scuppaugs or poggies, 28 bass, and 19 shad, in all 396 fish, weighing about half a ton."

Maine, H. R. STORER. Massachusetts, STORER. Connecticut, AYRES, LINSLEY. New York, MITCHILL, DEKAY. South Carolina, LIN., CUV.

GENUS XII. RHOMBUS, LACEP.

Head and body compressed. Body covered with minute scales. Extremity of the pelvis forming, anterior to the anus, a small, pointed, and cutting blade, which resembles a vestige of the ventral fins. A horizontal, partially concealed spine before the dorsal and anal fins.

RHOMBUS TRIACANTHUS, *Dekay.*

The Skipjack.

(PLATE XV. FIG. 4.)

Stromateus triacanthus, PECK, Mem. Amer. Acad., II. p. 48, pl. 2. fig. 2..
Stromateus cryptosus, *Cryptous Broad-Shiner*, MITCH., Trans. Lit. and Phil. Soc. of N. Y., I. p. 365, pl 1, fig. 3.
Peprilus cryptosus, CUV., Griffith's Transl., x. p. 203.
Le Rhombe à fossettes (*Rhombus cryptosus*, NOB., *Stromateus cryptosus*, MITCH.), CUV. et VAL., IX. p. 408.
Peprilus triacanthus, *Three-spined Peprilus*, STORER, Report, p. 60.
Rhombus triacanthus, *Short-finned Harvest-fish*, DEKAY, Report, p. 137, pl. 75, fig. 80.
" " STORER, Mem. Amer. Acad., New Series, II. p. 362.
" " " Synopsis, p. 110.

Color. Of a leaden color upon the back; lighter upon the sides; silvery beneath. The cheeks, intermaxillaries, chin, base of pectorals, and base of caudal fin, together with more or less of the abdomen, sprinkled with very minute black dots. The opercles are cupreous.

Description. The body is ovate, very much compressed laterally, particularly at the abdomen. The arch of the back is continued to the spine at the origin of the dorsal fin. The length of the head is rather more than one fifth the length of the body, and is gradually arched from the snout. The eyes are circular; their diameter is equal to one fourth the length of the head. The nostrils are small; the anterior is circular, the posterior a vertical fissure. The mouth is of moderate size. The jaws are of equal length, and present at their edges a large number of very minute, equal, compact teeth.

The lateral line, which is very well marked, commences just back of the posterior angle of the operculum, and, arching backwards, curves with the back to the base of the caudal fin. A slightly depressed straight line, destitute of scales, is seen passing from beneath the origin of the lateral line to the middle of the fleshy portion of the tail; and another line, similar in appearance to the last, though not so obvious, passes from the inferior base of the pectorals, curving with the abdomen, to the lower part of the fleshy portion of the tail, corresponding in its course to that of the lateral line. These lines gradually disappear after death. On each side of the dorsal fin, commencing at its origin and terminating towards its posterior half, are situated between twenty and thirty small circular black punctures, the orifices of mucous ducts.

At the origin of the dorsal fin is a small, naked, horizontal spine, pointing forwards. The dorsal fin commences opposite the anterior half of the pectorals, and is continued to the fleshy portion of the tail. The fifth, sixth, and seventh rays are the highest. The most posterior rays are not quite equal to one fourth the height of the highest rays. The height of the pectorals is one fifth greater than the height of the head.

Just back of the anus is a minute naked spine, pointing forwards like that before the dorsal fin.

The anal fin terminates opposite the extremity of the dorsal fin. The membrane uniting the rays of this fin, as well as that of the dorsal fin, is very fine, appearing to be a continuation of the cuticle of the fish ; it is not continued to the extremities of the rays, which are naked and bifid. Some distance anterior to the anus is a very minute spine, which is naked and directed backwards.

The caudal fin is deeply forked ; its longest rays are higher than the length of the head.

Length about ten inches.

The fin rays are as follows : — D. 45. P. 21. A. 43. C. 20.

Remarks. — This species was first described by Professor Peck in 1794, and his communication was published in the Memoirs of the American Academy for 1804. His description, which was a very accurate one, was accompanied by a respectable figure. His specimens were taken on the coast of New Hampshire. This fish, which is known upon some portions of Cape Cod as the *Sheep's-head*, and at Provincetown by the name of *Skipjack*, is not uncommon in the waters of our State. It is taken along the Cape, in considerable quantities, in nets with bass and mackerel. I have known a single specimen to be taken from one of the wharves in this city. A peculiarly unpleasant odor is emitted by this fish when caught, resembling somewhat that of sulphuretted hydrogen, which sometimes produces a faintness accompanied with headache in the captor. It is used as bait for the *Striped Bass* by our fishermen. By some it is considered an excellent pan-fish. Being very oily, it is principally used for manure upon several portions of Cape Cod.

New Hampshire, Peck. Massachusetts, Storer. Connecticut, Ayres, Linsley. New York, Mitchill, Dekay.

GENUS XIII. SPHYRÆNA, Cuv.

Body elongated, with two distinct dorsals. Lower jaw longest ; both with long teeth. Ventrals back of the pectorals.

Sphyræna borealis, *Dekay*.

The Northern Barracuda.

(Plate XII. Fig. 3.)

Sphyræna borealis, *Northern Barracuda*, Dekay, Report, p. 39, pl. 60, fig. 196.
" " " " Storer, Proc. of Bost. Nat. Hist. Soc., I. p. 148.
" " Storer, Mem. Amer. Acad., New Series, II. p. 300.
" " " Synopsis, p. 48.

Color. Of a greenish brown above, silvery beneath; this silvery appearance is more striking upon the inferior portions of the head and throat. The lateral line and caudal fin are yellow.

Description. Body very much elongated and slightly compressed. Length of head equal to about one fourth the length of the body; it is flattened above and ridged; this upper portion of the head, as well as its sides in front of the eyes, and the intermaxillaries, is destitute of scales; gill-covers with minute scales. The operculum terminates posteriorly in an acute angle; preoperculum rounded posteriorly. Eyes large, circular; distance between eyes equal to diameter of eye. Nostrils situated directly in front of eye; the anterior circular and the smaller. Snout obtuse; lower jaw projecting beyond the upper. Gape of mouth large. Fleshy protuberance at chin. Posterior teeth in lower jaw largest of all, with the exception of the two anterior. Two prominent sharp teeth on each side of tip of upper jaw. A large number of very minute teeth are seen upon the intermaxillaries; numerous teeth also upon the palatines on each side, the three anterior of which are much the largest. Tongue rough. The lateral line commences at the posterior superior angle of the operculum, and, curving slightly downwards to a line above the posterior half of the pectoral fin, pursues a straight course thence to the tail. The scales along the lateral line slightly resemble those in the same situation of the genus Caranx.

The first dorsal fin commences nearly opposite the origin of the ventral fin. It is of a triangular form; its membrane is exceedingly delicate; the second ray is the highest; the first and third are equal; the length and greatest height of the fin are equal. The tips of all the rays project considerably beyond the connecting membrane.

The second dorsal fin commences anterior to the anal, and is subquadrangular. The membrane connecting the rays is much firmer than that of the first dorsal. The first ray is simple, the others bifurcated.

The pectorals commence just beneath the posterior angle of the operculum. The first ray is simple; its height is about equal to that of the first dorsal.

The ventrals are situated beneath the first dorsal; they are a little shorter than the pectorals.

The anal is situated beneath the second dorsal, and its height is about equal to the height of that fin.

The caudal is deeply forked.

Length about nine inches.

The fin rays are as follows: — D. 5 – 10. P. 14. V. 6. A. 10. C. 20.

Remarks. Several specimens of this fish were sent me in September, 1843, by Dr. Yale, from Holmes's Hole.

Massachusetts, Storer. New York, Dekay.

FAMILY VI. ATHERINIDÆ.

Mouth protractile; no notch on the upper jaw, nor tubercle on the lower. Suborbital not dentated. A broad silvery band on the side. Very small crowded teeth on the pharyngeals. The first branchial arch with long pectinations. Two dorsal fins, most commonly distant. Ventrals behind the pectorals.

GENUS I. ATHERINA, Lin.

Body elongated. Two dorsals widely separated; ventrals further back than the pectorals; mouth highly protractile, and furnished with very minute teeth. A broad silvery band along each flank on all the known species.

Atherina notata, *Mitch.*

The Dotted Silver-side.

(Plate XVI. Fig. 1.)

Atherina notata, Small Silver-side, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 446, pl. 4, fig. 6.
L'Athérine de Bosc (*Atherina Boscii,* Cuv., *Atherina notata,* Mitch.), Cuv. et Val., x. p. 465.
Atherina Boscii, Small Silver-side, Storer, Report, p. 62.
" " " " Ayres, Bost. Journ. Nat. Hist., iv. p. 262.
Atherina notata, Dotted Silver-side, Dekay, Report, p. 141, pl. 28, fig. 88.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 366.
" " " Synopsis, p. 114.

Color. Alive, the entire fish is translucent, with the exception of the abdomen, which is rendered opaque by the contained viscera. The body is greenish above, with minute black dots distributed along the edges of the scales upon the upper portion of the sides, and over the entire scales upon the dorsum, making it to appear quite dark-colored. Upon the sides a beautiful broad silvery band runs from the upper base of the pectorals to the tail; along its upper edge runs the black lateral line; the portion of the body beneath this band is of a lighter color than that above it, and of a silvery appearance. Minute black dots exist between the rays of the anal fin at its base. The fins are all translucent, colorless, and articulated. The top of the head is covered with minute black dots, similar to those on the scales. The space between the eyes is nearly black, owing to the black pupils beneath. The pupils are deep black, the irides a beautiful silvery color. A golden reflection is seen upon the operculum, which in some specimens is continued along the abdomen to the vent.

Description. The body is elongated, somewhat compressed, flattened upon the top of the head. The scales are rounded, smooth at their edge with concentric striæ. Its greatest depth is equal to about one seventh its whole length. The length of the head is rather more than one fifth the whole length of the body. The eyes are horizontally oval; their greatest diameter is equal to one fourth the length of the head; the distance between the eyes is equal to their greatest diameter. The upper jaw is slightly the longer when the mouth is closed; the lower jaw, when closed, is situated obliquely with regard to the upper; both jaws are armed with minute teeth. The mouth is very protractile.

The first dorsal fin arises at a distance back of the posterior extremity of the pectorals about equal to half the length of the head. It is subtriangular when expanded, with a very delicate connecting membrane. Its first ray is shorter than the three next posterior; the last ray is connected to the dorsum by a prolongation of the connecting membrane.

The second dorsal fin is situated back of the first, at a distance equal to that at which the first dorsal is back of the extremities of the pectorals. This fin is quadrate, slightly emarginated above; its posterior ray projects slightly beyond the preceding rays.

The pectoral fins commence directly back of the upper part of the operculum; their highest rays are equal to three quarters the length of the head; the length of the fin is equal to one third of its height. The upper rays are as high again as the lower rays, when unexpanded. These fins cover a portion of the silvery lateral band.

The ventral fins are fan-shaped, and arise on a line opposite the posterior rays of the pectorals; their rays are multifid; they are connected at the inner edge of their base by a delicate membrane.

The anal fin is situated just back of the commencement of the first dorsal fin; it is much elongated, and terminates just posterior to the second dorsal. Its first eight or ten rays are much the highest.

The caudal fin is deeply emarginated. The height of its outer rays is equal to the height of the pectorals.

The fin rays are as follows: — D. 5 – 9. P. 12. V. 5. A. 25. C. 18.

Remarks. This species, specimens of which I have received from Holmes's Hole and Provincetown, in the spring and autumn accompanies the smelt in large numbers into the mouth of Charles River at Boston, and is taken by the boys, by whom it is invariably called the *Cupelin;* which is the common name of the *Mallotus villosus.* In the third volume of the *Massachusetts Historical Collections*, for 1794, this fish is called the *Atherina* (*menidia*), Lin., and is spoken of as being "found in great abundance in the River Piscataqua, in the months of August and September." The author's name is not mentioned, but we suppose it to be Professor Peck, who then resided at Kittery, N. H.

New Hampshire, Peck. Massachusetts, Storer. Connecticut, Linsley, Ayres. New York, Mitchill, Cuvier, Dekay. South Carolina, Cuvier.

FAMILY VII. MUGILIDÆ.

Body almost cylindrical, covered with large scales, and furnished with two distinct dorsal fins, the first of which has only four spinous rays. Head rather depressed, also covered with large scales or polygonal plates. Muzzle very short. Teeth very fine, sometimes scarcely perceptible. The ventrals are attached somewhat behind the pectorals. Branchiostegous rays, six.

GENUS I. MUGIL, Lin.

Ventrals placed a short distance behind the pectorals. The first dorsal with four spinous rays. The middle of the under jaw tuberculated within, and a corresponding cavity in the upper jaw. Teeth very small.

Mugil lineatus, *Mitch.*

The Striped Mullet.

(Plate XVI. Fig. 4.)

Mugil lineatus, Mitch., MS. communicated to Cuvier.
Le Muge rayé (*Mugil lineatus*, Mitch.), Cuv. et Val., Hist. Nat. des Poiss., II. p. 96.
Mugil lineatus, Dekay, Report, p. 144, pl. 15, fig. 42.
" " Ayres, Bost. Journ. Nat. Hist., v. p. 265, pl. 12.
" " Storer, Mem. Amer. Acad., New Series, II. 367.
" " " Synopsis, p. 115.

Color. Dusky grayish-blue above, thence to steel and to dirty silvery, with metallic reflections upon lower sides and abdomen. Sides throughout their whole depth from back to centre of belly marked with continuous longitudinal and parallel lines, equidistant, of little over a hair's breadth, and passing through the centre of each scale; the two upper reach over the top of the head to the snout; their number is from ten to fourteen. Snout and upper operculum clouded with greenish fuliginous; lower operculum a clear silver. Pupils black, irides yellowish. All the fins save the ventrals clouded with dusky, even the membrane of first dorsal. Second dorsal and caudal the darkest, the terminal margin of the latter edged with very dark brown. A deep purplish spot at upper base of pectorals.

Description. Body nearly cylindrical; dorsal outline somewhat convex, especially gibbous in region of second dorsal. Depth of body equal to length of head; depth near tail about one half of greatest depth.

Head moderate; its length about one fifth that of the entire fish; somewhat flattened above, cheeks slightly protuberant. Opercles entire, though their suture is plainly visible. Space between edges of interopercula of moderate size. Jaws nearly equal, the lip of the upper, which is protractile, a little projecting; the tip of lower jaw with a pointed knob, which fits into a corresponding cavity above. Gape of mouth moderate and triangular; outer edge of upper jaw with a single row of very minute teeth, those on lower jaw scarcely perceptible, even if present. Nostrils double; the posterior near upper anterior angle of eye; the anterior smallest and rounded. Eyes large, their diameter equal to about two thirds the distance between them; with a thick gelatinous membrane, which more than covers them, and extends to some distance around.

Scales throughout body, large, rounded, engraved; present also upon throat and top of head; in which latter locality some of them are strangely channelled and grooved, as if by worms.

First dorsal commences just behind a line midway between pectorals and second dorsal. Moderate, rounded triangular; its rays spinous, the second the longest, the last the smallest and least stout. When shut, concealed nearly from view. Rays so arranged as to fall alternately upon opposite sides of the median line when fin is closed.

Second dorsal quadrangular, emarginated posteriorly, or rather superiorly; fleshy.

Pectorals subtriangular, slightly falciform; with a large, delicate, and movable axillary scale.

Ventrals with a movable pelvic plate, their first ray spinous and welded to the next, the rest branched; in advance of the pectorals.

Anal commences slightly in front of second dorsal, and terminates about on a line with it; the first three rays progressively increase in length, the first of them being very short, and are spinous.

Caudal deeply emarginated.

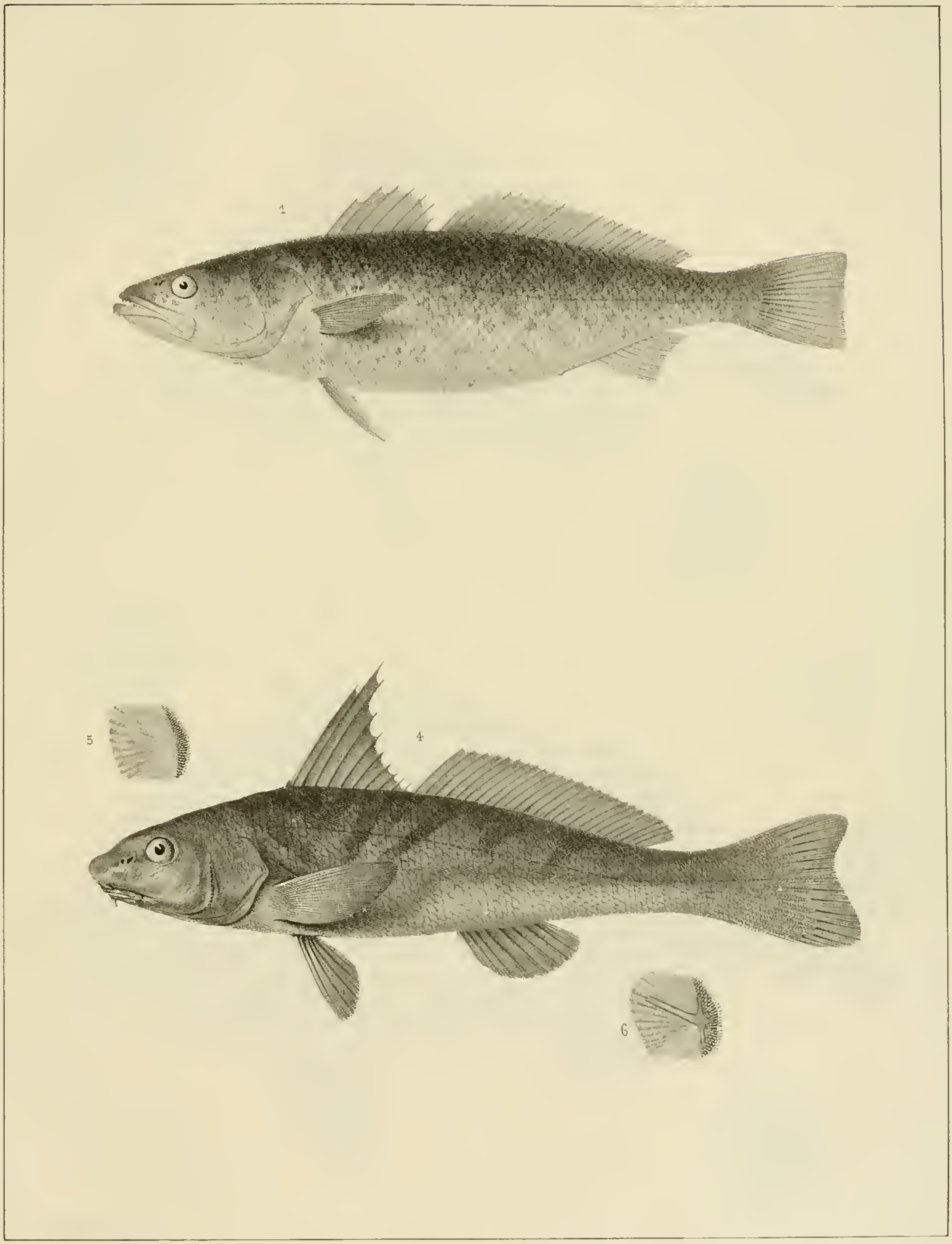
The fin rays are as follows: — D. 4–9. P. 16. V. 1–5. A. 3–10. C. 14.

Length ten inches.

Remarks. Dekay says this species "was first detected on our coast by Dr. Mitchill, who sent a specimen, with the name and a description, many years ago." Cuvier, in his *Histoire Naturelle des Poissons*, accepts the specific name of Mitchill.

The only individual of this species I have known to be taken in our waters was found by Captain Atwood on the northern side of Long Point, Provincetown, November 7th, 1851, where it had run ashore.

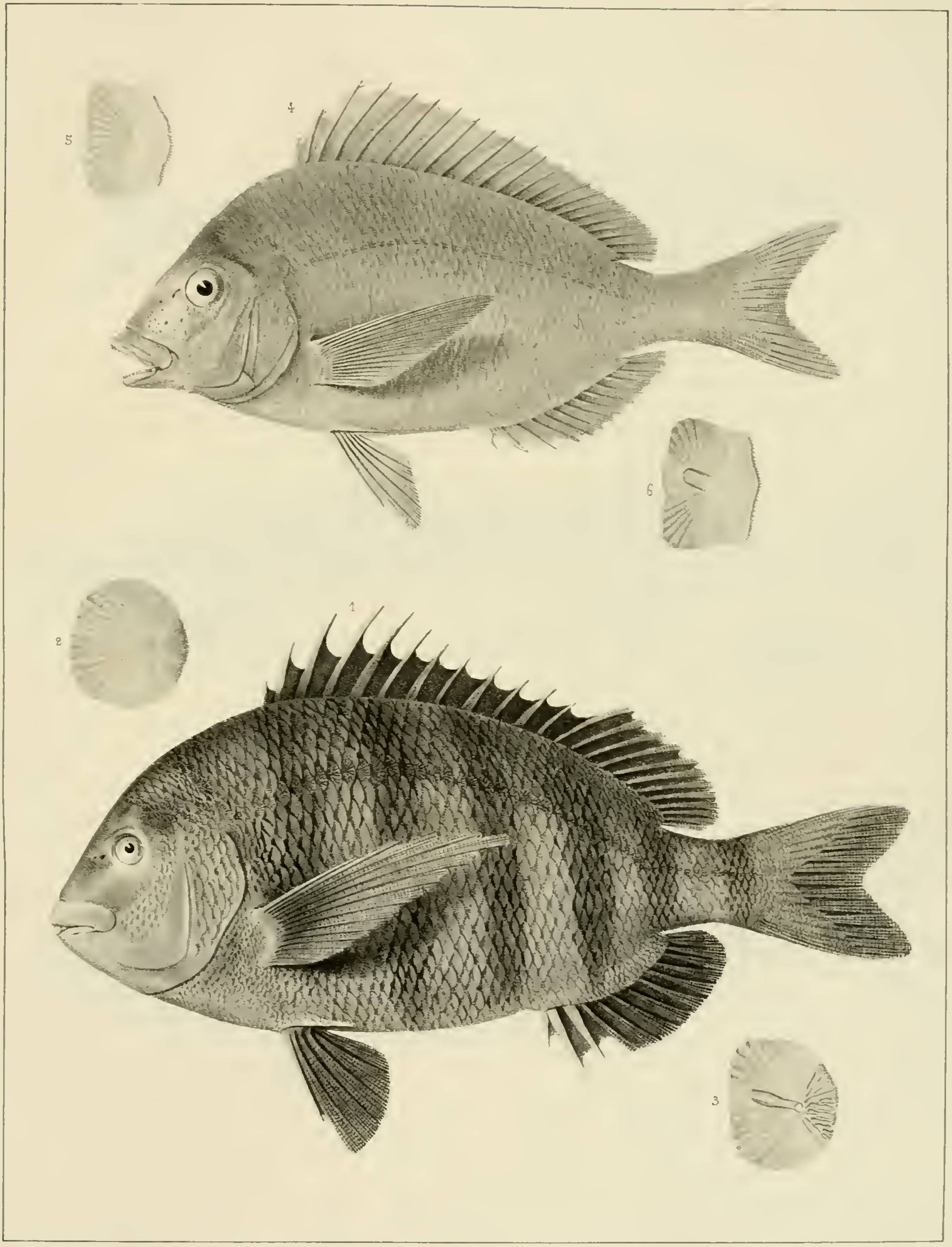
Massachusetts, Storer. Connecticut, Ayres, Linsley. New York, Mitchill, Cuvier, Dekay.



Tappan & Sonrel from nat

Printed by Tappan & Bradford

1. OTOLITHUS REGALIS Cuv — 4-6. UMBRINA NEBULOSA, Storer



A Sonrel on stone from nat

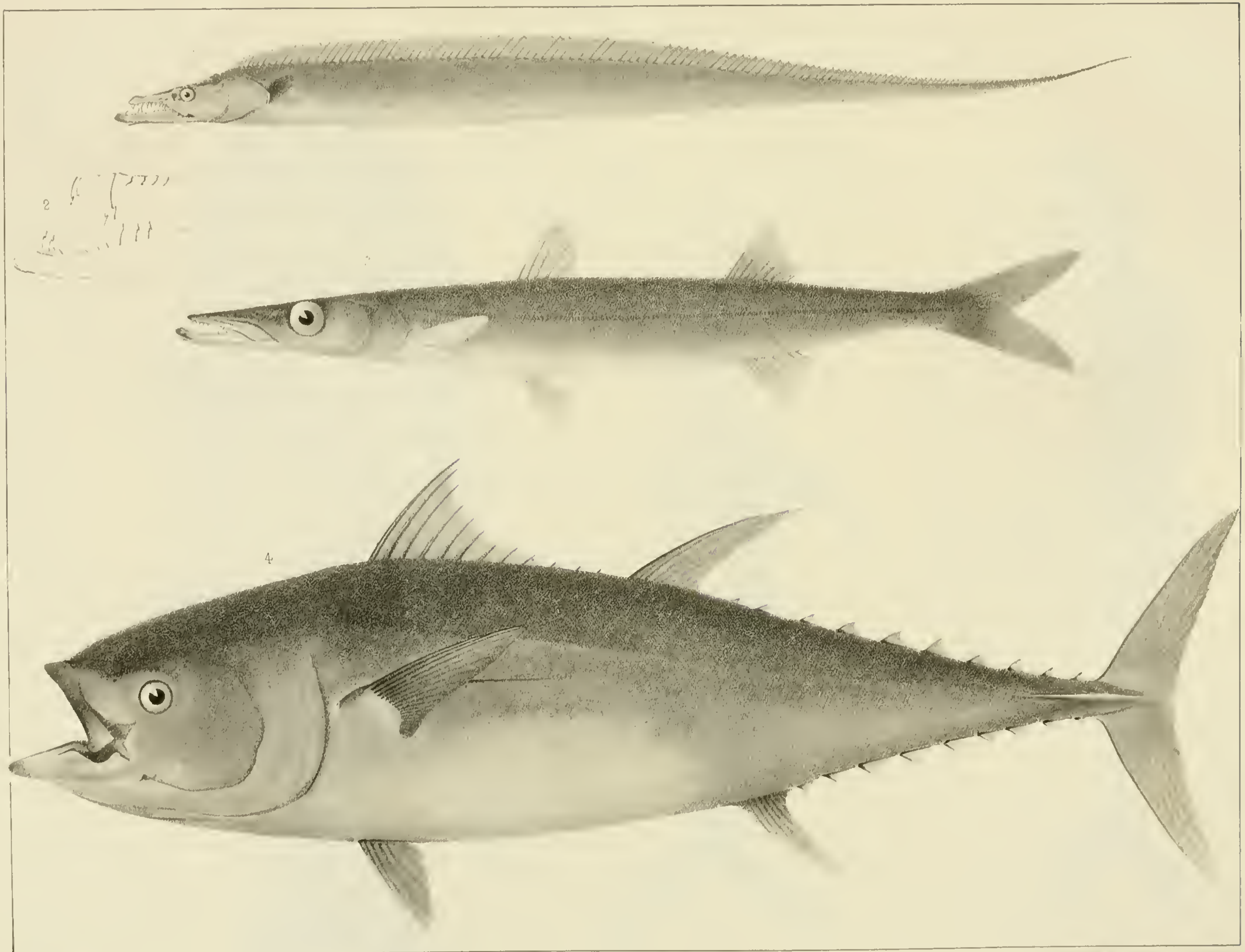
Printed by Tappan & Bradford

1-3. SARGUS OVIS Mitch. – 4-6. PAGRUS ARGYROPS, Lin

Tappan & Sonrel from na.

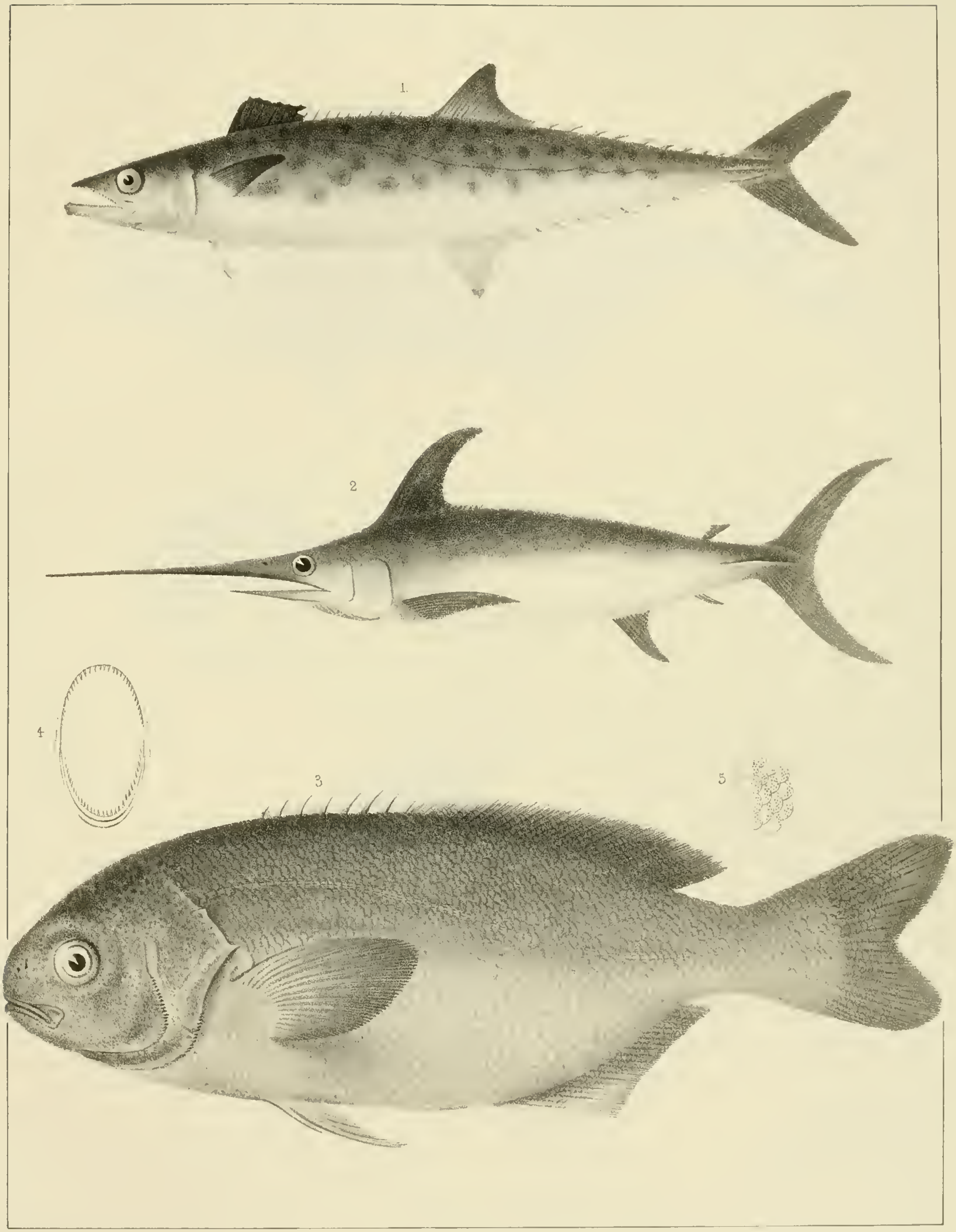
Printed by Tappan & Bradford

1, SCOMBER DEKAYI, Storer — 2, 4 SCOMBER VERNALIS Mitch
5 PELAMYS SARDA Cuv.



Tappan & Son ... lith

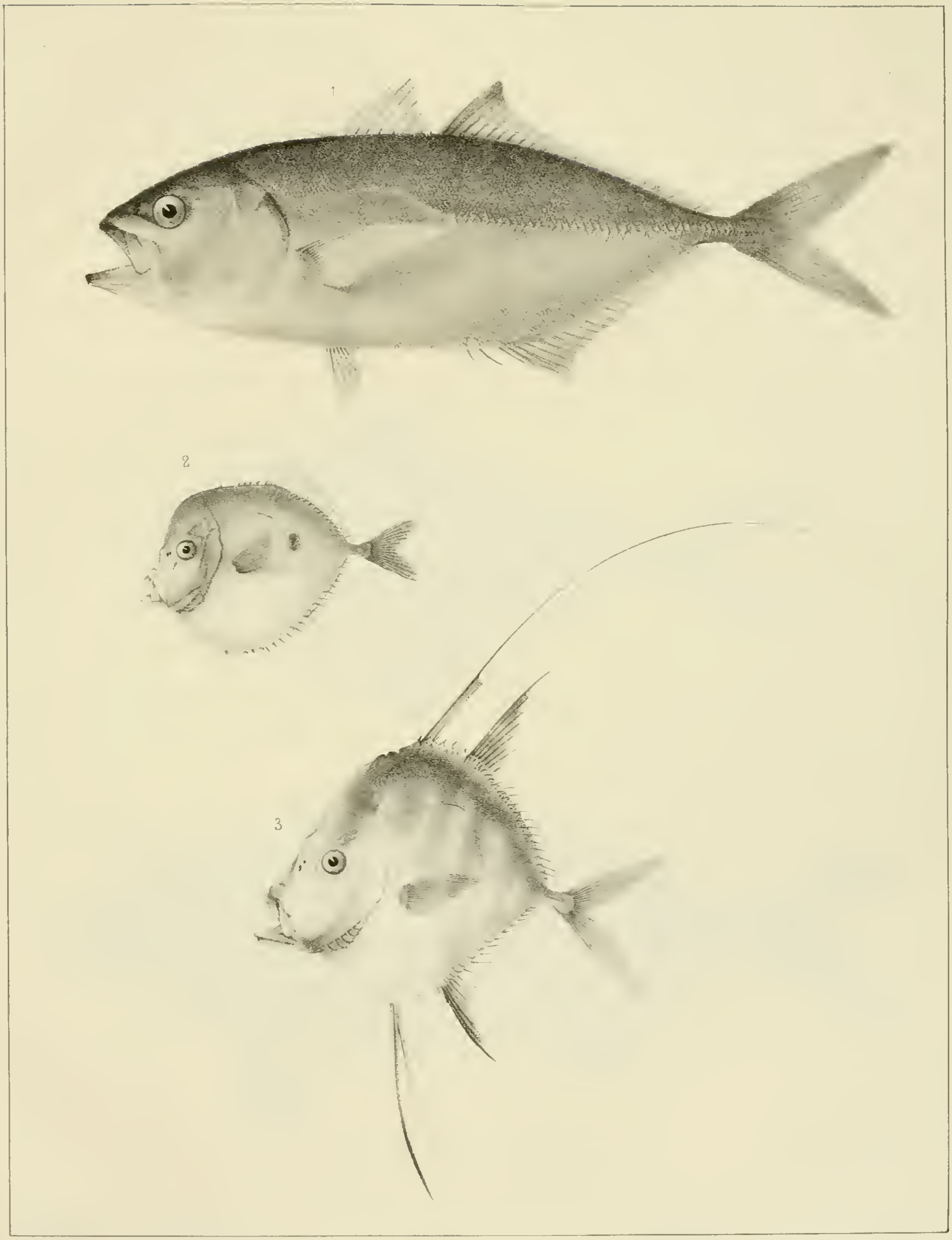
1,2 TRICHIURUS LEPTURUS Lin. – 3. SPHYRAENA BOREALIS Dekay 4. THYNNUS SECUNDO-DORSALIS



Tappan & Storm

Printed by Tappan & Bradford

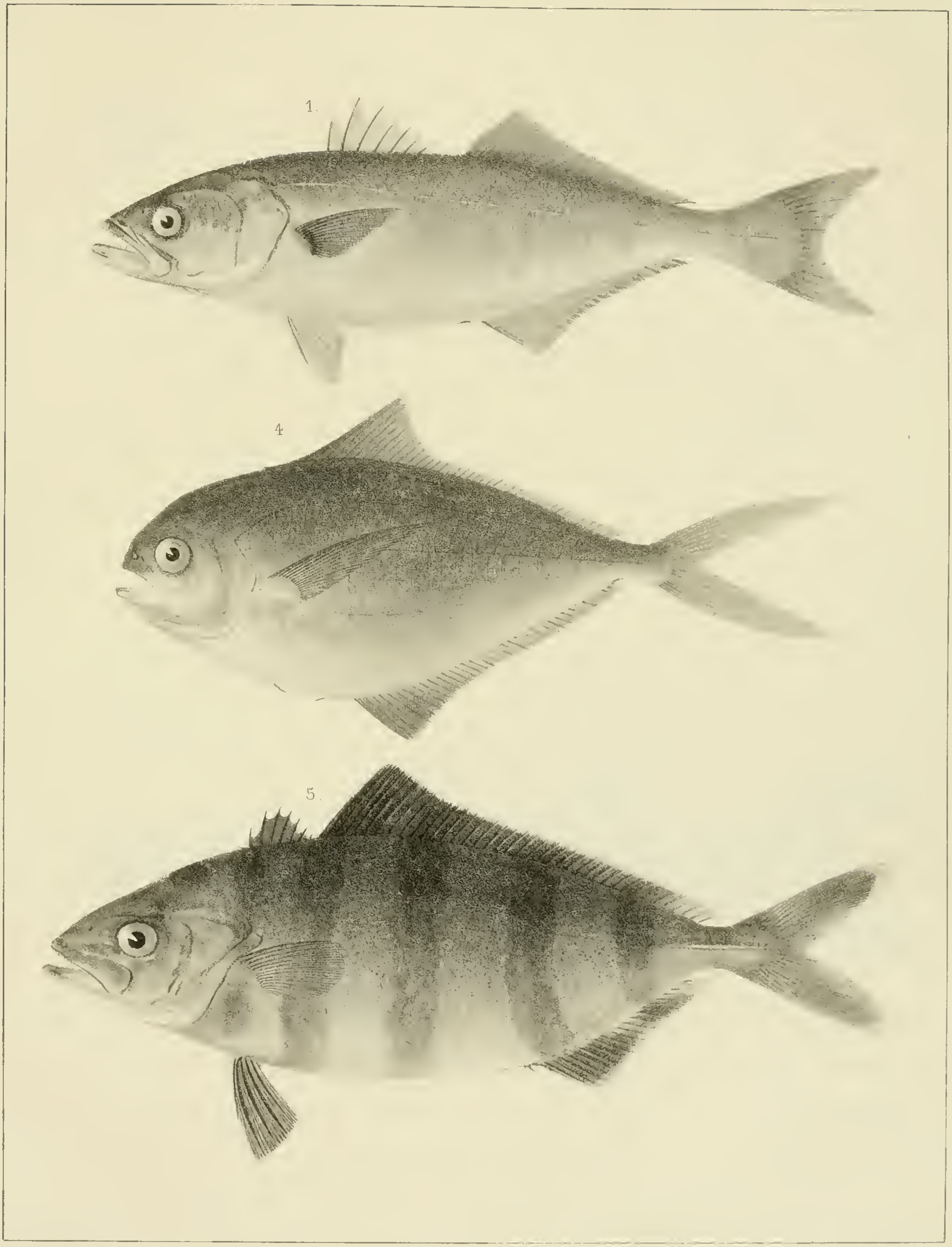
1. CYBIUM MACULATUM, Cuv — 2. XIPHIAS GLADIUS, Lin
3 5. PALINURUS PERCIFORMIS, Dekay



Tappan & Co.

Printed by Tappan & Bradford

1. CARANX CRYSOS, Cuv. — 2 ARGYREIOSUS UNIMACULATUS, Batch
3. ARGYREIOSUS CAPILLARIS Dekay



W. H. Tappan from nat. A. Sonrel on stone

Printed by Tappan & Bradford

1 TEMNODON SALTATOR Cuv. 4 RHOMBUS TRIACANTHUS, Dekay
5 SERIOLA ZONATA, Cuv.

A. Sonrel

Printed by Tappan & Bradford

1-3. ATHERINA NOTATA Mitch. — 4,5. MUGIL LINEATUS, Mitch

IX.

The Tornado of August 22d, 1851, *in Waltham, West Cambridge, and Medford, Middlesex County, Mass.* (*With a Map.*)

By HENRY L. EUSTIS, A. M.

(*Communicated February 3d*, 1852.)

Meteorology is every day gaining a stronger foothold, and taking a higher rank among the sciences of modern times. It would be no great tax upon our powers of retrospection, to look back to the period when its deductions were regarded, by most persons, as the mere speculations of scientific enthusiasts, having no tests whereby their fallacy or accuracy could be demonstrated, and therefore possessing little practical value. Nor is this to be wondered at, since it is preëminently a science whose laws can be deduced only from long-multiplied observations, affording a connected series of facts, which, however diversified by temporary or local circumstances, may still betray, amid all their variety, an obedience to certain fixed principles. How far man can go in his attempt to elevate it into an exact science, whose deductions shall be worthy of implicit confidence, is not for me to say. But thus much may be confidently asserted: that, as a means to this end, we need, not much speculation and theorizing upon a few facts, but abundant observations, whereby theories may be tested, and their true value assigned to them, in proportion as they accord with the facts observed, and may serve to explain and account for them.

Among the subjects which come within the proper domain of Meteorology, the laws of storms hold no insignificant place. Accordingly, we have already a multitude of theories upon the subject, each warmly supported and defended by its advocates, but of which it is enough to say, that there is such a decided conflict between them, that they cannot all be true. It is not a question of more or less, — of generalities and details, — but of black and white. If some of these theories be established as true, the others are necessarily false; and in a matter which may be made of so much practical importance, we cannot too soon ascertain on which side the preponderance of truth is to be found.

Every science is elaborated by a slow and gradual progress from its simplest elements. A stone falls, as stones have always fallen, and from reasoning which happens to be, by one mind, directed to this every-day incident, is elaborated, only after patient study and research, our present law of gravitation. So, in all sciences, the most common events, which are presenting themselves every day before our eyes, but without exciting our attention, do finally, when reason is properly directed to them, furnish the material — rude, rough, unshapen, it may be at first — which shall, when properly elaborated, form the solid and enduring structure of the true science. In Meteorology the work is hardly begun. Storms, of more or less violence, are constantly occurring, but they come without warning, and leave behind them evidences, not only of their own desolating power, but of man's ignorance, which prevented him from anticipating and guarding against them. How many millions of dollars, and how many valuable lives, would be annually saved, if we had that precise knowledge which could tell us with the voice of recognized authority that the storm is approaching, and that the ship which we are so joyfully cheering on her way is doomed to destruction if she leave the port! Nay, more, we may deny even the possibility of prediction, and assume merely a knowledge of the mode and sphere of action of storms, and even this shall enable the mariner to direct his course with judgment, and escape their fury, instead of running, under false theories, into the very vortex of ruin. If the storm be not a solitary exception to those general laws which govern our physical world, — laws whose beauty, harmony, universality, and mutual dependence, science is every day more and more demonstrating, — then it is not unreasonable to suppose that the time will come when its laws shall be so far made known, that the wayfarer on the mighty deep shall be able to escape from the approaching hurricane, with the same certainty and decision with which we now move out of the track of the rushing locomotive engine.

To those who have lived where the hurricane or the tornado is an event of common occurrence, it would be impossible to convey any idea of the intense excitement caused in this community by the tornado of August 22, 1851. It swept through the towns of Waltham, West Cambridge, and Medford, prostrating in its path orchards, fences, forest-trees, and buildings, and involving in a few instances the loss of human life. While multitudes visited the scene of its ravages from mere motives of curiosity, and stood appalled before the exhibition of such wondrous power, scientific men sought to explore its mode of action, and to find there a corroboration or a refutation of their preconceived views. It was in obedience to the call of many of this latter class, that I undertook the survey whose results are embodied in the accompanying map.

It is not my object, in this memoir, to present any new theory upon the subject, nor even to indulge in any speculations of my own, but simply to record the facts observed, and to state in the plainest manner possible how the survey was made, in order that those who study the map may know just how much confidence is to be placed in its indications. This appears to me the more necessary, for the reason that, heretofore, the tracks of tornadoes have not generally been surveyed. The most that is ordinarily attempted is a rapid and rough reconnaissance of the ground, which, from its very nature, can embrace only the most prominent general characteristics, and is moreover extremely liable to be warped and biassed by the opinions and theories of the observer. It was sufficiently evident to me, in the course of the present survey, that had I gone upon the ground to make a simple reconnaissance of this kind, selecting spots here and there upon which to devote my principal attention, I could have found ample corroboration of almost any of the many previously existing theories, as well as of the new ones to which this particular tornado has given birth. The effect of local causes is so great, that any examination, to be worthy of credit as a test, must embrace, not isolated spots selected here and there, but a continuous track, in which all the varied circumstances of woods and plains, hills and valleys, villages and cultivated fields, may appear in their proper succession. We may even go farther than this, and assert that the law of a storm's action may often be deduced, not so much by examining what has really suffered and been prostrated in its course, as by turning our attention rather to those parts, which, lying as it were in the very jaws of destruction, have yet escaped unscathed.

It will be seen, by referring to the map, that it embraces only that portion of the track included between the foot of Wellington Hill, in Waltham, and the Mystic River. It will be a source of regret with many, that the particular portions in which they are most interested are not to be found on the map. To such I can only say, that, had sufficient time been at my disposal, I would most gladly have traced out the whole course from the beginning to the end. And this would have been the more satisfactory, inasmuch as opinion is by no means settled as to the point either of commencement or ending, — some persons asserting that its terminus was in Malden, while others, with equal confidence, maintain that it went out to sea. As a limited portion only could be examined within the time which was at my command, I have seen no reason to be dissatisfied with the selection which was actually made. A previous reconnaissance had assured me, that, although individuals had experienced severe losses in their property at points farther south in the track than that which was chosen for the starting-point of the survey, still, as a whole, the violence of the storm had been most felt in those parts which are embraced within the limits of the map. Moreover, in no other part of the track are all the varieties of surface so well displayed within the same limited extent. Emerging from a thicket of forest growth, near the foot of Wellington Hill, in Waltham, the storm crosses an open meadow, and commences the ascent of the hill. Then it passes along the crest of the hill, meeting in its way houses and barns, orchards, cornfields, fences, and forests. Now it commences its descent, and, as if gathering fresh strength at each obstacle, flies with resistless violence through the town beneath, bathes its weary wings in the waters of Spy Pond, cools its feverish breath by the demolition of an ice-house, and with renewed vigor speeds its way through the heart of West Cambridge, over the plain to the Mystic River. Here we have, within the space of a few miles, every variety of surface and every kind of obstacle presented, better than in any other portion of the route. To these considerations might be added the accidental circumstance, that this is the part not embraced in the observations of other persons. The more southerly portions of the track were reconnoitred, and the more northerly part, beyond the Mystic, in the town of Medford, is the district which was principally embraced in the report made by the Rev. Charles Brooks in behalf of the committee appointed by the citizens of West Medford. No map of either of these portions has to my knowledge been published, but in one way or another the subject has been brought before the public of this vicinity, and to such the present map will serve as a connecting link.

Before commencing the survey, I had satisfied myself by a preliminary examination of various portions of the track, that the direction of the axis line lay between N. 60° E. and N. 70° E. A compass was placed at the point of the axis line corresponding to 0, on the marginal scale of distances on the map, and a line was started N. 70° E., and staked at the distance of every hundred feet. This line was then prolonged with a graphometer, and at the same time perpendiculars to it at each stake were run out on both sides, and staked at every hundred feet. While one party was engaged in running the axis line, others prolonged the cross lines as far as any trace of the storm's action could be found, and still others were engaged in filling in the sections thus formed. The position of every tree was determined by two rectangular coördinates, and the direction in which it lay on the ground, or, if removed from its original place, the direction in which it had been carried was determined with a compass. By these means, not only was perfect uniformity preserved in the field notes, but, what was of equal importance, the axis and cross lines being first laid down upon the map, the work of plotting was very much facilitated. Having graduated two of the sides of a right-angled triangle to the proper scale, one side is placed upon a cross line at the proper distance, and the other coördinate, which is always less than a hundred feet, is read off at once, and the position of the tree marked by a needle point, without drawing a single line. Each observer plotted his own notes, on a scale of fifty feet to the inch. This large scale was adopted in order to reduce the absolute errors as much as possible, and also to facilitate the detection of any errors in the notes. The several sheets were then united, and a new map of the whole made on a reduced scale of a hundred feet to the inch.

It will be perceived, by a reference to the map, that the axis line of the survey is represented by a heavy broken line. This line is not straight, but, in order to equalize the length of the cross lines, offsets of a hundred feet or more were made in some places, where it appeared that we were getting on one side or the other of the true axis of the storm. After reaching the northern base of Wellington Hill, it will be perceived, also, that the system above described is abandoned for a short time, while crossing a part of the town of West Cambridge, and that the line is carried forward by courses running at various angles. This method was adopted in order to avoid the well-cultivated gardens of this particular district, where the encroachments of a surveying party, and the dragging of chains through flower-beds might have aroused the apprehension of the several proprietors. No inconvenience can arise from this, however, as, when once laid down upon the map in its true bearing, it is easy for any one to overlook the axis of the survey, and to mark out for himself the axis of the storm, as indicated by the traces which it has left.

A few words seem to be necessary, by way of explanation, of the frequent recurrence of the symbol adopted to represent those trees which had been thrown down, but which were replaced at the time of the survey. The storm occurred on the 22d of August. At that time I was absent from Cambridge, and even had I been present, the survey could not have been undertaken until the members of my class had reassembled, at the end of the vacation. The survey was commenced on the 2d of September, and prosecuted without interruption during a period of ten days, with a party varying from twelve to thirty. As the storm passed over a section of country which is one of the principal sources of supply for the Boston market, and therefore in a high state of cultivation, the farmers were the chief sufferers, many of them experiencing very severe losses by the destruction of their orchards. Most of these trees were simply blown down, with the roots on one side still clinging firmly to the ground, and the farmers with great alacrity set themselves at work to replace them, supporting them temporarily with shores. This work had been going on during the period of ten days which had elapsed before the survey was commenced, and as it was considered important that some trace of these trees should be preserved, though the direction of their fall could not be given, a symbol was adopted to designate them.

Some persons entertain the belief that the more fragile substances, as corn and grain, give the best indication of the direction of a storm, and this the more especially, because they attach great importance to the evidences of reaction, after the immediate violence of the storm has passed. It is not from inadvertency that no trace is left, among the results of the survey, of any observations upon this point. Several cornfields were passed on the route, and each one was made an object of special study and observation. Unfortunately, the time which had elapsed since the occurrence of the storm rendered these observations useless. A farmer with whom I conversed described his cornfield as presenting, on the morning after the storm, the appearance of a field over which a heavy roller had passed, — the stalks all bent down in one direction. But for the several succeeding days strong northerly winds prevailed, and the consequence was, that, at the time of my observations, some of the stalks were straightened up again, others bent back, and the whole scattered to every point of the compass, so that I was unwilling to record a solitary observation as reliable.

So far as the reaction is concerned, I have no hesitation in saying, that many of the exceptional cases to be found on the map are to be explained by it alone, and too much caution cannot be exercised in basing any theory upon a few cases of anomalous action. A mere glance at the map will show that, throughout the whole track, the trees generally point inwards, towards the axis, so that at almost any point a person may put his finger upon the axis line. I believe that this indication is so reliable, that I had at one time intended to mark an axis line in each of the sections of a hundred feet, by this indication alone, and then, by connecting all these, to give upon the map the true axis of the storm, that it might be shown at the same time whether it was straight or curved, and if curved, how great was its curvature. But I finally determined to leave this to be done by those who might study the map, and preferred to hold to my first resolution, to put down nothing which did not present itself on the actual survey, and thus leave every thing open to the theories of others.

But while this first conclusion is very apparent, a more minute inspection will show, that even where the general indications are most distinctly marked, in other words, where the trees do with very great uniformity dip towards the axis, — those in its immediate vicinity coinciding with it in direction, and as we remove from it on either side making a greater angle, increasing with the distance from the axis, until at the outermost verge the angle reaches nearly 90°, — at these very places we may find some trees dipping back even to an angle of 180° with the axis. Now, these are just the cases where the reaction plays a very conspicuous part. To illustrate this point, let us suppose a tree to be situated in the axis of the storm, which we will assume to be N. 70° E. As it is struck by the wind, it bends down to the ground, but its southerly roots, being strong, yield under the action without breaking. Reacting under its own elasticity, the tree flies back, and is carried S. 70° W., precisely as if the storm had originally passed over it in that direction. The northerly roots are weak, and break, the tree falls, and its direction is taken as S. 70° W. The yielding or holding of lateral roots may vary this angle more or less, and thus give us any of the exceptional cases which we have observed. This is not a mere theoretical deduction of the mode of action. In many cases, ledges of rock, strong roots, stone walls, &c., did very evidently demonstrate that the tree could not fall in the direction of its surrounding fellows, and its exception to them was amply explained by these causes. In the field notes many remarks are to be found confirming these views, but to transcribe them here, with the necessary references, would swell this memoir beyond proper limits. They are referred to merely by way of inculcating the necessity of caution in reasoning from other exceptional cases, where the fallacy of the reasoning might not be so palpably presented.

In one sense, most of the observed phenomena may be looked upon as the effects of reaction. The general indication alluded to above, of a dip towards the axis, is most satisfactorily explained, not by considering the trees as thrown down by the direct force of the wind, but rather by regarding the storm as a mass moving with great velocity along its well-defined axis, overthrowing every thing in its way, and leaving behind it a vacuum towards which every thing on the borders of its path collapsed. And confirmatory of these views are the facts observed with respect to buildings. Roofs were raised, and I was informed that a light muslin cuff was lifted from a bureau, and, as the roof fell back into its place, was caught and held suspended in the crack formed between it and the wall of the room. In one case particularly, of a factory near the West Cambridge road, the whole effect produced, and to my own mind well and clearly defined, was precisely what we should have, if we could suddenly place in a vacuum a building filled with atmospheric air of ordinary tension. Even the foundation walls were inclined outwards, and there was every evidence of a force acting from the interior to the exterior.

The whirl theory, both in its grand convolutions, which may require miles for its exhibition, and in its more limited sphere, in which it drags every tree from its roots, as a screw is drawn from its bed, has its several advocates. With the more extended theory I have nothing to do, leaving that to be studied out from the map. But to those who claim the more limited theory, who maintain that each tree is twisted from its bed, as one might be supposed to extract a screw, I feel bound to say, that although a most faithful search was made for evidence, yet, throughout the whole extent of these observations, only two cases have been met with, which can even be twisted to agree with their theory. A tall young hickory was found standing, and twisted 180° upon its own trunk. The top rested upon the ground. The trunk was not broken off, but the fibres were separated, and the whole appearance was precisely what you would have if you took a bundle of fibres, and, placing it vertically, held the lower half, while you twisted the upper through 180°, and brought the top to the ground. The other case is that of a chimney lying on the left or northwest side of the axis. The bottom of this chimney stood firmly, while the top was twisted round upon it, as if it had been a distinct block, the south side of it moving towards the west. Even in the case of broken trees, no evidence of twisting is to be found. Any one who breaks a green twig, by twisting one part upon the other, will find in the broken parts, especially in the bark, the evidences of torsion. But here, although many broken trees were examined, some of them broken entirely through the trunk, others only as far as the heart, no evidences of torsion were found. The fractured fibres were in every case straight.

Another very significant fact, in its bearing upon this point, is the following. The course of the tornado was from southwest to northeast. It held in suspension a great quantity of muddy water, and we find, as we examine the houses, trees, and stone walls which it met with in its course, that the southwest face of these is bespattered with mud, while the northeast face remains clean. In some cases of trees which I examined, it is no exaggeration to say, that the line of demarcation between these two surfaces was as well defined, as if one face had been painted with a mud-wash and the other left in its natural state.

I have conversed with many persons who saw the storm-cloud, and watched its progress for many miles. There is some diversity in their accounts of its appearance, as we should naturally expect; for unless it were a perfect surface of revolution, it would appear differently as viewed from different positions, and even under the latter supposition, difference of elevation would affect its appearance. Upon one point, however, they generally agree; namely, that it had a conical shape, the vertex of the cone nearest the earth, and that it changed its distance, rising and falling as it advanced. Some add to this a lateral motion, and liken the movements of its elongated apex to those of an elephant's trunk. I mention this point merely to have an opportunity of calling attention to the facts observed during the survey, and which seem to confirm these views. In certain parts the apple-trees will be found to have suffered severely, while the tall forest-trees have escaped unhurt. In other parts we notice just the reverse, every thing of low growth having been apparently out of the reach of violence, and the only evidences of injury being found in the broken branches on the tops of the tall forest-trees. In connection with this point, I would also record one other observation. Standing upon the top of Wellington Hill, we have a fine unbroken view of the track of the tornado through West Cambridge, and a large part of Medford. Its path, wherever it had passed through woods, was very distinctly marked by its brown color, strongly contrasted with the green foliage around it. On reaching any of these places, it was found that the leaves were crisp and withered, as if scorched by a fire, or acted upon by frost, and it appeared to me that this effect was particularly marked upon the hickory-trees. The cause of this phenomenon has been variously ascribed to extreme heat, extreme cold, and electricity. My purpose is simply to record the fact. There was much speculation at the time, also, with reference to the baked apples, or, as some preferred to call them, the frost-bitten or electrified apples, which were scattered over the ground. The only observation I have to record upon these is, that they were baked, frost-bitten, or electrified only upon one side, and that, as they lay on the ground, this side was invariably turned towards the sun, which was, moreover, at that time, shining with an intensity which all my companions on the survey will well recollect.

Abundant testimony may be obtained from eyewitnesses as to the highly electric condition of the storm-cloud. One person describes a new lightning-rod upon his house as presenting the appearance of having been put into the fire. He also saw flashes of lightning from the cloud; but on this latter point, we should be cautious of judging too hastily from appearances. In a dense cloud, such as this is represented to have been, a mere board or shingle, or piece of slate, or paper, all of which were at different times held in suspension, might easily catch and reflect the sun's rays, and, by one who was looking for the evidences of electric action, such a luminous appearance would readily be mistaken for the lightning's flash. The conductor alluded to above I did not see, but in the same vicinity the following remarkable phenomena were observed. Several panes of glass were pierced with small round holes, as if a bullet had passed through them, and in one instance under the following peculiar circumstances. In a small room, with one window facing towards the south, there is a sash door opposite the window, and the sash was covered by a cotton curtain. The window is believed to have been open, and a small hole, not as large as a five-cent piece, is found in the cotton curtain, and in the pane of glass a larger one, about the size of a quarter of a dollar. The glass presents a clean fracture, and the edges are not sharp, but look as if they had been melted. We cannot suppose such a hole in a piece of glass to be much larger in diameter than the missile which produced it, and such a missile could not have first passed through the small hole in the curtain. Moreover, no further trace of it can be found, whereas a stone thrown with sufficient force to make such a hole would have made a deep indentation, and probably imbedded itself in the wall beyond. The only plausible explanation of this phenomenon seems to be found in the agency of electricity.

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X.

Caroli a Linné ad Bernardum de Jussieu ineditæ, et mutuæ Bernardi ad Linnæum Epistolæ;

CURANTE ADRIANO DE JUSSIEU,

ACADEMIÆ ART. ET SCIENT. AMERICANÆ SOCIO.

LINNÆANAS quas hic publici juris facimus epistolas ad nos hæreditas transtulit. Plures quidem extiterant; sed quædam amissæ aut dispersæ. Mutuæ Bernardi de Jussieu litteræ, cum cæteris musæi Linnæani gazis, in manus cl. Edwardi Smith transierant, et ab hujus interitu in Societatis Linnæanæ Londinensis musæo servantur. Ipsas quidem cl. Smith, inter selecta commercii litterarii celeberrimorum cum Linnæo botanicorum fragmenta,* jam evulgavit, sed et paulisper truncatas et e Latino in Anglicum versas, ita ut authenticas integrasque nunc Linnæanis, quas illustrant, intermiscere satius visum fuerit, quod permisit Societatis Londinensis, et præsertim librarii ejusdem cl. Joannis Bennett, litteras propriâ manu ideoque absque ullo erroris periculo transcriptas ad nos transmittentis, liberale obsequium.

Linnæi epistolæ currente ocissime calamo scriptæ, tot erant, inter multa alia momenti majoris opera, scribendæ! "*Certe,*" in epistolâ ad Abb. Duvernoy dicit, "*si mihi decem essent manus non sufficerent omnibus qui literas mittunt, et si hoc coram me videres, crederes me nihil aliud agere quam literas, in quo dilapido et res et tempus meum.*" Et iterum ad Jacquinum scribit: "*Si mihi tot essent manus, quot idolo isto Chinensi, non sufficerent semper respondere omnibus . . . . . interea hoc certum quam certissimum quod ego quotannis scripserim ad exteros plures epistolas, quam omnium facultatum professores n. 25 simul, ad exteros indigenasque.*" Præterea in documentis quæ de se ipso et vitæ

* *A Selection of the Correspondence of Linnæus and other Naturalists from the Original Manuscripts*, by Sir J. E. Smith. In two vols. London. 1821.—Jussieu's letters are inserted in the second volume, pp. 206–227.

cursu * tradidit, fatetur animum ad studia scientiarum naturalium totum conversum a litterarum et imprimis linguarum studiis semper declinavisse, ita etiam ut primi magistri adolescentis ingenium minimi facerent deque ipso in futurum humillime præsagirent pseudoprophetæ. Non mirum igitur si in epistolis nec otiose nec accurate nec provise expeditis mendæ non deficiunt. Quas tamen nusquam emendavimus, exemplum Halleri † atque Endlicheri ‡ secuti, ipsamet autographorum verba fidelissime transcribentes. Sermo enim Linnæi, si non grammatice castigatus, libero gradu currit vividus, nervosus, primigenius, denique suus, adoptione totius elapsi sæculi legitimus nec ideo ullo modo adulterandus.

Anno 1735 Linnæus, tum vigesimo-octavum degens, relictâ patriâ, Hollandiam petierat, ubi tres annos Amstelodami, Lugduni Batavorum, et præsertim Hartecampi in Horto Cliffortiano vixit, et opera præcipua, ut Systema Naturæ, Genera Plantarum et Classes, etc., etc. scripsit et edidit, et unde primum Angliam (anno 1736) invisit et denique in Galliam (a. 1738) transiit.

Parisiis sceptrum Botanices tunc tenebant, Tournefortio jamdudum et Vaillantio defunctis, ipsorum in Horto Regio Botanico Parisiensi successores Antonius et Bernardus de Jussieu, fratres arctissime sanguinis, studiorum et vitæ communitate devincti, posterior fratre tredecim annos junior, quinque senior Linnæo. Cum quibus jam mutuâ nonnullarum litterarum missione commercium iniverat et ad quos se contulit commendatus professoris Adriani van Royen, quocum aliquot menses commoratus hortum Leydensem ordinaverat, epistolâ quam nobis in diario servavit sequenti:

"*Viro clarissimo Antonio de Jussieu, medico experientissimo, Botanices professori celeberrimo, et Academiæ Regiæ Scientiarum in Galliis socio, et membro dignissimo S. P. D. A. van Royen.*

"*En Carolum Linnæum scientiæ botanicæ (si quem noverim) facile principem, qui in scriptis innotuerit, experimentis innotescat. Hic in plerisque historiæ naturalis partibus versatissimus, hasce tibi tradet literas. Hunc vere doctum, eruditum, et humanissimum tibi tuæque curæ commendo, ut per te, quantum potest fieri, opportunitatem habeat omnia quæ ad hoc negotium spectant perlustrandi: Quidquid autem ei feceris beneficii, mihi, cum per aliquod tempus intimus fuit, factum reputabo. Vale fratremque cum Nob. D. de Fay meo nomine salvere jube. Dabam Leydæ die* 7. *Maii* 1738."

* *Egenhändiga Anteckningar af Carl Linnæus om sig sjelf.* Stockholm. 1823. — Quod diarium jam prius ex manuscripto Suecico in Anglicum verterat edideratque W. G. Maton: *The Second Edition of a General View of the Writings of Linnæus, by R. Pulteney, with Corrections, considerable Additions, and Memoirs of the Author, to which is annexed the Diary of Linnæus, written by himself, and now translated into English from the Swedish Manuscript in the Possession of the Editor.* London. 1805.

† *Epistolarum ab Eruditis Viris ad Alb. Hallerum Scriptarum Partes* 6. Bernæ. 1773 – 75.

‡ *Caroli Linnæi Epistolæ ad Nic. Jos. Jacquin. Præfatus est Notasque adjecit Stephanus Endlicher.* Vindobonæ. 1841.

Linnæi Lutetiæ, ubi mensem commoratus est, familiaris fuit et quotidianus cum Bernardo usus, et inde postea inter ipsos existimationis, amicitiæ, officiorum mutuatio, ut et epistolarum, quarum pleræque post reditum in Sueciam Linnæi scriptæ, sed paulatim decursu, ut fit, temporis rariores, ac denique omnino intermissæ, quamvis vita utriusque parallela, ut ita dixerim, fluxerit, eodem fere tempore denique extincta.*

EPISTOLÆ.

ILLUSTRISSIMO VIRO

CAROLO LINNÆO, Sueco,

MEDICO ET BOTANICO CLARISSIMO,

S. P. D.

ANTONIUS DE JUSSIEU,

MED. D. ET BOT. PROF. REG.

Gratissimo animo, Vir Illustrissime, tuum de Musâ opusculum † accepi, avidusque perlegi, mihique maxime arrisit, tum ob plantæ singularitatem, tum propter observationis novitatem quâ plantam a me in Hispaniâ visam, floridam fructiferamque, apud Batavos nec florere, nec fructum dare suspicarer, cum eam in Horto Regio Parisiensi nec florentem nec fructiferam huc usque viderimus. De cæteris quæ recenses ‡ opusculis a te editis nullum ad me pervenit, remque mihi pergratam facies, si absque ullo tuo dispendio meque ea solvente ad nos velis mittere. Conscriptum a te Hortum Cliffortianum, Floramque tuam Lapponicam vehementer exoptamus, tantoque magis illud opusculum ultimum nos pungit, quod viros Academicos hanc in Septentrionis plagam Rex noster recens miserit,§ quibus plantas hac in parte inquirentibus pharus esset liber tuus, ut illarum ad nos aut semina, aut ramos siccos perferant; quapropter si brevi operi huic finem imposueris, duo a te poscimus exemplaria, ut cætera de quibus mones solvenda. Si quidpiam etiam te dignum e prelo nostro Parisiensi editum putes, maximâ cum voluptate mittendum ad te curabimus. Vale, vir Illustrissime, plurimamque fratris mei salutem ex me recipe. Parisiis Kalend. Julii anni 1736.

* Bernardus de Jussieu die 6° Nov. 1777 obiit; Linnæus 10° Jan. 1778.

† *Musa Cliffortiana, florens Hartecampi*, 1736, *prope Harlemum*. Lugd. Batav. 1736. 4to.

‡ Hinc videtur præcessisse prior, quæ deficit, Linnæi epistola.

§ Astronomi ex Academiâ Regiâ Scientiarum Parisiensi, ad metiendum, tum sub æquatore, tum polo pro-

VIRO ILLUSTRI

D: BERNHARDO JUSSIEU,

PROFESSORI BOTANICO, MEMBR. AC: REG: PARISINÆ, ETC.,

S. Pl. D.

CAROLUS LINNÆUS.

Circa initium hujus anni cum Genera * mea transmitterem simul ad te V: Ill: literas dedi, quas D: Marselie, mercator Amstelodamensis transmittere curabat. Altera vice † et ad te literas dedi, cum Floram lapponicam ‡ transferri curabam per vestrum Narille, medicum Amstelodamensem; Nolui meis literis Generosissimum vestrum fratrem amplius molestus esse, postquam audiveram quanta praxi medico quotidie distrahebatur; Tibi innotescere V: Illustr: ab eo tempore quo D. Dillenii per aliquod tempus Oxoniis uti licuit favore,§ qui profundæ eruditionis tuæ justus erat præco, semper flagravi. Interim ego adhuedum nullas tuas lætus aperui literas quas mihi exoptaverim præ aliorum omnium. Has quas exaro literas in Tuas proprias manus eo certius deventuras spero, quo eas cum noto et familiari Amico mittam, quem Tuæ curæ commendatum habeo. Est vir juvenis qui plantas maximopere amat, licet methodicus non sit, collector tamen industrius. Incipiunt jam etiam Russi flores amare, quos a seculis respuerunt.

Criticam || meam mitto, sed stylo barbaro conscriptam, rudi et incompto . . . . . coactus fere eam edere debui, licet omne tempus mihi negabatur, quem totum occupavit Hortus Cliffortianus, circa finem anni proditurus.

pius, circuli terrestris arcum, missi, hinc duce cel. LaCondamine in Peruviam (anno 1735), inde in Lapponiam (vere anni sequentis) duce cel. Maupertuis, quos posteriores hic innuit A. de Jussieu.

* *Genera Plantarum eorumque Characteres Naturales secundum Numerum, Figuram, Situm et Proportionem omnium Fructificationis Partium.* Lugduni Batavorum. 1737.

† Desunt hæ duæ, quas Linnæus se misisse nunciat et Bernardus accepisse respondet, epistolæ.

‡ *Flora Lapponica, exhibens Plantas per Lapponiam crescentes, secundum Systema Sexuale, collectas in Itinere Anno 1732 instituto.* Amstelædami. 1737.

§ "*In 1736 Linnæus went over to England. . . . . The learned botanist Dillenius was at first haughty, conceiving Linnæus's Genera (which he had got half printed from Holland) to be written against him; but he afterwards detained him a month, without leaving Linnæus an hour to himself the whole day long, and at last took leave of him with tears in his eyes, after having given him the choice of living with him till his death, as the salary of the professorship was sufficient for them both.*" (From Linnæus's Diary.)

|| *Critica Botanica, in qua Nomina Plantarum generica, specificá et variantia examini subjiciuntur, selectiora confirmantur, indigna rejiciuntur, simulque Doctrina circa Denominationem Plantarum traditur. Seu Fundamentorum Botanicorum Pars* IV. Lugduni Batavorum. 1737.

Siegesbeckii Hortus petropolitanus prodiit, Ludwigii characteres generici similiter, utrosque forte vidisti.

Exoptaveram hac æstate vestras Floras salutare, sed obrutus aliis negotiis vix potero, meque revocant in patriam fata varia.

Si me tuis literis dignum judicaveris, quæso me certiorem facias de progressu fratris vestri in Peru,* ejusque reditu; si redierit felix, quod opto summopere, sique plurima specimina secum duceret exsiccata, utinam, datis amicis, si quæ superessent et mihi, si ejus gratia concederet, aliquot remitteret; reddam quæ potero alpinas, lapponicas, suecicas, norvegicas. Spero me etiam vastam obtenturum plantarum copiam a medico quodam nomine Bartsch,† Botanico certe industrio, qui prope diem petat Surinamam et occupabit medici publici officium, mihi oblatum, sed ipsi relictum.

Vale, vivasque diu, me ama.

Dabam ex Museo Cliffortiano 1737. Jul. 26.

* Hicce, de quo toties in epistolis sequentibus mentio, Josephus Antonii Bernardique frater natu minor, Peruviam anno 1735 petierat, astronomis Academiæ Regiæ Parisiensis adjunctus. Dux expeditionis academicæ celeb. LaCondamine post decem tantum annos patriam regressus est; sed non J. de Jussieu qui, primum cupiditate vastam, vix cognitam perviamque regionem investigandi, postea Peruvianorum medici periti in epidemiâ egentium discessumque ipsius prohibentium fiduciâ nimium honorificâ, denique serius vi consuetudinis detentus, non nisi post triginta et sex annos (1771), ideoque vitâ tum fratris Bernardi tum Linnæi jam ad ultimum terminum vergente, Galliam revisit; sed valetudine nimiis laboribus curisque exhaustâ, ante ætatem senior nec rationis jam compos. Josephi ad fratres epistolæ variæque in itinere adnotatæ observationes manuscriptæ, tabulæque, sive botanicæ sive geographicæ, delineatæ quæ supersunt, doctrinam variam solidamque testantur multaque ab ipso visa et collecta fuisse. Sed pleraque et diversis neque hic enarrandis casibus, et præsertim hâc ultimâ maximâque mentis amissæ miseriâ perierant, et pars tantum minima servari potuit herbarii Peruviani, de quo tanta spes et cupiditas sæpius a Linnæo expressa.

† De quo sequentia in Florâ Suecicâ (p. 186) leguntur: "*Bartsiam dixi a Joanne Bartschio, Regiomontano, medicinæ doctore, juvene pulcherrimo, candidissimo, et certe doctissimo ac nationis suæ ornamento. Contractâ cum viro intimâ amicitiâ in Belgio, eum inextinguibili plantarum insectorumque ardore infeci, adeo ut in rimandis plantarum partibus iisdemque acutissime describendis paucos superiores habuerit. Vacuo munere medici ordinarii Societatis Belgicæ Indiæ Occidentalis, Surinamæ, me elegit divus Boerhaavius; cum autem recusarem torridas inhabitare zonas, sub arctoo ipse natus et educatus, mihi concessit beatus vir ad hoc munus vocare quemcumque vellem; arrisit hoc integerrimo amico Bartschio, plantarum solâ causâ, commendatur apud Boerhaavium, recipitur, et Surinamas petit; ubi nescio quo gubernatoris Surinamæ odio et malitiâ, nunquam ipsi læta concessa hora, hinc tædio, invidiâ, pauperie, æstu, post dimidium annum obiit, meliori fato, si quis alius, dignissimus vir. Qualis fuit hic vir docet Dissertatio de Calore, docebunt literæ ad me Surinamâ missæ, plenæ plantarum observationibus curiosissimis.*"

CLARISSIMO VIRO

DD. CAROLO LINNÆO,

DOCTORI MEDICO ET BOTANICO ILLUSTRISSIMO DOCTISSIMOQUE, ETC., ETC., ETC.,

S. P. D.

BERNARDUS DE JUSSIEU,

PROF. BOT. REG.

Tuas quas dedisti binas epistolas accepi, simulque Criticam Botanicam seu Fundamentorum Botanicorum partem quartam. Cætera quæ scribis misisse, Genera a te instituta et Floram Lapponicam non vidi huc usque. Ad meas licet non pervenerit manus Benevoli erga me animi testimonium hoc, grates tamen refero plurimas, et in justæ recordationis meæ signum, pauca hæc, opera levissimi momenti, quæ Parisiis prodiere, de plantis recipere digneris. Non parcerem sumptibus si per te liceret comparare mihi quædam de re herbariâ prætervisa Opera, Siegesbeckii scilicet Hortum Petropolitanum, Ludvigii caracteres genericos, Plantarum Indices circa Aboam aut Aboē, D. Tillands Floram Uplandicam, et Bromelii Chlorim Gothicam; hanc ultimam promiserat, dum Parisiis aderat, Lithenius vester. De fratre natu minori ad Peruvianas regiones botanices ergo misso, a Julio præteriti anni nuntium allatum nullum habuimus; si, ut spero, onustus herbis redierit aliquando incolumis, sicca harum specimina lubenter præbebo, sicque annitar consequi tuam benevolentiam et obtinere Lapponicas, Suecicas, Norvegicasve plantas quibus beare me volueris. Vale, dabam Parisiis die 9na 8bris 1737.

Salutat te plurimum frater meus.

VIRO ILLUSTRI

DD. BERNH. JUSSIEU,

PROFESSORI REGIO PARISINO, BOTANICO CONSUMMATISSIMO,

S. Pl. D.

C: LINNÆUS.

Literas et libros quas, Vir Illustris, ad me misisti cum Entio ut et Delacroixii Systema morborum per D. Royenum rite accepi, pro omnibus devota mente grates reddo maximas, utinam locus umquam concederetur mihi ad mutua præstanda officia.

Tua, Vir illustris, fratrisque tui maximi facilitas, Tuus in exteros favor, in plantas amor, in Botanophilos generositas non a paucis mihi demonstrata sunt et impressa adeo ut non possim non, quin Parisios adeam sub initio mensis Maji; Felix ego si Tuum obtinuero favorem, Felix si mihi concedas videre Tuas Tournefortianasque collectiones plantarum. Felix si per te profectus quosdam facere possim in studio, cujus insatiabili inflammatus sum desiderio. Suam mihi concessere gratiam quotquot adivi antea Botanicos, nec Te his difficiliorem fore spero, sed longe benigniorem persuasus iter ingredior.

Lætus dudum cognovi Fratris Tui, junioris natu, vigorem et profectus in ultimo Peru, de ejus successu ad innumera detegenda rara nuper exempla et documenta vidi apud amic: D. v. Royen ubi tot semina plantarum rariorum præsertim Plumerianarum, quot nunquam vidi antea.

Nova nulla referam, reservabo in tempus quo coram loqui licet. Litteria hic nulla ullius momenti. D. Jac. Sherardii obitus forte innotuit, qui nullum legatum D° Dillenio fecit, quod miror maxime. D. Amman edit plantas rariores Siberiæ et Tartariæ, nec non (sed in Actis Petropolit.) Tr. de filicibus, quarum species duplicia folia gerunt, alia sterilia alia fructifera. Siegesbeckii Botanosophia verior nuper edita sat stulta et mendax est; uti omnia Ejus. Vateri Hortus Wittenbergensis nuper editus nec non Ludwigii canones Botanici non visi sunt etiamnum a me.

Halleri ambæ Dissertationes de Veronicis alpinis et Pedicularibus pro more Viri doctissime conscriptæ et elaboratæ sunt. Breynius edat patris sui plantas nomine modo recensitas in fasciculis, cum descriptionibus et figuris ac vita auctoris.

Gronovius propediem edat Floram Virginensem, Burmannus vero plantas rariores Africæ per decurias, tabulas pro prima centuria incisas vidi. Post occiduum* Lugduni prodibunt meæ Classes plantarum, ubi exposui omnes methodos a fructificatione desumtas uti Cæsalpini, Morisoni, Raii, Knauti patris, Hermanni, Boerhaavii, *dein* Rivini, Ruppii, Ludwigii, Knauti, tum Tournefortii, Pontederæ, *demum* Magnoli, novamque aliam e calice, tandem sexualem et methodi naālis fragmenta, *ultimo* partiales uti Vaillantii et Pontederæ in *Compositis;* Morisoni et Artedi in *Umbellatis;* Raj et Scheuchzeri de *Graminibus*, Dillenii et Michelii de Muscis et Fungis, &c., addito synonimo generico.

Prodiit et *Artedi* Ichtyologia, ubi prima in parte Bibliotheca ichtyologica. 2°· Philosophia Ichtyologica. 3°· Genera, eorum Characteres et species cum Suis differentiis. 4°· Pinax omnium nominum, uti Bauhini in Botanicis, hic in ichtyologicis. 5$^{to.}$ Descriptiones. Omnes qui videre hoc opus fassi sunt quod in ista parte non visum fuerit. Vita authoris et editio cum variis aliis a me descripta et peracta sunt.

Vale, Vir illustris et fave peregrino.

Dabam die 28 Mart. 1738. Amstelædami.

* Eâdem revera die, vigesimâ scilicet Martii 1738, signata est præfatio operis: *Classes Plantarum, seu Systemata Plantarum omnia a Fructificatione desumta. Fundamentorum Botanicorum Pars* II. Lugduni Batavorum. 1738.

VIRO ILLUSTRI

DD: BERNARDO JUSSIEU,

MEDICINÆ DOCTORI, PROFESSORI BOTANICES, MEMBRO SOC: REG: ANGL., ETC., BOTANICO SUMMO,

S. Pl. D.

CAROLUS LINNÆUS.

Stockholm, 1739 Die 8 Jun: styl: vet:

Annus jam elapsus est ab istâ tristissimâ horâ, quo te, Mæcenatem meum, valere jussi flens abituriens. Inter exteros nullus certe me sibi devotum reddidit magis quam Tu, heu impensis nimiis, beneficiis innumeris, mente amicissimâ, charitate inæstimabili; vivis proin apud me, altâ mente reconditus quamdiu Spiritus hos reget nervos. Memor vivo præteritorum: liberalis mensæ et hospitii, itineris fontis bellilaquei tuis impensis instituti; dierum omnium mihi consecratarum; Horti et herbariorum mihi apertorum quotidie;* consortii et animi tui unice mihi inserviendi cupidi. Sed quid ego ad hæc omnia! Nil remanet nisi devota admiratio et coram meis simplex oratio et qualis frigida borealis lingua canere possit. Reddat tibi Ille qui potest omnia, qui tam liberali manu mihi aperuisti omnia.

Redii in patriam salvus. Sedem Stockholmiæ fixi. Ignotus fere per dimidium annum nostris,† tandem reconvalui; Comes Tessin his diebus qui vestras Lutetias

* "*At Paris Linnæus employed himself in viewing the fine garden, the herbaria of the Jussieus, Tournefort, Vaillant, Surian, and others, as also the large collection of books belonging to D'Isnard.*" (Linnæus's Diary.) — Quæ herbaria Parisiis adhuc extant, Tournefortianum scilicet et Vaillantianum in Museo Historiæ Naturalis, prius seorsim servatum, posterius herbario mixtum generali cujus primum fuit fundamentum. Jussiæanum continuata hæredum botanophilorum series religiose conservavit et naturali progressu auxit, cui accedunt Isnardianum a diversis vicissim, denique post Commersorium ab Ant. Laur. de Jussieu adeptum, et hic a Linnæo memoratum herbarium Suriani, decem tantum plantarum Americanarum centurias complexum, sed quæ nonnullius sint ad rem herbariam pretii. Ipsas enim in Antillis collegerat Surian Plumieri comes, ita ut Plumieranas naufragio amissas solæ nunc suppleant. Singulæ, more multorum (ut fit in plerisque Anglicis) herbariorum, singulis paginis adglutinatæ sunt in volumina decem digestis, nominibus vernaculis vulgo designatæ. — Isnardi, cujus *bibliophiliam* Linnæus pluries in his litteris recordatur, ditissima præsertim librorum historiæ naturalis bibliotheca (Vide: *Catalogue des Livres de feu M. Danty d'Isnard.* Paris. 1744. 12mo. pp. 378) Linnæo ad secundam suæ Bibliothecæ Botanicæ editionem profuit, quippe qui e Galliâ proficiscens ad Hallerum scribat: "*Vidi bibliothecas tam publicas quam privatas botanicas bene multas,*" Isnardianam unice in Diario memoravit, "*ut jamjam in statu sim, ut edam alteram Bibliothecæ editionem; habeo enim nunc duplo majorem librorum numerum.*"

† "*Stockholm received Linnæus in the month of September,* 1738, *as a foreigner. He intended to establish himself here as a physician, but, being unknown to every body, people were unwilling to trust their lives into the hands of an unexperienced practitioner; nay, they would not even trust him with their dogs, so that*

salutabit vir incomparabilis animum erexit meum; ejus enim ope (ille enim Vice Roya s. mareschallus ordinum fuit) emicui, Professionem Botanicam et Mineralogicam Stockholmiæ obtinui annuo cum reditu; Praxis mihi mox contigit summa medica Stockholmiæ; mox et medicus ordinarius classis nauticæ creatus sum; uxorem hisce diebus duxi diu desideratissimam ditem, si inter nos loqui deceat, ita ut nunc demum contentus quietam et contentam dego vitam.*

Linnæus often doubted if he should ever get forward in this kingdom. At every place abroad he had been honored as Princeps Botanicorum, *and in his own country he was looked upon as a* Klim, *arrived from the subterranean world: had Linnæus not been in love, he would certainly have left Sweden, and gone abroad again.*" Hæc e Diario Linnæi, ubi vide quo modo dein in tabernis, unde clientelam sibi pararet, versari coactus fuerit.

* Acta eadem, prætereaque anteacta, Linnæus, in epistolâ ad Hallerum, paulo fusius, paucis tamen cum solitâ phytographi characteres essentiales exponentis concisione, et res adversas secundasque, labores, amores longâ expectatione probatos, sponsalia, nuptias, semibotanico semipoetico enarrat sermone, quem hic transcribere juvat: "*Erat ibi* [Fahlunæ in Dalecarliâ] *medicus quem divitem dicere non erubescebat vulgus; imo erat inter omnes in istâ pauperrimâ provinciâ ditissimus. . . . . Adii domum ejus, non semel gratus ipsi hospes. Filiam habuit quam ambiebat Liber quidam Baro frustra. Vidi, obstupui, præcordia intima sensi attonitus novis intumuisse curis. Amavi; illa tandem victa blanditiis, votis, &c., &c., et me amabat, promisit, dixit: fiat! Patrem alloqui erubescebam pauperrimus; dixi tamen. Voluit,—et noluit. Me amabat pater, non mea fata. Dixit, intacta permanebit per tres annos, dicam tum demum. Compositis rebus, ad iter necessario paratis, exivi patriam, 36 nummis aureis dives. Promotionem medicam mox obtinui; redire magno meo cum commodo non potui; permansi in Belgio, ut novisti. Interim amicus meus Summus cl. B...... literas amicæ meæ ad me per tabellarios transmittebat; sancte præstitit. Ultimo anno, quo apud Van Royen vixi (quod erat quarto anno; non enim socer plures quam tres concessit annos) et hoc quidem metu sponsæ, sibi proximum judicavit B...... esse; mea enim recommendatione factus fuit Professor; mox me non reversurum in patriam demonstrabat; sponsam meam ambiebat, fere obtinuit, ni intervenisset alius fallaciam qui prodidit; punitus et ipse fuit mille fatis adversis. Redii tandem, sed pauper. Puella me amabat, non illum. Sedem fixi Holmiæ, irrisus ab omnibus ob meam Botanicen; quot insomnes noctes et laboriosas horas transegerim, nullus dixit . . . . . non erat, qui vel servum mihi curandum obtulit. Transegi vitam quocumque possem modo, tamen honeste; incepi praxin exercere valde lente; sed brevi fata cessabant adversa, et post diuturnas nebulas Phœbus. Emersi, ad Primates accersitus; cessere omnia secunda, nullus æger sanabatur me non præsente. . . . . . Interdixi floram . . . . . mox primarius medicus classis navalis constitutus fui; conventus civium mox me Botanicum regium, publice quo docerem Botanicen in regiâ sede Stockholmiæ, dixere; stipendio annuo auxerunt. Incepi iterum amare plantas. Sponsam adii tum meam quinquennem, tam dignus intravi thalamum sponsæ et uxoris.*"

Erunt fortasse qui curiose inquirant quisnam amicus iste malefidus fuerit, cujus nomen in omnibus operibus suppetentibus tantum ad litteram initialem B. redactum legatur. Ego Browallium suspicor, quippe qui Fahluni vixerit cum Mosæis familiaris, ibi amicitiam cum Linnæo iniverit consiliorum ejus particeps et sæpius auctor, unde anno 1738 discessit factus Aboæ professor, et a Linnæo alienatus, ut testantur generis *Browalliæ*

In lectionibus meis Tuum agere præconem non intermittam, lætor enim tuum nominare nomen. Nil mihi hoc tempore deest nisi sola Flora. Floræ fere exul sum alumnus. Hortus Agerumensis * jamjam impressus est, quamprimum prodiit, ut habeas curabo. Nil alias in hisce borealibus terris novi; in actis literariis Sueciæ catalogum animalium, insectorum, &c., inseri curavi cum citationibus auctorum.†

Instruitur hic societas scientiarum Stockholmiæ,‡ quæ observationes in historiâ naturali, physicis, mathematicis et œconomicis tradat, nil ultra. Quamprimum in actum pervenit Invitatoria ad te perveniet epistola.

Si quæ supersit memoria mei, si quis amor, supplex precor aliquot vel semina, vel plantas vel Orchides præsertim ad me derives, pro novo horto Stockholmiæ a me nuper incepto; quæ plantæ dein enatæ, tuum celebrabunt apud nostros illustre nomen.

Si quid ad me derivare velis benigne quasdam [quæso?] id mittas *quantocius* ad *Consulem Jacobum Borckers Roanæ* § habitantem, qui hoc tradat Capitaineo navis *Suenori Bolin* regens *navem* a *Roana* dictam, et ea habebo certissimus.

Devota mea officia reddas Illustrissimo fratri tuo, nec non Præcessori ejus,|| Viduæ Valantii, Pictori regio,¶ Botanico pharmaceutico per sylvam Fontis Bellilaquei

ipsi sacrati species, prima *exaltatæ* nomine ornata amicitiâ adhuc perstante, eâdem disruptâ duæ posteriores *demissæ* et *alienatæ* nominibus dedecoratæ.

* *Joh. Eberhardi* FERBER *Hortus Agerumensis, exhibens Plantas saltem rariores, quas Horto proprio intulit, secundum Methodum Linnæi Sexualem digestus.* Holmiæ. 1739.

† *Animalia per Sueciam observata*, in Act. Liter. et Scient. Sueciæ. 1736. p. 97–138.

‡ "*At this time Captain Triewald was projecting the institution of an Academy of Sciences in the metropolis, concerning which he frequently consulted Baron Höpken and Dr. Linnæus; and with these Jonas Ahlström, a man deserving well of his country, was also associated. These persons met, formed their regulations, and laid the foundation of the Academy in the month of May. They drew lots for the offices, and that of President fell on Linnæus.*" (From Linnæus's Diary.) — "*This was the origin of the present Academy of Sciences of Stockholm, which rapidly increased in numbers and reputation.*" (PULTENEY.)

§ Rothomagi.

|| Designare videtur Antonium Tristanum DANTY D'ISNARD qui reverâ professor in locum Tournefortii anno 1708 defuncti electus fuerat; sed cui, post primum lectionum cursum, valetudinis et studiorum gratiâ, mox abdicanti successit Antonius de Jussieu, tum annos viginti et tres tantum natus.

¶ Claudius AUBRIET, Catalauni anno 1651 natus, Tournefortium in itinere per orientem comitatus erat, cujus opera optimis iconibus illustravit, ut et Botanicon Parisiense Vaillantii. Sub his ipsorumque successoribus in Horto Regio longam vitam delineandis et pingendis rebus naturalibus, præsertim plantis, consumpsit, et, post Nicolaum Robert et Joannem Joubert, splendidam tabularum continuavit seriem, jussu Gastonis ducis Orleanici inceptam, quæ nunc in Musæo Hist. Natur. Parisiensi, sub nomine *Collection des Velins du Museum*, servatur in dies amplificata. — Hunc senescentem adjuvit, inque ipsius anno 1743 defuncti locum suffecta est, Magdalena Francisca BASSEPORTE, de quâ toties in sequentibus epistolis mentio, cui debentur icones in comiti;* futuro botanico Bras......† et si diis placeat desienaux.‡

Quid novi in actis vestris? quo modo valet frater tuus ex Peruvia redux?

Salutem ipsi dicas et si quid placeat mecum communices. Heu quantum mihi rude oblectamentum.

Ter vale Botanicorum Coryphæe.

BOTANICO INCOMPARABILI

DD: BERNH: DE JUSSIEU,

PROFESSORI BOTANICO,

S. Pl. D.

CAROLUS LINNÆUS.

Præterito autumno ad te, Vir Celeberrime, litteras dedi per capitaineum quemdam navis nostræ Roanum qui petiit; responsorias nondum habui. Si ad me scribere placeat epistolam mittas Stockholmiam et me inveniet.

Si adhuc vigeat Dom: Profess: d'Isnard, ipsi significes me quosdam libros botanicos accepisse, quos nondum in suâ collectione obtinuit; ad te eosdem mittam; si ipsos nolis habere ipse, habebit Dominus d'Isnard.

Quæso mihi dicas utrum acceperis a D. Clifortio ejus hortum necne; si non, curabo tum ut habeas.

Dedi in actis literariis et scientiarum quæ Upsaliæ prodeunt, catalogum animalium Sueciæ, ubi quadrupedia, aves, amphibia, pisces, insecta, vermes Sueciæ enumeravi, scilicet species sub suis generibus cum synonimis specierum; quem tractatum mittam una cum horto Agerumensi et actis academiæ scientiarum Sueciæ & oratione meâ de curiositatibus in insectis.§ Quamprimum societas liter: et scienti: crisin subiit, quod proxime fiet, te Membrum vocabit.

dissertationibus Bernardi de Jussieu insertæ. Octogenaria anno 1780 obiit, ita ut fere quadragenariam Lutetiæ noverit Linnæus.

* Laserre in domo Jussæorum, ut videtur, familiaris, ideoque a Linnæo tum sæpius infra in litteris, tum in ipso diario memoratus, cæterum vix notus.

† Verbum sub cerâ sigilli se subduxit; credo legendum *Brasiliano* cum in unâ litterarum sequentium de viatore Brasiliam mox adituro mentio fiat.

‡ Nomen ignotum, an e cacographiâ?

§ *Tal om Märkwärdigheter uti Insecterne.* — Orationem hanc de Memorabilibus in Insectis habitam a Linnæo coram Academiâ Scientiarum cum primum deponeret Academiæ præsidium d. 3 Oct. anni 1739, monente cl. Bernh. Jussieu ex Suecicâ in Latinam vertit linguam Parisiis 1743 Abrah. Bäck, M. D. (ut legere est in

Quæso per conterraneum meum D: Sohlberg proximo vere mittas aliquot semina et plantas rariores, præsertim Orchidum bulbos, quorum species adhuc semel coram videre flagro. Mittam ego vicissim quæ potero.

In Nosocomiis classis navalis, quorum medicus primarius sum, innumeris casibus expertus sum vires plantæ, quam Linnææ nomine indigitavit Gronovius; eamque ego certo Rheumatismum tollere, si per octiduum propinetur foliorum infusum, ac China in febribus.

Ut valet frater tuus qui Peru vidit? redierit adhuc necne? Quid novi secum tulit? Quot stamina in vera China? qualis flos? quid novi in Botanicis?

Quæso millies ad me scribas, ut per te omnia sciam; tuum in me favorem dum Parisios vestros vidi numquam prædicare satis possum; semper tamen Tua summa merita publice et privatim prædicavi, ut nullius hic botanices cultor non Te artis principem inter nostros agnoscat.

Nunc vivo et optime vivo. Legatus noster apud vestrum regem, illustrissimus Comes Tessin, antequam abibat me ad officium publicum docendi Botanicem et Mineralogiam admovit et infinita bona præstitit.

Professor Brovallius qui in academiâ Aboensi physicen profitetur, *Apologiam* edidit *contra Siegesbeckium* petropolitanum, in qua respondit ad objectiones factas adversus systema meum.* Librum transmittam.

Quando prodibunt insecta D: Obriet? Edidistine adhuc Plumieri † historiam plantarum? Si non fac per deos quamprimum stes promissis; eo enim opere et Plumierum et te immortalem reddas.

Plurimam salutem dicas generosissimis fratribus tuis et viduæ Vaillantii et D. Obriet et D. Reaumur et D. Isnardio et Amicis omnibus. Vivas diu felix artis nostræ ornamentum.

Dabam Stockholmiæ 1740, febr: 5.

titulo Latinæ orationis, in *Amœnit. Academ.* t. 2. p. 388), de quo paulo infra in epistolis agitur. Versionem hanc manuscriptam possidemus, ut et nonnullas Bæckii, serius regis Sueciæ archiatri, ad Bernardum, quocum amicitiam Parisiis conjunxerat, litteras in quibus frequens Linnæi mentio. Eidem debetur, præter varia de mineralibus vegetabilibus animalibusque diversis, oratio de Linnæo cui supervixit panegyrica: *Amminelsetal öfwer Carl von Linné.* 1779.

* Joh. Browallii *Examen Epicriseos in Systema Plantarum Sexuale cl. Linnæi a.* 1737 *Petropoli evulgatæ Auctore Joan. Georg. Siegesbeckio, Jussu Amicorum institutum.* Aboæ. 1739.

† Carolus Plumier, e Minimorum ordine, a Ludovico XIV. in Americam, ad res naturales indagandas, ter ab anno 1689 ad 1704 missus, Insulas Antillas, Sandominicam præsertim, exploraverat, ubi miram vegetabilium animaliumque copiam observavit, collegit, descripsit delineavitque scientiæ et artis æque peritus. Collecta naufragio periêre; manuscripta diversæ navi commissa servata sunt, quæ nunc extant in bibliothecis

À Monsieur, Monsieur LINNÆUS,

PROFESSEUR EN BOTANIQUE, MÉDECIN DE LA MARINE, ASSOCIÉ DE L'ACADÉMIE DE STOCKHOLM, ETC., ETC.,

À Stockholm.

Vir Clarissime, Amice plurimis nominibus colendissime,

Binas Epistolas accepi a te post reditum in patriam faustissimum, per has cognovi et jucundissimas nuptias, et tuam post exantlatos labores summos felicem, in vestrâ aulâ, sortem, in medicinâ famam studiis omnibus bene partam, in botanice promeritum munus. De collatis istis beneficiis gaudeo lætorque vehementer, nec usquam dubitavi de prospero tuo successu. Sed tamen gratissimum mihi fuit nuntium. Varia quæ edisti in lucem mittenda scribebas, nescio quo fato ad meas manus nequidquam appulerit, expectavi diu, moram injecit forsan longa itinerum distantia. Si ea ad me deferenda opera cogites adhuc, simul et libros de quibus loqueris pro Dantio nostro, per legatum apud vos Regis Christianissimi nostri mittere poteris, et cito venient optatissima munera summæ tuæ erga nos benevolentiæ. Hac occasione utar deinceps, aut D. D. Comiti illustrissimo de Tessin tradam quæcunque a te expostulata cognovero. Accipe interim recenter evulsas Orchidum radices, leve quidem grati pectoris memoriæ signum. Non rediit frater meus Peruvianas qui lustrat plagas, illum servet redeuntem Deus ter Optimus Maximus. Plumieri opera quæ volebam publica facere hæc nondum prodiêre nec prodibunt antequam, novo ordine digesta,* methodo naturali accommodata fuerint, vel ad methodum naturalem magis composita accedant. Examini

Parisinis, tum imperiali, tum musæi hist. naturalis. Auctor minimam tantum partem tot novorum edidit, maximam, cum quartum in Americam iter appararet, defunctus ineditam reliquit. — Antonius de Jussieu ex autographo horti regii exemplari plantarum Americanarum descriptiones transcripserat et icones plusquam octingentas ex archetypis exprimendas curaverat, materiam operis a Bernardo suscepti, vix tamen inchoati nedum perfecti. Earumdem alia ac nostrum, minus completa tamen, exemplaria extiterunt in diversis bibliothecis, ut Banksii et antea Boerhaavii, qui tabulas Plumieranas 508 per Aubrietum repictas obtinuerat, quas serius Joh. Burmann sibi comparavit vulgavitque sub titulo : *Plantarum Americanarum fasciculi* 10 *continentes Plantas quas olim C. Plumierus detexit atque in Antillis ipse depinxit, edidit, Descriptionibus et Observationibus illustravit J. Burmann. Amstelodami.* 1755 – 1760. fol. Iconum Plumieri autographarum, elegantissimarum amplissimarumque, sæpe fragmenta tantum in opere Burmanniano suppetunt. Recentius in libro de Palmis splendidissimo celeb. de Martius species Antillanas e manuscriptis nostris deprompsit et publici juris fecit. Nihilominus servandum totius operis a Bernardo nuntiati et a Linnæo expetiti desiderium.

* Bernardus methodo naturali intentus, in eâ jamnunc non parum profecisse videtur, quam nitatur ad nova genera speciesque ordinanda extendere. Plumierus suas plantas absque statuto systemate disposuerat, nunc affinitate naturali similiores, ut Filices et Palmas, consocians, nunc tantum charactere artificiali, ut scandentes, bulbosas, &c., &c.

novo subjiciuntur characteres harum Americanarum plantarum. Amicus * in Insulis ditionis Gallicæ degens labori huic se totum devovit et te ducem sequitur, e Tournefortiano Linneista factus, primo methodi tuæ aspectu. Jam quædam genera more tuo conscripta accepi, sed longe plura promittit et expecto.

Kina staminibus quinque gaudet, flos fructui vel embryoni insidet, — affinitate jungitur in eodem ordine quo Coffea, Randia, Vomica forsan, Cephalanthus (hujus capsula bilocularis est, et semen unicum adest in quolibet loculamento). Periclymeni species pleræque in catalogo Plumerii recensitæ, Morinda sive Roioc, Plum. &c.

Pilulariæ flores, totamque fructificationem detexi præteritâ æstate; hujus historiam dedi in Actis Regiæ Scientiarum Academiæ.† Lemma Theophrasti hoc anno addam,‡ cujus character naturalis accedit ad Pilulariam, differt tamen, unde genera servo; statim ac figuræ incisæ erunt, mittam has una cum explanatione variarum partium delineatarum.

De Dracone arboris Clusii, certior factus sum, nec Cordyline nec Palmæ species est, ut credunt et suspicati sunt plerique botanici; genus novum,§ quod Draconthema voco, constituendum puto, et proximis nostris in comitiis legam, quid sentiam hâc de re, et quâ ratione institutum genus fuerit. In ordine naturali militat cum Asparago, Convallaria, Tamo, Smilace, &c.

Hortum Cliffortianum|| suo tempore reddendum curavit Mæcenas tuus optimus

* Is absque ullo fere dubio fuit T. B. Renatus POUPPÉ DESPORTES, qui medicinam in urbe Sandominicanâ Capitis exercuit, et inde ab anno 1734 ad 1747 cum fratribus Jussieis commercium habuit litterarum quarum triginta circiter possidemus, quibus accedunt descriptiones generum, de quibus hic Bernardus. Idem serius Catalogum Plantarum Domingensium edidit in tertio volumine operis: *Histoire des Maladies de St. Domingue.* 1770.

† *Histoire d'une Plante connue par les Botanistes sous le Nom de Pilularia.* Mem. Acad. Roy. des Sciences. 1739.

‡ *Histoire du Lemma.* Mem. Acad. Roy. des Sciences. 1740. — Eadem, ut sciunt, quam nomine ac Marsileæ quadrifoliæ omnes nunc salutant.

§ Quod genus serius (a. 1769 in *Mantissâ Plant.*) institutum sub nomine *Dracænæ* ab ipso Linnæo, qui de stirpe sollicitus documenta a botanicis plagas calidiores colentibus aut invisentibus, ut Vandellio et Loeflingio, pluries quæsivit. Bernardus enim proprias observationes, quas hic nunciatas inter ipsius manuscripta possidemus magno numero magnâque curâ collectas, sed non perfecte digestas expolitasque, nunquam evulgavit, et in catalogo horti Trianonensis manuscripto ubi Draconis arbor *Cordyline draco* inscribitur, hic rejectum admisit nomen: pro quo postea, in catalogo eodem generum anno 1789 impresso, Ant. Laur. de Jussieu nomen Dracænæ jam non receptum substituit.

|| *Hortus Cliffortianus, Plantas exhibens quas in Hortis tam vivis quam siccis Hartecampi in Hollandiâ coluit Vir nobilissimus et generosissimus Georgius Clifford, J. U. D., reductis Varietatibus ad Species, Spe-*

D. D. Cliffort. Gratias egi summas benefactori illustrissimo, sed multas rependere debueram pridem ob collatum quod tibi debeo munus, vellem ut mea tibi utilia magis essent officia; pudet me silentio tantum temporis intervallum præteriisse; parcas quæso amico qui te studio omni prosequitur, et qui diligere te et amare semper non desinet. Vale. Parisiis dabat obsequentissimus et ex toto pectore devotissimus

BERNARDUS DE JUSSIEU.

Die 20° Julii 1740.

Salutant te plurimum frater meus et Pater, amicus Laserre, Aubriet, Vidua Vaillant, et D[a] Basseporte.

VIRO ILLUSTRI

DD: BERNHARD: DE JUSSIEU,

PROFESSORI BOTANICES PARISIENSI,

AMICO VENERANDO,

CAROL: LINNÆUS.

In itinere Botanico, impensis regiis constitutus mihi obviam venit amicus antiquus D: Sohlberg, nuncius Regis nostri (*Expres*) ad nostrum legatum Parisiis vestris degentem; data itaque opportunitate et occasione, has breve exaravi literas.

Tractatus isti quos desiderasti a me post reditum in patriam impressos et compactos, literisque inclusis circa initium anni composui, vestro legato dedi, sed nimis graves cum navi se eosdem missuros benignus promisit; præstabitque procul omni dubio. In his ad tuas ultimas responsum dedi.

Pro bulbis Orchidum missis iterum devotissimam mentem reddo; diu hæsêre apud legatum vestrum, prodiere tamen omnes, floruere etiam, sed tantum militares hiante cucullo.

Iter Seucipio [suscipio?] ad Insulas maris Balthici, Œlandiam Gotlandiamque, redibo, si faveat numen, mensis Augusti circa finem. Ibi plantas marinas, muscos et petrificata investigabo sedulo.

Nunc dei gratia a miserrimo servitio praxeos Holmiæ liberatus sum; stationem tandem obtinui, quam desideravi diu; jussu regis in Academiâ Upsaliensi * nuper profes-

ciebus ad Genera, Generibus ad Classes, adjectis Locis Plantarum natalibus Differentiisque Specierum, cum Tabulis æneis nitidissimis. Amstelædami. 1737.

* Botanices cathedram in Universitate Upsaliensi morte Olai Rudbeckii vacuam, quam obtinuit Rosen, Linnæus ambierat; mox ibidem, professore medicinæ Roberg abdicante, in ejus locum suffectus est, et demum, feliciori officiorum inter ambos collegas distributione, historiam naturalem habuit inter alia docendam.

sor medicinæ et Botanices factus sum, sicque floræ redditus a quâ exul per 3 annos Holmiæ inter ægros vitam degi. Si vita viresque a me aliquid in botanicis, ut spero, videbis.

Orationem inauguralem de progressu, fatis et statu Botanices (in hoc seculo) habui,* ubi publice tuas prædicavi ut potui et debi [debui?] laudes, ne me ingratissimum reperires. A medicinæ studiosis post annum qui vestras adeant academias quanti tuum nomen fecerim exaudies ipse.

Saluta Venerandum fratrem tuum et amicos omnes nostros communes D: Isnard, Laserre, Viduam Vaillantii, D. Obriet et omnes alios, dominum qui Brasiliam adiet.

Quid de fratre tuo? quid de ejus observatis? Quæso respondeas, scribasque sæpius. Si vixero post Septembris proximam diem, responsa dabo eodem die ad tuas, quoties hisce me beatum velis.

Ter vale, vivasque omni amico major. Dabam Norkopiæ d: 19 Maji stylo veteri 1741.†

Vir Clarissime, Amice Optime,

Redditæ mihi fuere literæ tuæ gratissimæ, quibus responsa facere volui non semel, et quominus scriberem plurima detinuere negotia. Parcas quæso elapsæ meæ negligentiæ, quasdam si prætermiserim occasiones meum erga te significandi studium. Varia suscepi itinera, totoque autumno præterito circa littora Neustriæ maritima erravi, nova non pauca detexi quibus animale regnum aliquando ditatum miraberis; ‡ meæ

Gratulamur nobis Galli suffragia in Galliâ de Linnæi meritis lata nonnihil profuisse ut ad debitos honores in patriâ promoveretur, quod ipse testatur in Diario ubi legitur: "*Count Tessin, who was then at Paris, having heard a great deal about Linnæus in that city, recommended him to Count Gyllenborg, at that time Chancellor. Count Gyllenborg arranged matters among the competitors in such a manner, that Rosen was to succeed to this* (O. Rudbeck), *and Linnæus to the office of Professor Roberg, who was to resign on account of age, but that Linnæus and Rosen should afterwards change professorships with each other.*"

* Quam nunquam edidit, forsan tamen serius in operibus dissertationibusque, ubi de botanices historiâ agitur, refusam inseruit.

† Huicce et proximæ epistolæ spatium interjicitur sex annorum, cum eodem quinquies Bernardus scripserit, e cujus responsis constat nonnullas, saltem duas, Linnæi litteras desiderari.

‡ In omnibus botanicis, a Cæsalpiniano usque ad Linnæanum, systematibus, jura civium obtinuerant Lithophyta, Spongiarum, Madreporarum, Coralliorum, &c., &c., inconditam intricatamque multitudinem complexa. Quorum naturam animalem medicus quidam Monspeliensis, cl. Peyssonel, agnoverat an. 1727, plerisque dissentientibus vel dubitantibus. Dubitationem sustulit Bernardus de Jussieu disquisitionibus, de quibus hic mentio, institutis et coram Academiâ Scient. Paris. expositis (*Examen de quelques Productions marines qui ont*

vero antequam prodeant in lucem observationes ulterius indagari has res animus est. Te Professorem Botanices in Upsalâ audivi summâ cum lætitiâ, floræ devotus omnino poteris viam quam monstrasti facilem amplius aperire, naturalemque methodum tandem perficere,* quam desiderant et expectant botanophili omnes. Nil novi apud nos præter tentamen historiæ naturalis provinciæ Cayenensis,† et herbarum officinalium catalogum. Ista opuscula tradet tibi chirurgus Comitis de Tessin, cum redibit in patriam. Addam et his fasciculum Quæstionum Medicarum Facultatis Parisiensis. Quæcumque ad me misisti nondum ad meas manus pervenere; gratias ago tamen plurimas pro eâ quâ me prosequeris benevolentiâ, in grati animi recordationem nonnulla offero semina exotica. Servet te Deus T. O. M. diu incolumem, vale, et me tibi devinctissimum credas

BERNARDUM DE JUSSIEU.

Parisiis die 15° Februarii 1742.

Salutat te plurimum frater meus gratulanturque tibi amici optimi quos Parisiis novisti.

été mises au Nombre des Plantes et qui sont l'Ouvrage d'une Sorte d'Insecte de Mer. Mém. Acad. Sc. 1742). Dissertationem hanc sequebatur et partim complebat altera, prænuntiata quidem, sed quam, etsi absolutam, tamen (ut sæpius sueverat) ineditam reliquit (*Dissertation et nouvelles Découvertes sur les Coquillages marins connus jusqu'aujourd'hui sous le Nom de Plantes marines et ligneuses*). Hanc prætereaque multas adnotationes iconesque manuscriptas de animalculis marinis servamus, serii sagacisque studii monumenta, cujus conclusiones a plerisque, duce Linnæo, admissæ. Quæ tamen veri limites non nusquam transgrediebantur, ut recentiores Algologorum, præcipue cl. J. DeCaisne, observationes demonstravêre, unde Corallinæ cum nonnullis aliis corporibus marinis, fructificatione ipsorum perspectâ, vegetabilibus nunc iterum adnumerantur.

* Hic innuitur iterum methodus naturalis de quâ verisimile est fuisse frequens Bernardi cum Linnæo confabulantis argumentum. Linnæus jam pridem (in *Classibus*, ann. 1738) fragmenta inchoaverat hujus methodi, quam *primum et ultimum in parte systematicâ Botanices quæsitum* vocat, sed cujus indagationem, continuo et alios fere excludente labore promovendam, ipse postea, sinon deseruisse, certe neglexisse, tot tantisque aliis laboribus avocatus, videtur. Alterum quidem serius (*Genera Plantarum*, 1764) ordinum catalogum edidit, sed quos minus prioribus cum naturâ congruere sentiamus.

† *Nouvelle Relation de la France équinoxiale, contenant la Description des Côtes de la Guiane, de l'Isle de Cayenne*, etc., etc., par Pierre Barrère. Paris. 1743. 12mo.

VIRO CLARISSIMO

D. CAROLO LINNÆO,

PROFESSORI BOTANICES UPSALIENSI DIGNISSIMO,

S. P. D.

BERNARDUS DE JUSSIEU.

Perquam mihi gratæ fuerunt litteræ* quas tradidit mihi illustris Baro D. de Schæffer, cognovi ab his quod mei apud te vigeat studii recordatio, et quod jucunda fuerint ea quæ olim miserim semina. Alterum accipies fasciculum eorum præsertim quæ a te desiderari significavit D. Bæck antequam redire in patriam cogitaret; hunc deferendum brevi curabit D. Cleberg, sed alium dispono quem secum asportabit et tibi meo nomine offeret illustris juvenis Comes de Spar. Ille mihi attulit binas dissertationes quæ sub tuis auspiciis propugnatæ fuerunt, 1ma de Fico,† 2da de Betulâ nanâ.‡ Pro his gratias refero plurimas. Si quid novi in re herbariâ aut historiâ naturali prodeat, ignorare me ne sinas; hæ res sunt tuæ, sunt meæ, deliciæ. Peloriam § miratus sum, an sit Linariæ vulgaris metamorphosis transmutatio vel progenies definire arduum mihi videtur. Si monstrum, sata semina indicabunt. Vidi quondam lusum naturæ in floribus Linariæ, sed adeo regularem nusquam perspexeram; nectarium multiplex aderat quidem, seu calcaria duo tria et quatuor, nullo modo tamen limbus figurâ tam regulari gaudebat ut tua fert icon; insuper non omnes unius spicæ flores ita mutabantur. Ea quæ polliceris hujus semina maximâ cum voluptate accipiam. Circa Lithophyta et marinas vulgo plantas quæ te nunc credere scribis ea sententiam quam amplexus sum mire fulciunt; et tuæ observationes meis decus non leve adjicient et pondus. De Coralliis Balthicis dissertationem || quam propediem habere promittis, hanc avide expecto. Quod attinet ad methodum meam Vermium et Zoöphytorum, illa est potius tentamen quam perfecta distributio; gloriosum tamen duco quod hanc vestris Actis inserendam judicaveris; forsitan ad id faciendum impulit te amor in me tuus, cujus jam multa mihi exhibuisti testimonia. Unum inter præcipua est cum me Aca-

* Quæ desunt.

† *Dissertatio botanico-medica quâ Ficus ejusque Historia naturalis et medica exhibetur*; resp. Corn. Hegardt. Upsaliæ. 1744. Et in Amœn. Acad., Vol. I.

‡ *Dissertatio botanica de Betulâ nanâ*, resp. L. M. Klase. Stockholmiæ. 1743. Et in Amœn. Acad., Vol. I.

§ *Dissertatio botanica de Peloriâ*, resp. Dan. Rudberg. Upsaliæ. 1744. Et in Amœn. Acad., Vol. I.

|| *Dissertationis de Coralliis Balticis*, resp. Henr. Fougt: Caput prius de Coralliis in genere. Upsaliæ. 1745. Et in Amœn. Acad., Vol. I.

demiæ vestræ Socium elegisti, proposuisti et confirmasti. Tu solus me noveras, ideoque hunc honorem mihi concessum a cæteris Academicis doctissimis viris ut tuum opus agnosco; grates meas, precor, referas singulis membris dignissimis, nec me hujus gratiæ immemorem fore unquam credas. Vale et me diligere ne desinas.

Parisiis die 7$^{\text{mâ}}$ Aprilis 1745.

Salutant te plurimum frater meus et D. Pater Laserre. Obiere D'Isnard et Aubriet, vidua Vaillant vivit, sicut Domina Basseporte quæ flores et herbas magnâ cum arte depingit. D. Clairaut, mathematicus præclarus, qui te in horto regio vidit et Suethicè allocutus est, salutem plurimam tibi dicit et deprecatur.

CLARISSIMO VIRO

DD. CAROLO LINNÆO,

PROFESSORI BOTANICES UPSALIENSI, ETC., ETC., ETC.,

S. P. D.

BERNARDUS DE JUSSIEU.

Nolui hanc occasionem prætermittere, quâ iterum possum meum erga te studium testari; benevole igitur accipias pauca hæc quæ nunc mitto semina, meque promptum paratumque scias, mittendi alia si novero quæ tibi grata et utilia sunt. Nil novi apud nos in re naturali. Bella Musas silere jubent. Expeto tuam de Coralliis Balthicis dissertationem, cæterasque lucubrationes de Botanicâ, si forte apud vos prodierint in lucem. Salutat te plurimum frater meus; ex toto pectore amplectitur te Pater Laserre, itineris quondam nostri comes. Vale et me diligere ne desinas.

Parisiis die 1$^{\text{mâ}}$ Maij 1745.

AMICO OPTIMO, VIRO ILLUSTRI, PROFESSORI DIGNISSIMO

D. CAROLO LINNÆO

S. P. D.

BERNARDUS DE JUSSIEU.

Hisce literis tuam expostulo benevolentiam pro D. Cleberg, qui nuperrime nuntium accepit de fato functo Litterarum Græcarum Professore in Regiâ Upsaliensi Universitate. Munus hoc adimplere cupit, paratus redire in patriam, tuum præcipue ambit suffragium, cum tibi sit notissimus. Quapropter exoro te ut dignissimo viro servire velis; officia quæcumque erga illum præstaveris in me lubenter recipiam, semperque tanti beneficii memorem me habebis. Fac igitur ut inter hos qui regiæ Majestati offeruntur unus numeretur. Cum nostras linquet terras, fasciculum deferet tibi selectorum seminum, grati pectoris tesseram. Vale, vir optime, et me eodem persequi studio ne desinas.

Parisiis die 6ª Januarii 1746.

ILLUSTRISSIMO DOCTISSIMOQUE VIRO

DD. CAROLO LINNÆO,

PROFESSORI BOTANICO UPSALIENSI,

S. P. D.

BERNARDUS DE JUSSIEU.

Semina quarundam plantarum a te desideratarum nunc mitto et ut quam cito ad tuas perveniant manus vehementer exopto; hæc deferenda in se recepit lubentissime D. Cleberg quem tuâ summâ benevolentiâ beare dignatus es; præstita a te erga hunc virum bona officia sincerum mihi præbent amoris tui testimonium, quapropter quibus potero gratas animi mei actiones semper rependam. Quæ de opere tuo nuper edito significas,* ut id commendem discipulis qui me quotannis in excursionibus botanicis per agrum Parisiensem concomitantur, hoc jucundissimo munere fungar eo lubentius, quod liber iste, diu desideratus, in historiâ naturali lucem novam affert, et quod aliunde de te verba facere amem; præterea scio quantum emolumentum receperint qui secundum principia tua student; memet experientia docuit. Poterit igitur tuus editor ea mittere exemplaria, 100 verbi gratiâ, et brevi, uti spero, si non omnia saltem plurima distrahentur. Bibliopola hujus civitatis ad tuum mittit epistolam, in quâ propositis a te et a D. Bæck respondet; is est honestissimus vir, insigni probitate clarus. Dissertationes tuas de Fico, de Betulâ nanâ, de Peloriâ, de Coralliis Balthicis, &c. habeo; traditæ mihi fuerunt vario tempore.

Nondum floruere apud nos Ximenia, Baobab, Guiabara,† Simarouba (pro certo non

* Operis hujus titulum indicare debuit epistola prior Linnæi, cujus itaque jactura demonstratur. Verisimile est fuisse primam editionem *Floræ Suecicæ* anno præcedente Stockholmiæ editam, etsi Floræ Parisiensium excursoriæ non plane aptam. Nam liber (*Genera Plantarum*), forsan melius ad usum discipulorum accommodatus, Lutetiæ jam tribus abhinc annis, curante Bern. de Jussieu, reimpressus venumdabatur.

† Synonymon *Coccolobæ*.

est Euonymus, neque ad illum in ordine naturali accedit) et Lucuma.* Sed flores ostendere Fagara et Citharexylon. Fagara mas staminibus quinque gaudet, sed hujus arboris caracterem scripsit D. Bæck; fœmina vero florere incipiebat anno præterito; hujus floris caracterem aliâ vice communicabo, simulque Citharexyli descriptionem, quoad partes singulas fructificationis, solo excepto pericarpio, quod ad frugem venire huc usque recusavit. Glans unguentaria mihi videtur longissime recedere a Bonduc, nec ullam cum hac arbore affinitatem reperio. Desunt mihi e plantis Sibiriæ, quarum semina possides, secundum Ammanni indicem, Cardiaca 62. Papaver 81. Sedum 93. Pentaphylloides 116. Lilium 139. Lupinaster 143. Vicia 147. Astragalus 166. Lathyroides 151. Melilotus 158. Delphinia 174–175. Absinthium 193. Lactuca 211. Aspalathus 282, 283, 284. Blitum 239. Amethystina 70. Ruyschiana 64. Lophanthus, Anandria, &c. Ea si mittere [mittes?] per quamdam amicorum occasionem, rem facies mihi pergratam; interim valeas, et fac ut noscam opportuno tempore quæ a te cupiuntur plantæ ex horto nostro, cujus Catalogos secum tulit amicus D. Bæck. Salutat te plurimum frater meus, ambabus ulnis amplectitur te D. Laserre botanicus chirurgus, de te memoriam pictrix virgo agit et te salvum esse cupit. Iterum bene valeas et me amare perge nec desinas.

Parisiis die 7ª Maij, Ann. 1746.

VIRO ÆTERNUM COLENDO

DD. BERN. DE JUSSIEU,

PROF: BOTANICO INCLYTO.

Aliorum omnium, quotquot desidero, literas accipio iteratis vicibus; tuas vero quæ præ aliorum omnium mihi suavissimæ raro obtineo; hoc me jam vexat; licet nunquam potuerim tibi tantas, quantas debui, grates reddere pro millenis et æternis beneficiis, tamen nullam intermisi occasionem de te cum veneratione loqui et de nomine tuo magnifice sentire.

Regiâ gratiâ Archiatrorum comitis nomine insignitus sum; hanc veneror, sed tuam gratiam nulli postpono, vellem potius Tuum dici amicum et servum.

Iter W.gothicum † nuper a prelo prodiit; refertum bene multis observationibus in historiâ naturali, sed linguâ Suecicâ; octavo, paginæ 300 et tab. 5, ubi et insecta marina et flores Algæ delineatæ et varia œconomica ac curiosa.

* *Achras mammosa*, L.

† *Wästgöta-Resa, på Riksens Högläflige Ständers Befallning förrätad år* 1746. Stockholm. 1747.

Flora Zeylanica * adhuc sudat, opus erit parvum, sed magni laboris, quem librum minime tibi displiciturum spero, licet nullus dubitem quin tu solus errores varios reperias, quos mea tenuitas evitare nequiverit; te multorum annorum experientia cautum fecit.

Nova Plantarum Genera † in dissertatione academicâ N° 50 proposita sunt, hisce diebus proditura, cum omnes philyræ jam impressæ sunt.

Vires Plantarum ‡ seu explicatio *Fundamentorum Botanicorum* a N. 336 ad 365 ante 14 dies publice ventilabitur.

Materiam botanicam § (absoluta Flora Zeylanica) edam compendiosissimam, evitabo omnia quæ nec propria experientia nec aliorum fidi casus confirmarunt; Tu qui in his multum vales, mihi unicam vel alteram observationem mittas, ut liceat honorificam Tuam facere mentionem.

Non novi ad quænam genera sequentes sunt referendæ: Myrobalani indæ, Chebulæ, Belliorcæ, citrinæ; Anisum stellatam; Gum: elemi, Sagapenum, Carannæ, Bdellii, Myrrhæ, Olibani, Ammoniac., Opobalsamum, Bals. peruvianum; Copaiva; Lignum aloes; sang. Draconis, Lign. Rhodium, Simanba. Si novisti horum aliquam, candide et amice genus mihi dicas; publicas tibi grates agam.

Nix et nocturnum gelu adhuc nos vexat, dum vos in beatissimo aere inter flores vitam transigitis.

Dicas mihi quæso quasnam acceperis e meis dissertationibus ut queam mittere reliquas. Fuere: Betula, Ficus, Peloria, Corallia, Amphibia, Martino-Burserianæ, Hortus Upsaliensis, Passiflora, Anandria, Acrosticum, Mus. Adolpho-fredericianum, Sponsalia plantarum. Floram et Faunam Suecicam te vidisse nullus dubito.

Alta quies omnium rerum in scientiâ naturali apud nos viget et habitat; Barbarus hic ego sum nec intelligor ulli.

Tu vivas diutissime et devota mea officia dicas venerando fratri tuo et dulcissimæ amicæ meæ *Pictrici horti regii* et Beato *Laserre* et reliquis apud quos innotui.

Dabam Upsaliæ 1747. d: 24 April.

* *Flora Zeylanica, sistens Plantas Indicas Zeylonæ Insulæ, quæ olim* 1670 – 1677 *lectæ fuere a Paulo Hermanno, Prof. Bot. Leydensi, demum post* 70 *Annos ab Augusto Guenthero, Pharmacopolâ Harniensi, Orbireddita; hoc vero Opere revisæ, examinatæ, determinatæ et illustratæ Generibus certis, Differentiis specificis, Synonymis propriis, Descriptionibus compendiosis, Iconibus paucis.* Holmiæ. 1747.

† *Nova Plantarum Genera*, resp. Car. Magn. Dassow. Holmiæ. 1747. Et in Amœn. Acad., Vol. I.

‡ *Vires Plantarum*, resp. Frid. Hasselquist. Upsaliæ. 1747. Et in Amœn. Acad. Vol. I.

§ *Materia Medica*, Liber I. de Plantis. Holmiæ. 1749.

CELEBERRIMO DOCTISSIMOQUE VIRO

DD. CAROLO LINNÆO

S. P. D.

BERNARDUS DE JUSSIEU.

Te suadente et cupiente suscepit iter aleæ plenum tuus non meus ex Florâ filius D. Missa. Etenim ab hac die quâ rem herbariam discere cœpit summo te prosecutus est studio, et a te edoceri exoptavit. Ipsi gratulor quod feliciter scopum attigerit tamdiu desideratum, gratesque simul refero quam maximas ob collata officia licet a me non expostulata.

In Africam proficiscitur juvenis botanophilus,* cæteris historiæ naturalis partibus optimè imbutus et informatus. Ab illo segetem amplissimam observationibus bene locupletatam expectamus, et sperare fas est; plantes et animalia juxta methodum tuam definire sibi proposuit. Specimina sicca, matura semina, mittet, sicut et insecta quibus cognoscendis utilem mecum hac æstate et autumno præteritâ navavit operam, tuæ Faunæ vestigia insistens, in quâ tamen non pauca emendanda, immutanda aut firmiori talo statuenda videntur. Cum quid ab his calidissimis oris novum appulerit tu profecto primus eris particeps, et offerre mihi jucundissimum. Semina quæ nunc mitto recentissima sunt, alia ubi primum significaveris lubenter colligam statimque

* Mich. Adanson, tum annos tantum 21 natus, quinque mansit in Senegaliâ, cujus historiam naturalem redux edidit anno 1757. Plures ejus longioresque epistolas, non mediocris ad rerum naturalium ipsiusque auctoris notitiam pretii, possidemus, inde ad Antonium et Bernardum de Jussieu scriptas; quibus utrumque, posteriorem imprimis, magistrum patronum amicumque profitetur. Quod Linnæum attinet, sæpius de ipso in his litteris mentio, et sequentia propositum a Bernardo hic enunciatum Adansonii, quamvis serius a vestigiis Linnæanis procul discesserit, confirmare videntur. "*Vous me ferez plaisir de me marquer si je fais bien de décrire les différences de chaque espèce de toutes ces sortes de plantes et d'animaux, ainsi que des endroits où ils se trouvent, avec leurs propriétés, afin de pouvoir à mon retour réduire cet ouvrage en forme de catalogue tel que le Fauna Suecica de Linnæus.*" (Lettre du 15 Août, 1749.) — "*Je vous laisse la liberté de communiquer à M. Linnæus le caractère du* Baobab; *je pense que cela ne peut m'être désavantageux ni tirer à aucune mauvaise conséquence : je vous prie même de vouloir bien assurer ce sçavant de l'estime infinie que j'ai pour sa personne et ses ouvrages, et que la distance infinie qui me sépare de lui est la seule raison qui me dispense de lui communiquer moi-même tout ce qu'il pourrait désirer. . . . . Pour ce qui est des autres genres, &c., je vous prie de ne les point faire paraître, parce que je compte après mon retour, après avoir fait paraître en Français l'histoire naturelle des environs du Senegal, donner en Latin suivant le système de Linnæus et dans la forme de son* Flora Zeylanica, *les observations faites en cet endroit. Comme le système de cet auteur est assez généralement reçu, et que d'ailleurs je n'ai pas encore vû assez d'objets pour constater la bonté du mien, je compte donner le* Flora Guineensis *suivant ses principes.*" (Lettre du 20 Février, 1752.)

deferenda curabo. Mutuum vigere commercium jam sinet pax alma. Floram Zeylanicam, Hortum Upsaliensem, Materiam Medicam, Systema recusum et cætera a te edita nondum videre contigit; afferet, ut scribis, D. Missa, at quam sero venient. Tu meæ expectationi molestissimum frænum injicere voluisti, fortasse ut tuæ citius responderem, votaque solverem. Culpam fateor, me invito, elapsam; itaque digneris me antiquæ redintegrari amicitiæ.

Sed quid moror? Ecce nova panduntur orbi litterato miracula. Jam sæculo labente ultimo, innumera corpuscula in semine masculino observaverat, vitali motu donata, natantia, et in quolibet diversi marium generis liquore analogo anxie quæsierat, imo invenerat, sedulus et sincerus arcanorum Naturæ investigator Leeuvenoekius, optimis adjuvatus microscopiis. Eadem corpora, animalculorum spermaticorum nomine insignita, ejusdem molis et figuræ, prorsus similia, pari motu agitata, progredientia veluti per æquora pisces, in spermate fœmineo, lentis vitreæ ope observavit demonstravitque D. De Buffon,* Regiæ Academiæ Socius, horti præfectus, physicis disquisitionibus clarus, historiæ naturalis studio et operibus præclarior. Hoc patefacto in viviparis animalibus, oculos convertit ad ovipara, volucrum genus omne, majora unde e tenebris suscitavit prodigia, dicam mysteria, captum humanum superantia; quæ quidem labore summo prosequitur, de iis alias locuturus. Spermatis fœminei latex visui non semper se prodit; sunt certa tempora, sua cuique animali lex data est, nec continuo marem appetit fœmina; itaque investigandus venit ille liquor dum œstro venereo percita, turbata, ludibunda, denique lasciviens currit undique fœminea gens; ludit, ejulat, anxia dolet, vulvam reserat rore perpetuo madefactam, conspurcatam, succuba impatiens; tunc ovaria seu testiculi subcrescentibus tuberculis immutantur quasi totidem mammillis succo plenis, apice fissis et hiantibus, e quibus postea pedetentim ejicitur semen requisitum manatque ad tubas uterinas. Res profecto stupendæ et quæ propagatam, ab animalculis spermaticis deductam, de generatione hypothesin penitus evertunt, necnon hominis primordia uti cæterorum animantium originem abstrusiori involvunt caligine.

Salutem plurimam accipias a carissimo fratre, fidelissimo D. Laserre et honestâ virgine D. Basseporte, quæ alteram a te appellari uxorem summopere gloriatur. Valeas, totaque tua progenies bene valeat. Amare me pergas semper qui tibi devoto pectore nexus vivere lætor.

Parisiis die 30[a] Januarii, anni 1749.

Musci Norvegici egregium specimen, Ceratoidis semina, tuæ erga me benevolentiæ munera, gratâ mente recordor.

* *Découverte de la Liqueur séminale dans les Femelles vivipares et du Reservoir qui la contient*, par M. de Buffon; dans les Mém. de l'Acad. Roy. des Sciences pour l'année 1748.

À Monsieur, Mons[r] BERNH. JUSSIEU,

MEMBRE DE LA ACADÉMIE DES SCIENCES,

PARIS.

Vir illustris ad cineres venerande,

Accepi litteras; accepi Semina; utraque tanquam a patre genuino accepta refero, te ut patrem botanices semper agnosco et agnoscam, pius tuus vivam; et mihi gratulabor esse tuus discipulus, utinam dignus.

In Fauna infinita emendenda habeo ipse; utinam ipse velles docere discipulum, ut possem emendare pleraque; proximo anno alteram editionem dabo; erat in hac scientiâ primum tyrocinium; forte non ita facile erat prima in hac scientiâ dare fundamenta.

Accessit D[nus] Missa* præterlapso autumno; de quo omnes Parisiis scripsêre quantus erat, excepi eumdem uti ex cœlo demissam Pandoram; excepi hospitio; curavi omnia quæ in me erant; nudus accessit; vestitus fuit; pecunias numeravi absque spe redditionis; quid non facerem discipulo tanti præceptoris? tandem ipse mihi retulit quam indigne se gesserat et in te et in inclytum Reaumurium; observavi, nil dixi.

Erat mea mensa, simplicissima licet, ipsi patens. Meridie et vespere post ferias nativitatis Christi rediit Stockholmiâ Upsaliam bene vestitus a nuper defuncto illustri legato et omnibus nostris non satis laudando de Lanmary, sed quod dolui aliis moribus. Sermo de germano botanico, ita alienabat animum ejus ut non tantum reliquit domum meam, sed vituperiis, maligno sermone, se reddidit affabilem inimicis omnibus, ut si ipsa invidia ex inferno surexisset, ego non pejus fuissem contaminatus; discessit sic ex hospitio meo non salutato hospite, ac si fecissem pessima. Deus me inter et

* Iterata mentio et querela in litteris, tum hisce, tum ad cl. medicum et herbarium Monspeliensem Sauvages Delacroix adhuc ineditis, de doctore isto Missa, cæterum tam obscuro. Memoratur etiam idem in epistolâ Linnæi ad Hallerum 25ª (Sept. 1748), quâ teste, è Germaniâ in Sueciam redux litteras summorum virorum alterius ad alterum retulerat. Eodem fere tempore exortum inter ipsos dissidium, in quo Missa a Linnæo alienatus partes adversas suscepit. Hunc quidem non plurimi fecisse videtur Bernardus et in Adansonii litteris supra laudatis legimus: "*Je souhaite que, s'il est vrai que le S[r] Missa fasse son retour en France, il laisse tout du moins le volatil de son esprit en Suède, et ne nous rapporte que le fixe.*" Altrinsecus hæc Archiater Reg. Suec. Bæck in epistolâ ad Bernardum: "*Surement M. Missa deviendra habile homme, s'il ne l'est pas. J'aimois à la fureur sa compagnie et je plains Linnæus de l'avoir irrité. Mais encore il est un mystère ici ce qui auroit pu faire* odium plus quam Vatinianum *entre ces deux messieurs. Aumoins autant que je voye, c'est M. Linnæus qui a tort pour n'avoir pas mieux ménagé un étranger, et qui plus est un François.*" — Citatur in Bibliothecâ Botanicâ Halleri Henr. Missa auctor Dissertationis *de Vi Sanguinem comprimente Lycopodii* (in Commentariis Bononiens. Scient. et Art. Instituti), unde patet, ut ex nomine, genere Italum fuisse.

illum judicet; feci quod dolebo nunquam, quod conterraneo nollem et possem præstare. Utinam daretur occasio declarandi affectum in genuinum Tuum filium, quod vereor me in spurium commisisse. Hisce omnibus sepositis, tamen obtuli ei omnia, si velit adhuc reportabit animum meum, eam tantum ob caussam, ut non ingratus moriar, qui tanta a te reportavi, quanta a nullo alio mortalium.

Utinam daretur occasio mittendi; si velis indicare aliquem Holmiæ cui possem ad te tradere tractatus; si non tum habeas omnia, ego in culpâ ero.

Desino et termino litteras eâ contestatione quod quandiu vixero, ero pius tuus cultor et tibi magis quam ullo mortalium, exceptâ unice uxore, cultor certissimus devotissimus.

Plurima officia dicas amicissimæ D[næ] Bassaport, de quâ in somniis loquor; erit mea altera uxor nolens volens, si viduus permansero.

Pete ab eâ ut mihi det pictum et exsiccatum specimen Loniceræ illius Canadensis repentis quam plantam puto esse Linnææ speciem.*

Vale et vive.

Dabam in itinere Scanico constitutus, die 12 Aprilis 1749.

C: Linnæus.

BOTANICO SUMMO

DD. BERNH. DE JUSSIEU,

S. Pl. D.

CAROLUS LINNÆUS.

A primo vere in hoc usque tempus occupatus fui in itinere Scanico quod nunc absolvi et Upsaliæ redditus sum; proinde et mihi primum erit Te, quem maximi semper facio et cui plura grata et curiosa accepta refero, interpellere.

Semina ista rarissima quæ liberalissimâ manu et in ingenti copiâ misisti, accepi; plures inde natæ plantæ feliciter crescunt: Passiflora foliis bilobis peltatis; item Granadilla folio tricuspide obtuso *Feu:*; Tournefortia caule volubili foliis glabris; Sphæranthus; Coix seminibus angulatis; Poterium spinosum; Datisca s. Cannabina cretica; Coreopsis foliis verticillatis *Gron.*; Rudbeckia quæ Obeliscotheca integrifolia *Dill. Elth.*; Glycyrhiza leguminibus glabris; Corylifolia; Fumana lutea; Ketmia bras. folio ficus, p. pyramidato sulcato *Tournef.*; Dodartia; Malva frutesc. hirsuta, fl. luteis in capitulum congestis *Plum.*: Capraria curassavica; Sida foliis ovato-lanceo-

* Vide infra, not. † ad p. 216.

latis, caule paniculato *Roy.*; Ocymum fruticosum; Cedronella canariensis; Sison foliis ternatis *Hort. Cliff.*; Sideritis cretica tomentosa candidissima flore luteo *Tourn.*; Azedarach; Sideritis orientalis, phlomidis folio. *Tour.*? Amaryllis Belladonna; Reseda erucago apula. *Columm.*; Papaver cambricum *Dill. Elth.*; Apocinum curassavicum; Solanum bonariense *Dill. Elth.* 2. 272; Mandragora; Alypum frutex terribilis; Sherardia tenui folio, fl. purpureo *Vaill.*, ut reliquas taceam.

Tam multæ tamque raræ plantæ quas antea non vidit Suecia, non possunt non me coram pedibus Tuis gratissimâ mente prosternere.

Expecto flores Lupuli sylvestris Americanæ claviculis donatæ Pluk. t. 201 f. 8, quam vix a facie dicerem Bannisteriam,* nisi tu mihi dixisses. Egregie crescit et forte proximo anno flores ostendet.

Axyris mihi novum genus est; floribus masculis triandris, ab Amaranthis diversum cujus species mihi sunt

1° Axyris fruticosa, floribus femineis lanatis, orientalis.

2° Axyris erecta herbacea amentis masculis simplicibus. } Sibiriæ.
3° Axyris herbacea, amentis masculis corymbosis. } Sibiriæ.
4° Axyris herbacea, floribus capitatis. } Sibiriæ.

et forte

5° Axyris foliis linearibus, caule herbaceo, fl. nudis. *Linaria Scoparia.* Si habeas plantam florentem quæso examines.

Mihi tantum species 2ª in horto est.

Napæa vocavit (a νάπη Saltus lucus, Nympha sylvatica, quia umbrosa amat) Clayton novi generis plantam, quam nuper delineavit D. Ehret Londini splendidissime, est Althæa magna Aceris folio, cortice cannabino, floribus parvis etc. Bannist. in Ray hist. 2. p. 1928. Hæc in diversâ plantâ flores gerit masculos et femineos ideoque dioica mihi est.

Sub hoc genere ego comprehendo Althæam virginianam ricini folio *Herm.*, quamvis floribus hermaphroditis; ubique plantæ facies eadem, flores et fructus iidem; excepto sexu. Distinguitur facile Napæa a Sidis calyce non plicato sed urceolato et stylis non capitatis; adeoque prior Napæa floribus dioicis; posterior Napæa fl. hermaphroditis. Has procul dubio dudum accepisti.

Calamistrum † in itinere Scanico copiose collegi; vidi quod sit genere diversissima a Pilulariâ tuâ quam ibidem copiose offendi primâ vice intra Sueciæ limites; offendissem nunquam nisi tu eamdem mihi demonstrasses in tuo gratissimo itinere. Calami-

* Recte quidem; nam est *Gouania Domingensis*, L.

† *Isoetes.*

strum fert fructum intra basin foliorum exteriorum; ut eamdem delineavit Dillenius; at vero squamam floris cordato-sagittatam a latere inferiore folii non vidit; nec antheras observavit; folia enim interiora plantæ intra basin gerunt antheram magnam ovatam, polline copioso refertam, habent et flores similes femineis a latere inferiore folii, quæ omnia delineabo in Itinere Scanico.

Muscus norvegicus umbraculo ruberrimo examinatus est a D. Montin * qui hoc anno petiit Lapponiam, caret absolute omni calyptrâ, adeoque Sphagni genuina species est.

DD. Kalm † qui Canadiam petiit et nunc in Canadiâ versatur misit plusquam multa semina. Ego primo vere colligam ex his pro te, ut habeas eadem. Redibit D. Kalm proximo vere cum plantis siccis et vivis, modo vivat. Utinam haberet secum plantam siccam Loniceræ herbaceæ repentis Canadensis, quam tu habes in horto parisino; vellem lubenter videre, nonne hæc planta species esset Linnææ.

D. Hasselquist ‡ d. 2 Augusti solvit Stockholmiæ versus Palæstinam, a quâ si salvus redeat mihi multa promitto, quum solius botanices causâ istam regionem adiit.

* *Splachnum rubrum.* — Laurentius Montin, Linnæi magistri exemplum et consilium secutus, plagas boreales investigavit, cujus itinerarium ex epistolâ ipsius (Dec. 1749) ad Bernardum de Jussieu excerpere licet. "*Ineunte nimirum anni hujus vere, iter, suasore et auctore archiatro nostro Linnæo, in me suscepi Lapponicum, ut naturalia dissitarum provinciarum colligerem, atque in ea ulterius inquirerem. Lares itaque Upsalienses reliqui; Westrobotniam peragravi; Lapponiam petii Lalensem; circa initium æstatis ad alpes perveni, quas mox conscendi iter Norvegiam versus dirigens: rariora conquisivi; nova licet paucissima descripsi; tandem, Norvegiâ ad mare usque Septentrionale perlustratâ, Westrobotniam repetii; ultimâ ibi æstatis particulâ jucunde transactâ, Upsaliam spoliis tam vivis quam alias conservatis, finito cum mense Septembri itinere, redux factus sum.*" Litteras comitabatur herbarium plantarum a Montino collectarum, pro quo recepto Bernardus infra grates agit, quodque typis Floræ Lapponicæ Linnæanæ pretiosum servamus.

† Petrus Kalm Linnæi discipulus, jam tunc itineris per varias Sueciæ provincias relatione, nec non doctrinâ sub magistro summo comparatâ, insignis, ipso impellente et commendante, e patriâ Dec. 1747 in Angliam et inde in Americam transiit, ubi, castris Philadelphiæ positis, provincias boreali-americanas a Canadâ usque ad limitem Pensylvaniæ australem (Linnæus tamen in litteris et Virginiam pluries nominat) investigando peragravit per tres annos, post quos redux sedem Aboæ, professor patrocinio Linnæi factus, fixit, ibidemque itineris rerumque collectarum et observatarum historiam in tribus voluminibus (*Resa til Norra America.* 1753–1761) edidit, serius a J. R. Forster Anglice translatam (*Travels into North America; containing its Natural History, and a Circumstantial Account of its Plantations and Agriculture in general.* 1770–71.)

‡ Fredericus Hasselquist discipulus alter Linnæi, verbis incitatus magistri qui de indagationibus in Oriente et præsertim in Palæstinâ, ad illustrandam Scripturarum Sacrarum historiam naturalem, instituendis frequenter et facunde disseruerat, hoc iter, etsi valetudo et pecuniæ vix sufficiebant, suscepit; primo Smyrnam, Magnesiam, Natoliam, montem Sipylum peragravit, dein Ægyptum, Palæstinam, et Syriam, tum Cyprum, Rhodum, et Chium insulas, et denique Smyrnam redux ibi, tabe pulmonum consumptus, die 7ª Febr. anni 1752, trigesimum agens, occubuit. Quæ collecta scriptaque reliquerat, a creditoribus detenta, ægre nec nisi per munificam reginæ opem, patriæ restitui potuêre, et Linnæo cujus operâ serius apparuit *Fr. Has-*

Naves chinenses multos pisces, insecta et siccas plantas pro me adduxêre, sed merces istæ Gothoburgi hærent, nondum mihi traditæ sunt, expecto has quotidie.

Actis nostris Upsaliensibus quæ nunc sudant inserui Coldenii characteres plantarum Coldenhamensium in Noveboraco Americes conscriptos,* qui curiosi sunt et tuis acutissimis oculis forte digni.

Nova litteraria nobis attulêre quod Museum Horti Regii Parisini † prodibit prope diem in 4 voluminibus quarto; avidissime expecto hunc librum, qui procul dubio habebit multa curiosissima.

Misisti ad me præcedente vere spicam, per Suecum qui erat Parisiis, sed absque foliis, absque nomine; habuit ni fallor stamiña multa et pistilla 2; quæso dicas mihi quænam sit planta.‡

Annon vidisti flores Bahobab; egregie crescit apud nos ex seminibus quæ olim misisti, sed florere recusat, miror admodum cujus sit generis.

selquist Iter Palæstinam, aller Resa til Heliga Landet förrättad ifrån år 1749 *til* 1752. Stockh. 1757. Versiones hujus extant Germanica, Gallica, Anglica.

* *Plantæ Coldenghamiæ in Provinciâ Noveboracensi Americes sponte nascentes, quas ad Methodum cl. Linnæi Sexualem observavit et descripsit* CADWALLADER COLDEN (in Act. Acad. Reg. Scient. Upsal. 1749 et 1751). — Originem hujus opusculi narrat sequens præfatiuncula: "*Illustris auctor Americam adiit ante* 40 *annos, non superficiali Botanices cognitione imbutus, nihilominus latuere ipsi plantæ in novo orbe crescentes, quas nullâ ratione ad genera et species amandare potuit; hinc seposuit Botanices sacra per annos triginta, dum in manus ejus incidunt opera cl. Linnæi botanica, secundum principia cujus incepit plantas feliciter et facile examinare atque detegere, et ad genuinas familias reducere; hac ratione plantarum Coldenghamensium collectio nata est. Plantas sic graphice delineatas misit illustris auctor ad cl. J. Fr. Gronovium, et hic ad Linnæum nostrum, qui demum ab auctore obtinuit veniam has publici juris faciendi.*"

Ipsi manuscriptum possidemus, herbariolo Noveboracensi a Coldenio misso junctum, quod supplementum operis præcedentis videatur, cum hoc ad numerum 237 desinat, ad 240 nostrum incipiat. Subscriptio (*To D^r Gronovius, Leiden.*) indicare videtur similiter destinatum fuisse ac partes a Linnæò vulgatas, quamvis ineditum remanserit. Sed, quod mirum, in observationibus quæ, Anglice inque modum epistolæ scriptæ, descriptiones Latinas botanicas sequuntur et manuscriptum terminant, judicium fertur mite quidem sed tamen libere et recte censorium de Linnæi quibusdam opinionibus (v. g. Floram Americanam ab Europæâ omnino diversam nec species communes inter ipsas admittit Colden), generibus et toto etiam systemate utpote, cæterorum instar, naturæ repugnante, ita ut his verbis desinat: "*From what I have now wrote, you will see the reason I have to prefer the method of reducing the plants into certain orders* [*ordines*] *rather than to a general system, as I took the liberty to write to you in my last, because I believe by this method we will not so easily fall into mistakes of dividing and confounding what should be joined or separated, as we are tempted to do for the sake of a favourite system.*"

† Sub quo titulo designatur magnum opus (*Histoire Naturelle de Buffon*), cui in primâ editione subjungebatur *avec la Description du Cabinet du Roi.* Tria volumina anno 1749 prodiêre; quartum tantum 1753.

‡ Vide infra, not. * ad p. 216 et p. 220.

Si poteris mihi comparare virum Stockholmiæ, scilicet aut legatum vestrum aut mercatorem aliquem Gallicum aut alium quemcunque, cui possem merces meas committere, haberes a me omni anno quæ prodeunt curiosa in Sueciâ et quæcunque rariora sese hic sistant. Habito enim itinere unius diei Stockholmiâ; facile possum omnia Stockholmiam mittere, sed obtinere Stockholmiæ virum qui inquirat naves Galliam petentes, nunquam offendere potui. Cures hoc si poteris. Ingratissimus mortalium Missa abibat insalutato me hospite, adeoque nihil mittere potui.

Annon velles inserere Actis nostris figuram Loniceræ nummulariæ folio Canadensis.

Saluto amicissimam, dulcissimam nobiliorisque sexus ornamento virgini Bassaport et D^um^ Laserre. Vivas diu felix et sospes; te stante virebo et virebit Hortus noster academicus.

Dabam Upsaliæ d. 22 Septembr. 1749.

ILLUSTRISSÕ B. DE JUSSIEU,

BENEFACTORI SEMPER COLENDO,

S. Pl. D.

CAR: LINNÆUS.

INTER Botanicos nullus est quem majoris facio quam te, nullusque ad quem magis difficile est aliquid mittere. Accepi aliquot semina a D. Kalm ex Virginiâ; vellem ad te mittere, modo scirem quo pacto ut non fieret tuis impensis. An liceat ea mittere sub couvert ad Acad. Reg. Paris.? vel an sub involucro Præfecti horti D^ni^ Buffon? Vel quâ ratione id fiat rogo quæsoque quanto ocyus rescribas, ut semina in tempore habeas.

Apud nos nihil novi. Ego paro iter Scanicum, sed linguâ Suecicâ.

Dissertatio de Splachno a D^no^ Montin; seu de musco Norvegico, umbraculo ruberrimo et luteo, impressa est.*

Diss. aliam imprimo de seminibus muscorum detectis.† Capitula muscorum esse

* *Dissertatio Botanica sistens Splachnum, quam Præsid. C. Linnæo publicæ Censuræ modeste subjicit Laur.* MONTIN. 1750. Exemplar a Linnæo missum lineas quatuor manu ipsius scriptas in titulo exhibet: "*Sisto muscum vilem, omnium maxime singularem, inter plantas detectas rarissimum, ut in manus perveniat* VESTRATIS, *qui habenas regit Botanices.*" C. Linnæus. R. Ac. correspond.

† *Semina Muscorum detecta*, resp. P. J. Bergius. Upsaliæ. 1750. Et in Amœn. Acad. Vol. II. — Dum urnam muscorum antheræ phanerogamarum assimilat Linnæus, non plane quidem abhorret a vero; nam harum analogiam recentiores, monente Cl. H. Mohl, agnoverunt, sed alio argumento innixi, sporarum scilicet intra cellulas matrices quaternatim, pollinis granorum instar, nascentium genesi: quæ Linnæum latebat

antheras patet ex pollinis natura. Ubi anthera et pollen ibi necessarium est pistillum. Quæsivi multum. Reperi. Sed alio quam speraveram modo. Verbo semina muscorum carent omnino cotyledonibus, carent adeoque tunica, adeoque corcula sunt seminum decorticata et in Dill. Musc. tab. 56, f. 1. litt. h. i. k. l. m. n. o. p. depinxit et florem femineum calyce tetraphyllo et semen foliosum s. decorticatum; idem patet in reliquis examinanti.

Vianelli observatio quæ nuper prodiit Venetiis, de aqua marina juxta navem phosphorisante pulchra est et nova; quis crediderat lucem hanc deberi vermiculis? Nunc evictum est.

Dalibardi floræ paris. prodromum videre avidissime gestio; cum vos potestis absque impensis literas mittere Parisiis ad alias terras (ut audio) annon velles singulâ vice mittere 6 philyras sub couvert ad Societatem regiam Upsaliensem, tum haberem ea absque impensis, cum ipse effringo omnes societatis litteras. Si hoc poteris, quæso facias.

A D. Hasselquist ex Smyrnâ litteras habui jucundissimas; hisce diebus spero quod Hierosolymam pervenerit. Si sanus redierit ab eo multa mihi polliceor; fuit meus discipulus optimus.

Nullus apud nos supervixit tam mitem ac inertem hyemem quam hanc quæ discessit cum novo anno.

Quæso cures ut aliquis studiosorum botanicorum apud vos accurate observet quo die arbores sylvestres vestrates et sponte nascentes, quando et quo die veris s. mensis folia e gemmis promant,* et simul quo die hordeum seratur et quo die idem autumno maturum dissecatur, et ut hoc mecum communices pro tuâ amicitiâ rogo quæsoque.

cuidam sacci utriusque fariniferi minus intimæ similitudini solum attentum. At cum aliunde pro seminibus gemmas habeat, et quidem sæpius antheridia gerentes, sexus omnino in hac classe plantarum invertisse videtur.

* Quanti sit momenti phenomenorum naturæ quot annis periodice recurrentium tempus plus minus properum serumve sedulo notare, solitâ ingenii acie intellexerat Linnæus, observationes ipse domi instituerat, aliis aliarum regionum incolis commendabat. In Sueciâ per quatuor annos perrectas promulgavit in Dissertatione (*Vernatio Arborum*, 1753, et *Amœn. Acad.*, Vol. III.), quem proposuit H. Barx magistri interpres verbis sequentibus: "*Quartus jam agitur annus ex quo populares nostros in novellis literariis exhortatus est nob. D. præses, ut omni curâ et diligentiâ observarent, quo quilibet arbor tempore suas expandat gemmas foliaque explicet, non vanâ innixus divinatione futurum, ut ex pluribus hujusmodi, variis in locis, institutis observationibus, novum et fortasse non expectatum fructum nostra capiat patria.*" Serius (1756) ingeniosum *Floræ Calendarium* (*Amœn. Acad.*, Vol. IV.) eâdem mente confectum; et posthac ab aliis auctoribus editæ similes diversarum Florarum Ephemerides. Temporibus nostris studia de his generalius a Linnæo inchoata renovavit et extendit cl. astronomus Belgicus Quetelet, qui, expositâ ratione quâ colligi debeant observationes e pluribus et dissitis locis, sed uniformes et iisdem speciebus applicatæ (*Instruction pour l'Observation des*

Si hoc vellent botanici continuare per 3 annos, credo eos plura præstitutos [præstituros ?] quam mathematici meteorologicis suis observationibus per seculum.

Accepi librum Illustris. Reaumurii de Pullitie seu incubatione artificiali ovoque: reddas ipsi devotissima mea officia.

ILLUSTRISSIMO BOTANICO

DD: BERNH: DE JUSSIEU,

PROFESSORI BOTANICO REG. SCIENT: PARIS; LONDIN: BEROL: ET UPS: SOCIO.

Gratam arripio occasionem testandi devotum animum in Fautorem quem præ mortalibus omnibus magni facio ob candorem, amicitiam, plantas numerosissimas et denique ob scientiam in arte nostrâ summam, quem omnes hodierni Botanici principem agnoscunt.

Tua in me amoris testimonia quotidie mihi in horto obvia sunt, virent et florent absque intermissione et mihi refricant memoriam generosissimi Fautoris. *Tournefortia caule volubili* propediem florebit, cujus racemi nuper pulchre enati sunt, et mihi dabunt flores antea nunquam visos, ut taceam alias infinitas.

Dalibardi Flora Parisina,* Tui in me amoris summum testimonium, mihi in manus pervenit. Ibi exposuisti et declarasti animum quem nullus, nisi pater in unicum filium offerret. Alii omnes lucubratiunculas meas invito dente et malevolo rodunt; Tu solus candidissimus pro more Tuo, fuisti: Hujus testimonii memor vivam dum vixero, nec ulla rerum vicissitudo me a tuâ devotione removebit.

Illa flora me excitabat ut mox inciperem edere observatiunculas meas, sub *Philosophiæ Botanices* titulo, in qua explicavi Fundamenta mea Botanica; 14 philyræ impressæ sunt, ut libellus intra mensem e prelo prodibit. *Iter* meum *Scanense* † sudat etiam hoc tempore, sed linguâ suecicâ; jubentibus sic superis.

Phénomènes périodiques), ædificii communis e lapidicinis variis extruendi fundamenta, singulis annis a 1840 (in Actis Acad. Bruxell.) seriem Observationum, tum propriarum, tum communicatarum, edere non destitit.

* *Floræ Parisiensis Prodromus, ou Catalogue des Plantes qui naissent dans les Environs de Paris ..... arrangées suivant la Méthode Sexuelle de M. Linnæus*, par M. Dalibard. Paris. 1749. — Quo modo Dalibardi opus amorem Bernardi erga Linnæum testatur non poterat intelligi. Ænigma solvit excerpta e Bæckii epistolâ (Mai. 1750) sequens linea: "*M. Linnæus m'écrit que M. de Jussieu a publié une Flora Parisiensis sous le nom d'un autre.*" Bernardi in epistolâ responsoriâ censura paternitatem respuit operis, quod Linnæus, suo systemati consentaneum, minus severe judicaverat.

† *Skänska Resa, på Höga Öfverhetens Befallning förrättad år* 1749. *Med Rön och Anmärkningar uti Oeconomien, Naturalier, Antiquiteter, Seder, Lefnads-sätt.* Stockholm. 1751.

Misi Dissertationes meas *Splachnum* et *Semina Muscorum*, non dubito quin in manus tuas venerint.

Vidisti procul dubio *Vianelli tractatum* de Polluce et Castore s. *de aquâ marinâ* noctu lucente ab insectis caussatâ ; Tu Lynceus posses solus nobis detegere characteres hujus insecti et genus, quod, ut facias, ex animo precor.

Schieræ Dissertationes duæ Mediolan. 1750. *octavo*, quorum altera *de sexu Plantarum*, altera *de Plantarum affectione ad perpendiculum* nuper in manus meas venit.

Hasselquist, discipulus meus, qui petiit Palæstinam varia curiosa ad me rescripsit Smirnâ et Chio, misit *Cornucopiæ* exsiccata specimina, ejusdem promisit semina ; nuper literas dedit Alexandriâ, hodie Cairo versabitur ; si redeat mihi multas ab eo promitto plantas.

Kalmius noster, qui in Virginiâ versatur, alter meus discipulus, redibit ad finem anni ; multa, ut scribit, collegit in Canadâ et Virginiâ, de quibus rescripsit ; misit semina novi generis dicti *Gallisoniæ*,* a vestrate præfecto Canadæ, qui plurima ipsi officia præstitit ; sed semina non germinabant ; ex flosculo sicco incluso, intellexi plantam generis esse *Swertiæ ;* collegit enim Stellerus et Gmelinus eamdem omnino plantam in Sibiriâ ; refert planta Gentianam 3 Dalibardi ac ovum ovo, sed floris structura est Peloriæ, 5 corniculis caudatâ corollâ, adeoque vere singularis.

Pereunt apud nos *Equi* ex plantâ quam edunt siccam in fœnis et vocant rustici non modo plantam sed et morbum *stäkra ;* dudum intellexi *plantam* esse *Phellandrium*, sed miratus quî fieret, quod equi non perirent ubique, sed tantum in certis provinciis ; tandem mihi innotuit caussam mali equorum caussari ab insecto quod habitat intra caules Phellandrii et est Curculio primus Faunæ.†

In Hordeo apud nos sato, dum trituratur sæpe $\frac{1}{3}$ a $\frac{1}{5}$ pars dat grana tabida, lævia et inania ; nuper observavi hæc grana, licet integra, destructa esse a vermiculo muscæ minutissimæ, quod eorum substantiam interne erodit.‡

Quæso mittas mihi aliquot semina per DD. Aurivillium Bibliothec : nostr. ; ille ut nullus dubito, semina per tabellarium mox transmittet.

Coriariæ	Gundeliæ	Anrederæ
Bocconiæ	Morinæ	Sphæranti
Veratri	Coris	Boerhaviæ

* Le Marquis de la Gallisonière.

† *Curculio Phellandrii*, L. — Consul. *Noxa Insectorum* in Amœn. Acad., Vol. III. p. 357.

‡ *Musca Hordei*, L. — Consul. Act. Stockh. 1750, p. 182, et Amœn. Acad., Vol. III. p. 354.

Turneræ	Hydrophylli	Osyris
Collinsoniæ	Frankeniæ	

si modo habeas et supersint abs Tuo incommodo.

Vive artis nostræ decus diutissime; Devota mea dicas officia Illustrissimo Raumurio (cui grates pro libro de pullitione), Mad. Bassaport, Laserre. Vale.

Dabam Upsaliæ, d. 10 Augusti, 1750.

ILLUSTRISSIMO BOTANICO

DD. BERN. JUSSLÆO,

S. Pl.

C: LINNÆUS.

Discedente alumno medicinæ et præprimis Chirurgiæ ad vestras beatas terras, non possum intermittere testari gratum animum in Amicum, quem præ omnibus colo et magni facio.

Mitto una simul Poam viviparam Fl. Lapp. 79. *β.* ex alpibus Lapponicis, quod apud nos in Horto læte germinat, et perennat necnon seritur, modo terra sit humidiuscula postquam fuerit satum seminibus vel potius propaginibus non exsiccatis. Gramen hoc non est proliferum sed vere viviparum, nec in folia excrescunt glumæ, sed semina. Propagatur omnino more muscorum; cui simile in herbis non vidi præterquam in graminibus alpinis.*

Nuper vidi characterem essentialem Cardiacæ, qui consistit in punctis glandulosis vel globis minutissimis niveis adspersis supra antheras ab utroque latere. Hæc nota obtinet in Cardiacâ vulgari; Leonuro utroque Horti Upsaliensis et Sideritide 1 et 2 Horti Cliffort. Quæso inspicias nudis vel armatis oculis, si non antea vidisti hoc phænomenon, qui omnia vides plus quam Lynceus.

In horto crevêre Veronica prima Fl. Suecicæ † et Verbena vulgaris in eodem pul-

* *Poa alpina, β.*, L. Sp. — Miror mirari Linnæum: nam minus rarus, ut compertum est, in Gramineis monstrosus ille spicularam in ramulos foliosos transitus, præcipue in Pois, non alpinis tantum, sed et nostratibus, v. g. in Poâ bulbosâ, ubi forma vivipara normali frequentior.

† *Veronica maritima*, L. Sp.; hybrida autem filia *V. spuria*, L. Sp. — Ex quo experimento orta Dissertatio (*Plantæ hybridæ*, resp. J. Haartman, Upsaliæ, 1751, et in Amœn. Acad., Vol. III.), ubi tot ingeniosa et meditatione digna, sed simul conjecturæ et ipsæ observationes naturæ leges sæpius prætergressæ, dum auctor plantas genere, imo ordine, diversas et etiam longe dissitas maritari et gignere inter se posse admittit. Itaque miratur et *novum in naturâ spectaculum prorsus stupendum* declarat in epistolâ responsoriâ Bernardus.

villo per plures annos. Juxta hos mihi hoc anno enata est planta hybrida, quæ agnoscit Veronicam matrem et Verbenam patrem. Ita similis est Verbenæ ut demtis floribus vel maxime Lynceus ipse DD. Jussieu juraret esse Verbenam; at flores omnino sunt Veronicæ, at corollæ non majores corollâ Verbenæ; cætera Veronicæ omnia, ut pistillum, stamina. Folia in caule plerumque duo opposita, sed summa folia infra spicam terna sunt ut in Veronicâ. Folia lata sunt ut in Verbenâ; similiter secundum vasa sulcata et singulari modo laciniata uti Verbenæ, ut demtis foliis nullus distingueret folia a Verbenâ. Floruit egregie hoc anno, et Glaux et Veronica et Verbena juxta positæ fructus maturabant, hæc planta tamen fructum non maturavit, sed germina non majora quam in flore, contabescunt; at radix vivax esse videtur; nescio utrum unquam exstitit par exemplum de certitudine plantarum hybridarum, earumque existentia.

His vale et fave tuo cultori.

Dabam Upsaliæ 1750 d. 12 Sept:

ILLUSTRISSIMO BOTANICO

DD. BERN. DE JUSSIEU,

PROFESSORI PARISINO,

S. Pl. D.

C. LINNÆUS.

Has non mitto literas ut Tibi, Illustrissime Domine, oneri sit tabellarius; sed ut tester continuo quanti Te faciam, et ut fungar officio, quum me receperis correspondentem Regiæ vestræ Academiæ.*

Quum nihil habeam hac vice quod scribam ex propriis observatis, mittam quæ discipuli mei detexêre, quorum unus *Kalmius* in Virginiâ hærens, alter *Hasselquist* in urbe Cairo Ægypti, tertius nuper petiit Chinam nomine Osbeck.†

* Dum Lutetiæ, imo Academiæ, adesset, fuerat electus ut ipse narrat in Diario: "*On the 14th of June* (1738), *Linnæus requested Du Fay, at that time chairman, to obtain permission for him to attend the Academy of Sciences; when the sitting was over, Linnæus was told to wait a little while, and was afterwards informed that the Academy had chosen him a corresponding member.*"

† Petrus Osbeck, præpositus et pastor in Hasslöf, historiæ naturalis studio impulsus, capellani munus in nave Suecicâ suscepit Chinam petente, quam invisit, ut et Indiam, Javam et Ascensionem insulas. Multa inde, post tres annos redux, reportavit et Linnæanum herbarium sexcentis plantis ditavit, quorum multa serius (1757) nota fecit in narratione itineris (*Dagbok öfver en Ostindisk Resa åren* 1750–1752), cujus versiones prodiére, Germanica (1765) et ex præcedente Anglica (*A Voyage to China and the East-Indies*, 1771) auct. J. R. Forster.

Hasselquist scripsit Cairo d. 7 Septembris quamplurima quæ naturalem historiam concernunt; misit antea descriptionem avium nonnullarum, et historiam *Sepiæ octopodiæ* dictæ, quo modo insidiatur *Conchæ Pernæ* s. *Pinnæ* dictæ, nisi *Cancer Pinnotheres* ejus custos esset, et sic confirmavit historiam antiquam Aristotelis et Plinii. Misit historiam *Phœnicis s. Palmæ*, sed in ultimis varia habet alia egregia.

*Cycomorus** gaudet duplicis generis calycibus. Receptaculis aliis scilicet exsuccis, aliis succulentis et esculentis. Esculenti fructus sunt masculi, at vero hermaphroditi exsucci contrario modo ac cum Ficu, quod mirum.

Habet et Cycomorus proprium insectum s. Tenex, quod est species Cynips.

Descripsit *Tæniam* Ægyptiorum eorumque *Ophtalmiam* et *Scabiem.* Pulchra habet de *Gummi arabico* contra famem. Docuit *Sal ammoniaci* confectionem apud Ægyptios, negatque dari naturale tale.

Habet *Casuarium minimum griseum.*

Formicam minimam, corpore globoso, antennis longissimis, unam ex plagis Pharaonis, ut et *Cancrum cursorem Bellonii* descripsit; nec non varia novi generis insecta.

Lapides, plantas, Quadrupedia Ægypti annotavit. In his video Cerastem et Jaculum esse species anguis, nec Colubri, in Ceraste Alpini dentes caput egrediuntur. Duodecim nova genera Piscium habet.

Integram et perfectissimam descriptionem *Camelopardalis* et *Mimosæ* cujusdam Actis Upsaliensibus inseram una cum Mure ægyptio.

Mus hic refert Leporem capite, Suem rostro, Murem corpore, Leonem caudâ. Pedibus anticis nunquam terram attingit, sed semper salit pedibus posticis, quorum etiam femora nuda sunt. Anterioribus pedibus vero, solum aquam haurit dum potat. Inter quadrupedia maxime singulare animalculum.

Permanebit in Ægypto in proximum ver, tum vero Palæstinam petat.

Kalmius autem noster redibit ex Americ proximo vere. Ille detexit nobis stupendam medicinam, specificum scilicet Indorum sylvestrium contra luem veneream, quam extollit tanquam medicamentum nunquam incassum propinatum; ut eo ægri semiputridi e lue intra 10 vel 16 dies perfecte curati, absque incommodo absque dolore; dum e contra quamplurimi methodo usitatâ mercuriali sæpe diem curantur dolorifice, pereunt sub curâ. At vero novum medicamentum curat absque recidivâ, absque dolore, absque difficultate, absque ullâ fere observatione in diætâ. Certe si Helvetius vester hanc medicinam detexisset, integros auri montes a rege vestro reportasset. Est hæc medicina radicis *Ceanothi americani* infusum, cui additur, si morbus sit nimis radicatus, radix *Ranunculi fol. subrotundo virginici, flore parvo.* Herm. Lugdb. 514.†

* *Ficus sycomorus*, L. Sp.

† *Ranunculus abortivus*, L. Sp.

Hoc infusum s. debile decoctum hauritur mane, vacuo ventriculo, si vero purgat tum insequentibus diebus parciori dosi et debiliori infuso. Radix Ranunculi tamen parcissime addenda, cum illa ventriculo infesta sit.

In debiliori morbo sufficiunt solæ radices *Lobeliæ secundæ Hort. Cliff.** in infuso s. decocto, non diu decocto, et quotidie pro potu ordinario poto.

Confirmata observationibus legi cum stupore, hæc videas graphice ab authore descripta in Actis Stockholmiensibus.

Quæso et supplex quæso mittas mihi semina istius Lobeliæ, ut habeam in horto; non dubito quin ea secum ducat Kalmius, sed forte sero nimis accedat, ut semina vix germinent.

His vale et fave. Dabam Upsaliæ, 1750.

ILLUSTRISSIMO CLARISSIMOQUE VIRO

D. D. CAROLO LINNÆO,

BOTANICES PROFESSORI UPSALIENSI CELEBERRIMO,

S. P. D.

BERNARDUS DE JUSSIEU.

Annis proxime elapsis semina habui quamplurima, quorum amplissimam copiam e Peruviâ miserat frater carissimus, eheu nondum redux! Aliam segetem uberrimam subministravit ex Africâ D. Adanson, de quo scripsi olim cum Senegalam peteret; alteram non mediocrem collegit vir apostolicus P. D'Incarville† jesuita circa Pekin Sinarum metropolin. Ex his omnibus selegi quæ recentiora erant, aut quæ jam a

* *Lobelia siphilitica*, L. Sp.

† Is scientiarum curiosus nec imperitus et Academiæ Parisiensis corresp. socius, ex imperio Sinarum tunc Europæis tam ægre pervio, commercium litterarum ab anno 1741 ad 1755 habuit cum Bernardo de Jussieu, ad quem varia naturæ et artis Sinensis producta, præsertim plantarum specimina, semina, icones, libros transmittebat. Epistolas ejus plus quam viginti possidemus, cum catalogis, descriptionibus, observationibus variis, et, inter alia, herbariolum circa urbem Peking collectum, ubi specimen plantæ hujus Bignoniaceæ ex quo genus Incarvillea ab A. Laur. de Jussieu institutum. Cæteras enumerare et describere in florulam digestas animus erat; sed abstinuimus cum plerasque easdem notas fecerit in Act. Academ. Petropolitanæ cl. Al. Bunge (*Enumeratio Plantarum quas in Chinâ boreali collegit.* 1832). Notanda in hâc florâ Pekinensi, quæ ad geographiam botanicam tanti intersit, quædam hinc cum Europæanâ affinitas, inde cum Boreali-Americanâ; cujus cæterum nunc, semireseratis Cœlestis Imperii prius undique clausi ostiis, notitia plenior expectanda.

plantis in horto regio educatis maturuêre semina. Utinam hæc opum nostrarum pars opima sit tibi jucundum nostri erga te studii et gratæ recordationis testimonium!

Vianelli vermes in aquâ marinâ noctu lucentes vel potius scintillantes nunquam observavi. Proposita ab authore figura indicat hos esse minutissimas Scolopendras, seu Nereides a te nominatas, quas iterum recognovit et microscopii ope accuratius delineavit Griselini alter Italus. Ab illis animalculis lumen per æquora sparsum et late diffusum proficisci dixerunt nonnulli physici, et ab aliâ causâ oriri nuperrimis observationibus et experimentis demonstravit juvenis medicus Le Roy Parisiensis, scilicet a materiâ quâdam *phosphorinâ* aquis immixtâ marinis. Hanc opinionem tueri videntur, æstuantes maris fluctus lucidi, ampla illius superficies noctu sæpe fulgens, vestigia navium corusca, ipsam navem circumfluentes undæ radiosæ, remigia quorum pars immersa splendet emersa, aqua marina cum in tenebris effunditur quasi lumine plena, tandem linteum guttis ejusdem aquæ irroratum, postea manibus siccatum, per spatia irradians, etsi prius in illâ aquâ nulli fuerint detecti vermes vel cujuslibet generis insecta. Curiosam hac de re coram Academiâ Regiâ Scientiarum legit dissertationem. Donati historiam Maris Adriatici non novi; quæso quo prodierit anno, titulum hujus operis, et quâ in urbe editum, inde protinus comparabo, et dicam si fuerint recte depicti vermes Corallii.

Spica florum quam habuisti a Sueco e Parisiis reduce, est Phytolacca Americana, in horto dudum culta. Stamina numero sunt triginta et amplius, styli vero quinque; hinc polyandris pentagynis annumeranda, singularis admodum species, quæ tantopere distat a constituto caractere. Sicca specimina vidisti in nostro Musæo et hanc plantam vocabas, Phytolacca caule arboreo; a Plumerio nec descripta nec observata, licet calidas Americæ regiones habitet, sed ditionis Hispanæ.*

Diversum a Lonicerâ reposcit genus Chamæpericlymenum Canadense, seu Baccifera Mariana, etc. Pet. Mus. 363, nec ullum cum Linnæâ habet consortium.† Titulis aliis insignita a Coffeâ in ordine naturali non longe recedit, simulque Galii, Rubiæ, Crucianellæ, etc. prosapiam ingreditur. In Horto Regio floruit quondam et brevi periit. Plantam virentem fructus et specimina sicca ab amico Regis conciliario et medico ‡ in

* *Phytolacca dioica*, L. Sp., sæpe in hortis *arborea* salutatur.

† Recta de hac plantâ Bernardi sententia, in quam ivit Linnæus in dissertatione paulo post editâ (*Nova Plantarum Genera*, resp. L. J. Chenon, Upsaliæ, Oct. 1751, et in Amœn. Acad., Vol. III.), ubi sub nomine *Mitchellæ repentis* species novi generis instituitur.

‡ Sarrazin cui genus *Sarracena* ab amico Antonio de Jussieu in *Appendicibus ad Tournefortii Institutiones Rei Herbariæ* (anno 1719) sacratum. E Canadâ, quam jamdudum, ut hæc data testatur, colebat, missarum ab ipso plantarum catalogum habemus manu Antonii ipsius scriptum. In quibusdam libris (e. g.

urbe Quebec Novæ Galliæ expostulavi, quæ omnia versus hujusce autumni finem accipiam, et protinus tibi mittam; nostra enim specimina floribus destituuntur, aliunde figura delineata a D. Aubriet imperfecta adhucdum superest.

Nata in horto Upsaliensi hybrida est vere singularis progenies, quæ si felices habuerit eventus, prolemque dederit fertilem, novum erit in naturâ spectaculum prorsus stupendum, unde generis alterius a mutuo diversarum plantarum concursu facile demonstratur procreatio; quod mirum et huc usque inauditum, in solo vegetabili regno forte obvium.

Præclara sunt ea quæ invenit, observavit et descripsit tuus discipulus D. Hasselquist, curiosa quæ de Sycomori floribus narrat, a te edoctus plura videbit quæ ceterorum oculos effugissent; varia scitu digna Actis Upsaliensibus inserenda polliceris, quamprimum ut facias rogo et obtestor.

Kalmius alter discipulus pretiosam ex Americâ mercedem tibi renuntiavit, specificum Indorum sylvestrium adversus luem veneream, medicamentum nobile experimentis et observationibus sæpe confirmatum, cujus vires eximiæ probantur facili medicatione, et promptâ morbi hujus curatione, optandum. Superest ut eosdem salutares apud nos sortiatur effectus, medicina ægris tantopere utilis.

E gemmis arborum quo die prodierint folia sedulo annotabo, sylvestrium præcipue arborum, uti mones et desideras. Eodem modo hordei seminati et resecti diem observabo. Hoc fiet anno. Alia si a me cupieris, scribas velim, me semper reperies ad vota tua exequenda paratissimum. Non vidi Cardiacæ caracterem essentialem, globulos nempe illos minutissimos niveos supra antheras ab utroque latere aspersos; cum primum florebunt species hujus generis a te designatæ, huic indulgebo spectaculo. Floræ Parisiensis Prodromus Dalibardi incuriam ostendit, erravit enim non semel in illis quæ a te mutuatus est; sed nihil mirum cum in re herbariâ sit parum versatus. Neminem consultum voluit, ne quid forte gloriæ detraheretur, quam lucrari autumavit tuis sic et aliorum spoliis indutus.

Methodus quâ spiritus vini coercetur ne avolet descriptam a D. Daubenton reperies in Præfatione Historiæ Naturalis Cymelii Regii,* vol. 3°, et a D. Reaumur in eo volu-

Boehmeri Comment. de Plantis in Memoriam Cultorum nominatis) falso confunditur cum cognomini docto Dioscoridis interprete (anno 1598) Jano Antonio Sarazin Lugdunensi, qui tamen sæculo et ultra antecessit; ex quo Sarracenam dictam affirmat, per alium errorem, cl. Wittstein in opere recentiori (*Etymologisch-botanisches Handwörterbuch*).

* *Histoire Naturelle du Buffon.* Voluminis hujus prior et dimidia circiter pars a cel. Daubenton redacta inscripta est: *Description du Cabinet du Roy*, et ulterius *Description de la Partie du Cabinet qui a Rapport à l'Histoire Naturelle de l'Homme* in quâ documenta hic indicta continet caput (p. 171 – 210) *Pièces d'Anatomie conservées dans les Liqueurs.*

mine Actorum Academiæ Regiæ Scientiarum quod prelo subactum mox tradetur curiosis. Quidquid hac de re tentatum fuit et comprobatum a pluribus annis uterque seorsim declaravit; artem hanc melius ab authoribus accipies deprômptam quam si tibi illam brevi compendio enarrare susciperem.

Schieræ dissertationes nondum apud nostros bibliopolas prostant et sero venient. Quas vero misisti varias et multiplices accepi, Philosophiam Botanicam, Acta Upsaliensia, et alia bene multa. Vigent Poa vivipara et Chamærubus; qui hæc attulit simul semina tradidit. Pro tot donis grates amplissimas refero, et vix spero posse me unquam collata erga me beneficia tua æquare.

Quæ de Calamistri floribus scripsisti legere aveo, et figuram videre tuo junctam Itineri Scanico. Causam morbi equorum lethifici detectam a te didici, necnon hordei exesi et evanidi. Sic me edocere semper allaboras ubi primum quamlibet rem e tenebris eduxisti; sic se prodit tuus in me ubique amor.

Axyridis et Napææ nova genera placent. Linaria scoparia gaudet floribus hermaphroditis. Grata fuere plantarum vestræ Lapponiæ a D. Montin oblata.* Fac quæso ut me agnoscat istius munificentiæ memorem. Ingratus rediit Missa. Quomodo se gesserit in Sueciâ et apud Batavos ignoro; vidi solum modo propositum Novæ Materiæ conspectum ab illo editum Amstelodami; sed ridiculum. Accessit bis apud me, siluit de suo itinere, totum se praxi medicæ vovere jactitat, et quasi novus homo fugit quos coluerat antea et amicos et collegas. Nulla verba de te fecit. Ille laudat, ut audio, Hallerum, Bæckium, Burmannum, Royenum et alios medicos, cum quibus familiaritate conjunctum esse dicit.

Si volueris novum quid deinceps mittere, uti poteris benevolentiâ D. Bæck aut D. Salvii, qui ambo curabunt deferri ad D. Delaisemant pharmacopæum, vel ad D. Dangerville, Rothomagi, et tuto res quæcumque venient. Optarem ut Salvius Systematis Naturæ exemplaria nonnulla Parisiis divenderet; hujus editio Lipsiensi anteponenda est. Salutat te frater meus. Diu vivas artis nostræ decus. Te semper colere amant D. Laserre et D. Basseporte. Me vero diligere ne desinas, et inter nos vigeat perpetuum idem et mutuum studium. Vale.

Dabam Parisiis die 19ª Februarii anni 1751.

* Vide supra, not. * ad p. 206.

ILLUSTRISSIMO BOTANICO

DD: BERNH: DE JUSSIEU,

PROFESSORI PARISINO,

S. Pl. D.

CAR. LINNÆUS.

Mitto aliquot semina lecta præterito anno in Virginiâ a discipulo meo D. Kalmio. Non potui non hæc communicare cum scientiæ nostræ antesignano, cui debeo præ omnibus delicias horti Upsaliensis. Vale.

Dabam Upsaliæ d. 12 Martii 1751.*

VIRO ILLUSTRISSIMO

DD: BERN. DE JUSSIEU,

PROFESSORI BOTANICO PARISINO,

S. Pl. D.

CAR. LINNÆUS.

Pridie accepi Tua dona, Vir illustris, mihi omni auro chariora. Stupefactus vidi semina plantarum rarissimarum, quæ antea a me nunquam lectæ fuêre. Utinam germinarent. An Dalechampia uuquam creverit in vestro horto; si creverit quæso des mihi exsiccatum specimen.

Nequeo satis mirari cur non frater tuus junior redeat. Expecto eum anxie, qui detegat innumeras novas plantas.

Ego qui non habeo plantas rariores, misi pauper bono animo semina qualiacunque possidebam, per legatum vestrum, unde nullus dubito quin hæc tibi rite sint tradita.

Pulchra et docta retulisti de Vianelli vermibus; dies dabit quodnam sit verius.

Donati titulus est *Della Storia naturale marina dell' Adriatico*, Saggio del Signor Dottore *Vitaliano Donati* giuntavi una Lettera di Signor Dottore *Lionardo Sesler* intorno ad un nuovo Genere di Piante terrestri. In Venezia appresso Francesco Sorti. M.CC: L. 4° majori. pag. 81. tabulæ 10.

Ejus novum genus *Vitaliana* est *Sedum alpinum Fr. Gregorii Regiensis. Columm. Ecphr.* 63 † sed forte est tandem species Androsaces.

Miratus diu e quâ plantâ erat spica a Te missa quondam. Nunc vero intelligo hanc

* Hujus litterulæ jam editum fac simile in Guillemin *Archives de Botanique.* I. p. 185.

† *Primula Vitaliana*, L. Sp.

esse novi generis plantam,* media inter Saururum et Phytolaccam. Nequit hæc esse species Phytolaccæ ob numerum, alioquin conjungerentur Ruta et Peganum, Evonymus et Celastrus; non minus peccarem si conjungerem diversa genera, quam si separarem in plura genera generis hujusdem species.

D. Missa dixit Loniceram canadensem adeo exacte referre Linnæam, ut crederet esse ejusdem generis non tantum, sed et speciei; nunc autem novi plantam, Loniceram Gron. Virg. 22. quæ est

Chamædaphne, Mitchell Eph. n. cur. vol. octavo app. n. 15.†

Cal. *Perianthia* bina, disjuncta, quadridentata, erecta, eidem germini insidentia.

Cor. monopetala, infundibuliformis: *Tubus* filiformis; *Limbus* quadripartitus, erectus, acutus.

Stam. *Filamenta* 4, filiformia, erecta, ex intersticiis corollæ. *Antheræ* oblongæ, acutæ.

Pist. *Germen* orbiculatum, didymum, infra receptaculum.
Stylus filiformis, longitudine corollæ, bifidus.
Stigma quadrifidum, patens, magnum.

Per. *Bacca* globosa, bipartita, umbilicis disjunctis.

Sem. singulis loculis 4, rotunda, compressa, callosa.

Hybrida mea ex Verbenâ Veronica duravit per hyemem et incipit nunc stolones e terrâ producere plures, ut nullus dubito quin vivat.

Inclusa mitto folia Suecica ex itinere Scanico de *Calamistro.*

Gloriosam esse speciem *Erythronii* non cogitaveram antea, nec bene novi Erythronium, quod non vidi nisi semel et quidem ante 14 annos. Gloriosam esse affinem Uvulariæ, Medeolæ, Asparagi, Smilacis, Tamni, etc. non dubito.

Hasselquistii observationes hac æstate prodibunt. In his etiam habet descriptionem *Mimosæ aculeatæ, floribus polyandris spicatis, legumine compresso* lævi elliptico,‡ Tuæ, ni faller, ejusdem.

Dodonæam Pteleæ accedere stupendum est.

Utinam cresceret ex seminibus tuis *Peltaria Zeilanica.*

Annon vidisti Montii *Aldrovandam*, quæ mira planta est.

Floret nunc in meo horto *Dodecatheon*, planta pulcherrima et amicissima, quæ *Auricula ursi Virginiana. Pluk. Phyt.* 79. *f.* 6 floribus speciosis condecoratur; si accipiam semina, uti nullus dubito, mittam libens, nisi habeas antea. Herba Primulæ, flores Cyclaminis.

* Genus revera novum e *Phytolaccâ dioicâ* institutum, *Pitournia* Moq. in DC. Prodr.

† *Mitchella*, L. Vid. supra, not. † ad p. 216.

‡ *Mimosa Senegal*, L. Sp.

De exemplaribus *Systematis* curabo; gratulor tibi quod te commendatore dignum censeatur.

Discipulus meus *Petr. Lœfling* * hoc vere adibit *Hispanias* botanices causâ, impensis potent. Regis Hispaniæ; a quo minutissimas Hispaniæ plantas expectabimus: est juvenis vere lynceus et ex meis discipulis optimus.

Adansoniæ genus perplacet.† Assumam mox nomen; utinam nossem characterem; si habeas quæso mittas ut inseratur Tuo sub nomine Actis nostris.

In Te hodie Res Herbaria, uti in illustr. *Reaumurio* Sacra Zoologiæ se vertunt et innituntur; conservet hos ocellos orbis Deus ter optimus, in Galliâ decus et scientiarum fulcimentum. Alta scientiarum quies et somnus occupavit jam Anglos, Belgas, Italos, Germanos, Russos, Danos, et cum vestrâ jacturâ aliquando forte Gallos, nisi aliqui e vestrâ scholâ prodeant digni artis filii.

Tu vale et vive felicissime, diutissime et patiare me numerari inter eos qui Te sincerâ devotione colunt, venerantur, amant.

Dabam Upsaliæ d. 28 Martii. 1751.

* Petrus LŒFLING, designante magistro Linnæo, a quo rex Hispaniæ botanicum expetierat qui res naturales hujus regni perquireret, anni 1751 vere profectus, Lusitaniam appulit, quam et Hispaniam explorans ita mandatis satisfecit, ut, ad similia exequenda, in Americam australem (anno 1751) mitteretur. Circa medium Aprilem Cumanæ constitit cujus littora et provinciam usque ad fluvium Orinocum peragravit; sed, anno vix interlapso, febre correptus et consequente anasarcâ præmature periit (Feb. 1756). Linnæus de discipulo quem carissimum et æstimatissimum habuerat, hæc in *Reformatione Botanices*: "*Nullus huic facile erat anteferendus vel amore plantarum, vel solidâ eruditione.*" Et in Diario: "*He was the best of my pupils, and communicated a great many remarkable observations made during his travels.*" Obitum ejus igitur sincere deflevit et memoriam consecrandam curavit, operis litteras ipsius et plantarum tum Hispanicarum tum Americanarum descriptiones exhibentis promulgatione. (*Iter Hispanicum, eller Resa til Spanska Länderna uti Europe och America, förrättad ifrån år* 1751 *til år* 1756, *med Beskrifningar och Rön öfver de markvardigaste Växter utgifren efter dess Frånfälle af Carl Linnæus.* Stockholm. 1758.) Liber extat in linguas Germanicam et Hispanicam versus, et partim quoque Anglicam. (*An Abstract of the most useful and necessary Articles mentioned in Lœfling's Travels through Spain and that Part of South America called Cumana.* Printed with the Travels of Bossu, translated by J. R. Forster.)

† Nomen *Adansoniæ* a Bernardo in Hort. Paris. propositum, jure ut Linnæo sic et cæteris placuit, et omnes adoptavêre, nisi tamen ipse Adanson, obstantibus hinc modestiâ inde peculiari botanicæ nomenclaturæ theoriâ. Scribebat enim ad Bernardum (Aug. 1750): "*L'honneur que vous me faites d'imposer mon nom au calebassier est audessus de ce que je puis jamais meriter. Epargnez je vous prie mon humilité et mon peu de hardiesse pour quelquetems, dumoins jusqu'à ce que j'ai fait quelque ouvrage qui me fasse connaître. L'obligation que je vous ai de toutes façons de vouloir bien penser à un si petit sujet que moi, surpasse tous les termes que je puis employer pour vous en marquer ma reconnaissance.*" Itaque nomen vernaculum, more suo, retinuit et in eximiâ Dissertatione (*Description d'un Arbre d'un nouveau Genre appelé* Baobab, *observé au Senegal.* Mém. de l'Ac. Roy. des Sc. 1761), et in Familiis Plantarum (1763).

Devota mea officia dicas Illustrissimo Reaumurio et fratri tuo medicorum parenti et principi, nec non salutes plurimum D^m Laserre et dulcissimæ meæ Bassaport. Ter vale.

BOTANICO SUMMO

DD. BERNH. DE JUSSIEU,

BENEFACTORI SUMMO,

S. Pl. D.

CAR: LINNÆUS.

Misisti ad me primo vere, pro amicitiâ tuâ in me maximâ, egregium thesaurum seminum rariorum, recentiorum et selectissimorum; pro quibus grates nunquam sufficientes rependere valeo; ut autem intelligas quo modo messis mea successerit, hanc rationem tibi reddam.

Progerminarunt mihi e Tuis sequentes plantæ:

Fagonia; *sed quæ nunquam apud me semina tulit, licet aliquoties floruerit.*

Chicorium creticum spinosum. Egregie crescit; proximo florebit die.

Coris cærulea *floruit.*

Chamæpithys fol. serratis *floruit.*

Frankenia marit. quadrifolia. *Egregie floruit nondum.*

Asperula verticillata luteola. *Eximia planta nunquam mihi visa egregie floruit; an Sherardia?*

Centaurium capite Pini *enatum, sed multoties antea et semper hyeme periit.*

Sinapi siliquis ad ramos adpressis. *Myagrum.*

Eruca hispanica sativæ similis. *Habui hanc unicam antea.*

Astragalus ægyptius. *Floruit et semina dedit.*

Absinthium maderaspatanum: *rarissima planta adhuc floret.*

Dodonæa. *Plurimæ plantæ nobis enatæ sunt; quot quæso ipsi stamina?* forte Ptelea.

Nagacpu Hort. Mal. etc. *Blattaria Zeilanica Hort. Amstel. Floruit sed non dedit semina; est absolute* Pentapetis *species.*

Adansonia seu Bahobab. *Retinebo nomen; utinam scirem characterem.*

Sophora tomentosa. *Crescit bene.*

Licium e Sina. *Crescit.*

Solanum foliis quernis. *Nondum floruit.*

Echinopus. *Propediem florebit.*

Bidens calyce oblongo. *Mira planta, floret.*

Mimosa e Senegal. *Una pl. excrevit.*

Poinciana. *Pulchre crescit ; sed semper hyeme moritur.*

Psoralea corylifolia. *Crescit.*

Lobelia Act. Ups. etc. Lobelia antisiphylitica, *sed teneræ adhuc.*

Bocconia. *Unica planta egregie crescit.*

Cestrum. *Unica planta enata.*

Nicotiana calyce inæquali. Profecto stupendæ raritatis planta. Floruit, non semina dedit.

Nicotiana tubo prælongo. *Floruit et semina dedit pulcherrima.*

Lycopersicum pimpinella sanguis. folio. *Floret sed non dat fructum ; racemi bini.*

Lycopersicum fructu Cerasi rubro. *Dedit fructum.*

Abutilon Lavateræ fr. cristato. *Dedit fructus.*

Malva capsulâ seminis bidentatâ ; rarior planta. *Semina dedit.*

Malva ribesis folio fl. parvo ; rarissima planta. *Semina dedit.*

Alkekengi fl. violaceo. *Eximia planta. Vera Physalis.*

Œnothera fr. brevi tetragono, unico semine. *Certe novi generis. Floret.*

Tot totidem plantis rarissimis auxisti hortum nostrum ; hisce plantis me lautissime excepisti ; excitasti ; vires animumque infudisti.

Inter eas quæ *non germinarunt* maxime doleo et defleo sequentes.

Digitalis acanthoides. — Alsine lotoides. — Digitalis ferruginea. — Coldenia (sed vixerat). — Dalechampia. — Triumfetta. — Camphorata. — Gloriosa. — Genipa. — Achyranthes lanata. — Cephalanthus indicus. — Browallia peruana. — Carica. — Bauhinia. — Pongati. — Portulacæ affinis. — Persicaria Sinensis.

Si apud te succreverit Hottonia Burmanni, quæso mittas ad me in literis plantulam et simul dicas ad quod genus referatur ; examinavi quidem olim plantam siccam cum Burmanno, at specimen antiquum ita exsoletum erat, ut nihil certi inde elici potuerit.

Quæso dicas mihi quot semina Alsine lotoides habeat. An 15 ?

Hac æstate exstruxi vivarium in Horto Academico pro avibus et animalibus.

Leptostachya *Mitchell* s. Verbena floribus reflexis Gron. Virg. et absolute novi generis * planta floret.

Plantæ Catesb. Carol. 2. p. 28 et Pluk. t. 161. f. 3. sunt absolute ejusdem generis novi. Character consistit in corollâ cyathiformi, quæ extus habet 10 cornicula in orbem posita.

* *Phryma*, Linn. (in dissert. supra memoratâ *Nov. Plant. Genera*).

Est mons per horam unicam ab urbe altus et amplus; in hoc monte ante hos annos serui plurima semina plantarum Sibiricarum, quæ nunc ibi sylvestres factæ, egregie luxuriant et se multiplicant, uti nostrates et jura civium Floræ Suecicæ sibi expetunt.

Impatienter expecto reditum desideratissimi fratris Tui, de quo audivi quod sit in itinere constitutus, quod secum habeat plantarum thesaurum stupendum exsiccatum. Quæso, patrone optime, pro me apud eum intercede, ut aliquot mihi det plantas quas in decuplo habeat; more receptum apud omnes nationes est, quod divites et opulentes eleemosynas dent clamantibus pauperibus. Utinam redeat brevi, felix, sanus et incolumis.

Discipulus meus Kalmius rediit præteritâ æstate dives plantarum Canadensium et Pensylvanicarum; alter Lœfling accessit ad Hispanos. Tertius Hasselquist redux ex Ægypto et Palæstinâ adhuc in Cypro hæret.

Kalmii plantas extricare quotidie occupor. Genera inde plura nova reportavi, quæ nunc imprimuntur, et ad te propediem mittam per Legatum vestrum; videbis inter ea varia forte minus trita; Kalmius interea quotidie occupatur in conscribendâ florâ Canadensi, quæ erit satis dives; addet loca natalia et usum tam medicum quam œconomicum, nec non descriptiones rariorum.

Lœflingius occupatissimus est in indagando animalcula marina, Polypos et quæ Coralla constituunt; nec non in Muscorum notitiâ versatissimus est.

Observavi ante aliquot dies in staminibus Ocymi versus basim dentem singularem, qui constituit characterem essentialem, et præsens est non modo in vulgari Ocymo sed et in Zeylanico.

Totam æstatem debui transegisse apud Clementissimam Reginam nostram redigendo in ordinem Museum ejus, quod habet selectissimum, nullis parcens sumtibus modo acquirat rariora. Conchas et Cochleas ejus omnes descripsi; ad genera subalterna reduxi, differentias specificas imposui; varietates speciebus subjunxi, synonyma e Rumpfio, Bonano, Dargenvillo, Gualtero imposui et sic in his puto me aliquid præstitisse, quod antea factum non fuit.

Quo magis istud problema volvo, de plantis hybridis * s. novis plantarum speciebus ortis ex diversis parentibus, eo magis in istâ cogitatione confirmor; nequit hoc latere iis, qui probe plantas examinant, præsertim iis qui hortos possident academicos. Utinam etiam Tu animum hisce impendere velles! Sunt nobis plantæ, de quibus non conveniunt botanici utrum species sint diversæ vel non; varietates non facile alias dicimus, quam quæ colore, odore, sapore, magnitudine, monstruositate solius individui

* Vide supra, not. † ad p. 212.

differunt, et quæ a loco, terrâ, sole, ventis, &c. caussari possunt. Sed sunt et aliæ caussæ occultæ; sunt aliæ varietates constantes non mutabiles, nec restituendæ mutato loco et cœlo. Confer sequentes:

Urtica pilulifera romana — et altera Parietariæ foliis.

Cyanus orientalis luteus — et Cyanus orient. purpureus, albus.

Differunt calyce, radio, semine. Conveniunt toto habitu.

Poterium Pimp. Sanguisorba — et Pimpinella agrimonioides.

Catananche cœrulea — et lutea.

Crista-Galli mas — et fœmina.

Acanthus spinosus — et mollis

Saponaria vulgaris — Saponaria anglica.

Hemerocallis lutea — et fulva.

Verbascum.

Dipsacus vulgaris — Dipsacus perfoliatus.

Insuper Solana Africana, Solana Europæ annua; Quercus Virginicæ; Asteres et aliæ innumeræ; quas dabo in dissertatione de plantis hybridis, ubi hoc non uti evictum proponam, sed ad alios excitandum proponam.

Hisce diebus * prodiit apud Salvium alter tomus Amœnitatum mearum Academicarum, in quâ habentur dissertationes sequentes:

Œconomia naturæ,	Tænia,	Sapor medicamentorum,
Lignum colubrinum,	Senega,	Plantæ Camschatcenses,
Semina muscorum,	Splachnum,	Officinalia animalia,
Generatio calculi,	Gemmæ arborum,	Pan Suecicus.

In Actis Upsaliensibus † habentur Usus Electrisationis in Rheumatismo. — Hasselquist. Descr: Mimosæ Africanæ. — Linnæi Scabiosa corollulis quadrifidis, foliis pinnatifidis, lobis lateralibus erectiusculis, Penthorum. — Hasselquist Camelopardalis descriptio. Mus ægyptius bipes. Turdus solitarius. Fulica. Vipera vera officinarum. Coluber cornutus. Anguis cerastes. Lacerta scincus. Octopodia sepiæ species. — Linnæi Cyprinus pinnæ ani radiis XII. — Gronovii pisces duo: Scomber et Labrax. — Lœfling monoculus caudâ foliaceâ planâ. — Colden, continuatio pl. Noveboracensium descriptionis: dein Astronomica, Meteorologica, Antiquaria, vita O. Celsii.

Ego nunc a die in vesperam ultimam manum addo Museo Reginæ exscribendo, sed præcipue species plantarum conscribendo et enumerando quotquot novi omnes cum

* Hinc constat anni quo hæc epistola data est numerus qui deficiebat, scilicet 1751.

† *Acta Soc. Reg. Scient. Upsaliensis ab Anno MDCCXLIV. ad MDCCL.* Stockholmiæ. 1751.

differentiâ specificâ, synonymo, loco, sub suis generibus. Paucas novi, sed tamen aliquas.

Silent jam omnes Botanici in Angliâ, Belgio, Germaniâ, Russiâ. Tu vitam et animam Gallis das.

Audio Italos varios Florentiis adhuc negare quod animalia caussent corallia; de hoc amplius apud me dubium non est; vidi varios lapides qui id absolute evincunt, et quod majus est omnibus, Tu Lynceus hæc propriis vidisti oculis; Lœflingius pulchre descripsit vermes in Escharæ poris habitantes.

An habeas ullas observationes circa Titanokeratophyta Boerhaavi;* s. rete et flabellum Veneris dictum; et quo modo hoc conficiatur; Crustam tartaream a vermibus oriri facile intelligo; et dicas mihi quo modo substantia cornea?

D. Buffoni opera posteriora expecto avide; ille incipit a cane et equo in naturali methodo. Hoc experimentum sufficit. Vellem modo videre practicum, vidi theoreticum.

Devota mea officia dicas D. Patri Laserre; ille optime servavit oleum, cujus lucerna adhuc lucet proprio oleo. Salutes quæso itidem suavissimam dulcissimamque sponsam D[m] Bassaport; illa nondum mihi dedit fœtum, tamdiu promissum, neque ingenii, neque manus; si posset mihi pingere parvum B. Jussieu in quarto, quem possem Botanicis meis interserere in Musei pariete, mihi daret filium gratissimum.

Scriberem ego sæpius, ni metuerem quod meæ litteræ tibi impensas facerent. Tu poteris, ut audio, ad me scribere absque impensis; quæso millies facias hoc sæpius; nullius mortalis literæ mihi gratiores, instructivæ magis nullæ, et si scribas sub involucro ad Societ. Scient. Upsaliæ, habebo omnes literas gratis; posses tunc interserere plantulam exsiccatam sæpius. Si tu posses dicere mihi rationem, quî ego mitterem absque tuis impensis ego idem facerem sæpius. Non possum oblivisci frustuli illius quod olim misisti et nuper dixisti fuisse Phytolaccam; sed quænam quæso; et quo modo possint tam diversæ conjungi in unum genus?

Quid jam D. Reaumur? quid D. Guettardus?

Studiosus quidam,† informator filii mei, qui olim detexit insectum quod plodit ano et alterum quod cribrat pollinem antherarum, nunc exclusit istud insectum, quod apud nos caussat spicas albas effœtas copiosissimas in agris secalinis; evadit Phalæna; unius ejusmodi vermis intrat sæpe plurimos culmos et infinitam noxam adfert colonis.

* *Gorgoniæ* species Linnæo ipso auctore, sub nomine generico *Plexauræ* distinxit cl. Lamouroux.

† Daniel Rolander, qui in illo præceptoris munere Lœflingio peregrinanti successerat. — Variæ de insectis quas hic Linnæus memorat observationes de Carabo crepitante, Vespâ cribrariâ, Phalænâ pycali, cum aliis relatæ in *Vetensk. Acad. Handling.* nec non *Analect. transalp.*

Sed manum de Tabulâ ; dies mihi deficeret, priusquam desiderium tecum loquendi. Devota officia dicas venerando fratri tuo, artis nostræ seniori. Det ipsi Deus T. O. tranquillam viridemque senectam. Cum redierit junior frater quæso ipsi dicas mox mea officia et vota pro ejus felicitate.

BOTANICO SUMMO

DD: BERNH. DE JUSSIEU,

BENEFACTORI COLENDISSIMO,

S. Pl. D.

CAR. LINNÆUS.

Quamvis nihil habeat pauper, quod non ditissimus possideat, attamen ut tester gratissimum meum animum, mitto hæc quæ præterito anno, reduce ex Canadâ Kalmio, accepi semina; nomina adposuit Hortulanus ea, sub quibus nobis tradita fuêre. Spero quod hæc quæ ad hortum spectant non solvantur a Tuo ærario, sed ab horti; sin minus ea nunquam ausus fuissem mittere. Hac datâ occasione a Te mihi veniam expeto interrogandi de plantis quæ mihi maximum facessêre negotium, et quum habeam modo unicam ad manus, eamque a Te missam, hæreo de reliquis. Sunt hæ:

α. Hibiscus inermis foliis serratis: inferioribus ovatis integris, superioribus trilobis. Hort. Cliff. 350 cum synonymis Fl. Zeyl. 262.

β. Hibiscus inermis, foliis serratis: infimis indivisis: mediis bipartitis: summis quinquepartitis. Roy. Lugdb. 359.

γ. Hibiscus foliis palmato-digitatis quinquepartitis: laciniis lanceolatis; caule aculeato. Fl. Zeyl. 268.

δ. Alcea benghalensis spinosissima, acetosæ sapore. Comm. Hort. 1. p. 35. t. 18.

Me quæso instruas num hæ quatuor inter se sint satis distinctæ, an eædem et tantum varietates.* Vel si diversæ quibus notis distinguendæ? Mihi videntur multam habere affinitatem, nec notæ a me datæ dum olim eas videram mihi ipsi sufficiunt.

Servet te Deus T. O. in Rei botanices ornamentum et sustentationem; mea officia dicas venerando parenti tuo, artis amabilis Seniori et Botanicorum antesignano; nec-

* Easdem ipse distinxit, quæ sunt: *Hibiscus Sabdariffa, α et β*; *Cannabinus; Surattensis.* L. Sp.

non plurimum valere jubeas amicissimæ virgini D. Bassaport necnon amicis et fautoribus reliquis.

Quod jam fit de vestro Buffon; expecto avide Museum regium in naturâ; præfationem audivi et vidi; sed quid magis.

Opto tibi, vir colendissime, florentissimam æstatem et herborisationes impluvias; ego Tui in meis nunquam obliviscar cum meis sociis.

Dabam Upsaliæ die 14 Martii 1752.

ILLUSTRISSIMO BOTANICO

DD. BERNH. DE JUSSIEU,

BOTAN. PROF. PARISINO, ETC.,

S. Pl. D.

CAR. LINNÆUS.

Festus mihi est dies quotiescunque liceat literis Tecum, Benefactor Summe, loqui; fieret hoc sæpius si modo scirem quâ ratione possem ad te scribere absque tuis impensis per tabellarium. Mihi enim res salva est. Ignoscas, artis nostræ Præsul, quod his Tibi sim molestus. Accepi nuper plantam e Finlandiâ quam videre fastidio, ignoto genere proprio; novi quantus Tu sis in omni naturæ ambitu, et quod tibi nullum sese subducat minutissimum vegetabile. Planta quam tuo subjicio nunc judicio est lecta in horto Finlandiæ, suâ sponte nata in pulvillo juxta alias plantas et videtur esse planta vernalis; rudi homines legerant in Horto isto plantas et ad me misêre, quarum radicibus, ejusque annexæ terræ, hæc plantula inhærebat; nescio utrum sit muscus vel Herba; flores non obtinui, nec obtinere possum. Si in aquis cresceret credidissem fuisse Subulariam, licet nec hanc omnino exprimat. Mihi videtur esse admodum singularis planta.*

D. Lœfling dudum Hispaniam attigit, observat plantas minutissimas; reperit *Alsinem spuriam pusillam repentem fol. Saxifragi aureo. Raj. Syn.* 352. *Pluk. Phyt.* 7. *f.* 6.† quæ copiose crescit in Hispaniâ et Lusitaniâ; nescio sub quo nomine nota aliis Botanicis, qui peragrarunt eadem loca. Multa habet cum Veronicâ communia, a quâ abunde distinguitur corollâ quinquepartitâ, staminibus 4 per paria approximata et 2 breviora.

* Litteræ specimen plantulæ obscurioris insertum adhuc inest, quod nihil aliud videtur nisi Scirpulorum germinantium (*Scirpum acicularem* crediderim) fasciculus, foliis primis jam evolutis, testis tamen seminum apici cotyledonum exsertarum adhuc adhærentibus.

† *Sibthorpia Europæa*, L.

Floruit apud nos *Lysimachia lutea angustifolia, flore minore. Pluk. Alm.* 285. *t.* 202. *f.* 7. *an?* planta altissima biennis flore primo die albo, dein rubro, fructu facie Seminis Fagopyri, sed tetraedro, quadriloculari, monospermo nec dehiscente.* Si non habes mittam Semina copiosissima spectatissimæ plantæ et biennis.

Buffoni liber a nonnullis nostratum admiratur; Chemiæ professor noster in scholis nostris resuscitavit Generationem æquivocam, quam demonstrat ex authoritate summi Buffoni; negat strenue Corallia oriri ex animalibus, sed Lœfling nuper misit ad Acad. Holmiens. observationem de duobus Coralliis cum eorum animalculis et methodam eorum fabrificandi corallia, tamen negat Vallerius, quæ tu primus tam solide demonstrasti, Itali et alii confirmarunt; ego rideo ejus inscitiam.

Lœflingius noster plurimum laudat D. Godin † vestratem, cujus favore multoties usus est apud proceres Hispaniæ; si nunc sit Parisiis, quæso nomine Floræ ipsi grates agas, quod [eam ?] ejusque genuinum filium tanto amore et favore prosecutus sit.

Duas Dissertationes *de novis plantarum generibus* et *de plantis hybridis* mittam mense Martio una cum Seminibus quas possideo.

Hisce diebus periit Bocconia a Te præterito anno missa, nondum flores proferens, meo insigni cum dolore.

Infinito desiderio expecto fratris Tui junioris reditum; utinam de ejus felici accessu me primum participem redderes. Utinam meæ per Te preces efficerent ut aliquot in duplo plantas mihi daret.

D'Isnardi herbarium ‡ publicâ auctione, ut intellexi, ante aliquot annos divendebatur; sed ille qui emerat vellet idem divendere, procurare possem ipsi pecunias, modo non nimis enormes.

Accepi heri supplementa *Materiæ Medicæ D. Geoffroy* in quibus tua ubique lucet sapientia,§ pro quâ tibi grates agimus omnes.

* Ex breviori descriptione planta est Onagrariea; e characteribus fructûs Gauræ species; ideoque ab icone citatâ Plukenetii, quæ potius Ænotheræ, diversa.

† Ludovicus Godin Acad. Reg. Sc. Paris. socius, unus ex astronomis in Peruviam missis (vid. supra, not.) et clarissimorum Bougue et Lacondamine docti laboris particeps, anno tantum 1751 remeavit, sed conditione post productam diutius absentiam in patriciâ non sufficiente, in Hispaniam migravit scholæ nauticæ Gaditanæ præpositus, ubi post annos circiter decem, Galliam jamjam rediturus, obiit.

‡ Vide supra, not. * ad p. 186.

§ Stephani Francisci Geoffroy *De Materiâ Medicâ Tractatus* volumina tria Latine prodierant anno 1741, et mox versio ab Ant. Bergier Gallica. Idem, post obitum auctoris opus persecutus est (*Suite de la Matière Médicale de M. Geoffroy*, 1750), cujus in præfatione legitur: "*Un illustre médecin, M. Bernard de Jussieu, nous a aidé de ses lumières et a bien voulu revoir notre travail. Ainsi c'est en partie à ce savant naturaliste qu'on doit l'ouvrage qui parait dans le public; nous lui en cedons avec plaisir toute la gloire, et nous nous bornons à la satisfaction d'avoir tâché de nous rendre utiles.*"

Typographus quotidie expectat *Kalmii Itinerarium per Canadam, Pensylvaniam,* etc.: quod totum contineat res naturales in triplici naturæ regno observationibus certe copiosissimis.

Annon aliquis Botanicus sequutus est astronomum vestrum qui petiit Caput b. Spei?* Certe ista terra scatet plantis inter omnes maxime singularibus.

Audio *Hernandez herbarium* adhuc servari Matriti in bibliothecâ regiâ et satis bene conservatum, ut mihi retulit Lœfling.

Te plurimum valere jubet DD. Bæck, qui bene ipse valet.

Accepi librum Ill. D. Reaumurii de ovis, pro quo quæso ipsi grates meas verbis reddes.

Artis nostræ antesignanum fratrem tuum Illustriss. D. Antonium, dulcissimam D. Bassaport, et D^um^ Patrem Laserre plurimum quæso salutes.

Dabam Upsaliæ 1751. d. 23. Decembr.

VIRO ILLUSTRI

DD: BERNH. DE JUSSIEU,

PROFESSORI PARISINO,

ARTIS NOSTRÆ FULCRO PRIMARIO,

S. Pl. D.

CAR: V. LINNÉ,

EQUES.

Dum inopinato mihi iste honos contigit, qui me inscripserat numero Membrorum Academiæ Regiæ Parisinæ,† quem agnosco per vitæ meæ curriculum Summum, non potui non me temperare, quin hisce erga Te, vir illustris, devotissimam piamque declararem mentem et gratitudinem, cum hunc Tibi me totum debere plane convictus sim.

* Nicolaus Ludovicus DE LA CAILLE inter mathematicos et astronomos Galliæ inclytus, Caput Bonæ Spei petierat ubi mappam hemisphærii cœlestis alterius perficeret; unde consecutum de *Cœlo Australi Stellifero* (1763) opus eheu posthumum. Defuit comes, quem Linnæus hic reposcit, botanicus. Sed ipse, noctu astronomicis observationibus deditus, non nunquam diei otia botanicis impendit, plantasque Capenses collegit quibus redux herbarium Jussiæanum donavit, in quo nomen viri illustrissimi sparsim nancisci juvat.

† "*The French Academy of Sciences having a right to nominate eight foreign members, and the great astronomer Bradley being dead, Archiater Linnæus was, on the 8th of December* (1762), *appointed in his stead. This honour is esteemed by the learned the highest that can be attained, and had never before been conferred on a Swede.*" Gratias Academiæ ipsi simul agit Linnæus in epistolâ quæ in Litterarum ejus collectione ed. Stoever impressa (p. 74–76) invenitur, non tamen absolute sua. Namque, ut per notulam sub-

Hoc tanto magis miratus, quo noveram quam me apud te male explicavit ille, a quo longe alia promerui et cui Tu fidem adhibere tenebas, cum ego non alium haberem testem, quam eum qui fata nostra gubernat, quique novit quam pio et sincero Te semper colui mente, quodque faciam quamdiu me sinant fata inter vestrates numerari.

Lætus ex literis Alstroemerii intellexi Te etiamnum vegeto corpore et inconcussâ sanitate valere, me vero jam incipiunt anni ingravescentes comprimere.

Absolutis propediem Speciebus meis Plantarum* incipiam edere breves descriptiones Insectorum et Conchyliorum Musei Ser: Reginæ M. L. U.†

Clerck nostro æri incidit omnes Papiliones ex Museo Reginæ numero stupendos, eosque vivis coloribus delineavit tam pulchre, ut audeam confiteri magis pulchrum nunquam vidisse orbem; hujus unicum exemplar obtulit S. Reginæ, sed fata adversa ita eum suffocarunt, ut vix spes supersit, quod plura exemplaria prodeant; nisi aliquis egregius pictor ab eo emat icones et tabulas.

Devota mea officia dicas Illustr. Du Hamel, ad quem responsorias dudum dedissem, nisi expectassem quotidie missum librum.

Cum vix habeam in Horto plantam quam Tuus non alat, non novi aliquam Tibi gratam. Inclusa tamen mitto semina *Ethuliæ conyzoides* in terrâ prægnanti serenda, *Mesembryanthemi pomeridiani* cum capensibus commune requirens solum et *Astragali Chinensis* sub dio alenda. Utinam scirem plures quas mittere possem.

Vive diu felix a me perpetuo colendus.

Dabam Upsaliæ 1763. d. 1 Martii.

junctam docemur, "*Quum in elegantiis Latinæ linguæ non habitaret illustris a Linné, has litteras, Suecice ab auctore exaratas, Latine reddidit Latialium penes nos musarum, dum vixit, peritissimus arbiter, celeb. Bibliot. Upsal. Bergerus Frondin.*"

* *Caroli Linnæi Species Plantarum.* Edit. 2ª, 1763 (quam hic, quoties species nominanda fuit, secuti sumus). — Prima anno 1753 prodierat.

† *Museum Sacræ Regiæ Majestatis Ludoricæ Ulricæ, in quo Animalia rariora, exotica, imprimis Insecta et Conchylia describuntur et determinantur, Prodromi instar editum.* Holm. 1764.

Dolendum languisse ante diem et desiisse litterarum inter summos botanicos commercium, quo non intermisso, vitæ et studiorum utriusque cursum ulterius sequi et totum quasi comprehendere licuisset. Eo dolendum magis quod Bernardus, anno 1759, postquam scribere ad Linnæum desiverat, periculum naturalis suæ methodi in horti Trianonensis plantis ordinandis fecit; cujus rationem Linnæo certe pro suâ consuetudine exposuisset, forsan responsa tum approbantis dissentientisve tum propriam sententiam proponentis habuisset, ita ut suas de argumento tanti momenti judices tam idonei et ut ita dicam supremi notiones clarius tradidissent. Quanto melius Linnæus cum Bernardo de methodo naturali egisset, quam cum Gisekio per quem quid de principiis ejus senserit quantulumcunque innotuit! * Felicior quidem Bernardus discipulum et interpretem habuit nepotem Ant. Laurentium, alter Elias alterum Eliseum; sed obscura tamen remansit in hoc legum taxonomicarum codice pars ipsius, quam alibi † notam facere tentavimus.

Hic igitur, silentibus utrinque amicis, editoris penso absoluto finem imponere debuimus, at non sine expresso ejusdem citius absoluti desiderio. Post ultimam epistolam quâ Linnæus se extraneum Academici Parisiensis titulo decoratum gratulatur, supremam subjungere placuit ineditam, eidem Academiæ, utpote secretario ejus celeb. Condorcet, inscriptam, Linnæi modo defuncti nuntiam, quæ nonnulla de extremis ejus annis et aliis ipsum attinentibus narrat. Continetur in ditissimâ manuscriptorum celeb. Condorcet litterarumque virorum illustrium ipsi missarum collectione, quâ filia ipsius Bibliothecam Instituti Gallici recenter donavit.

Stockholm, 12 Février, 1778.

Monsieur, —

M. de Linné, le fils, vous a sans doute notifié la mort de son Père, qui arriva, le 10 Janvier de cette année, après un affaiblissement continuel de près de deux ans, causé par des accès d'apoplexie qui avaient même attaqué sa mémoire et sa faculté de parler distinctement.

Aux mémoires de sa vie, que j'eus l'honneur de vous envoyer, il y a deux ans, je n'ai presque rien à ajouter, car sa longue maladie ne lui a pas permis de travailler, quelque

* *C. Linnæi Prælectiones in Ordines Naturales Plantarum. Edidit P. D. Giseke.* Hamburgi. 1792.

† Vid. *Annales des Sciences Naturelles* (Vol. VIII. p. 227). 1837.

envie qu'il en eût, particulièrement quand M. le Docteur Sparrman, de retour de son voyage autour du monde avec M. Forster, lui apportait une grande collection de nouveautés d'histoire naturelle de toute espèce. M. le Docteur Thunberg qui a été 16 mois au Japon, et en a visité la capitale, avec plus de liberté de faire des excursions que les Européens n'y ont ordinairement, lui a aussi envoyé de Batavie quantité de productions naturelles rares. M. de Linné aimait à voir et regarder ces trésors, mais sans presque se souvenir d'aucun nom.

La dernière édition de son *Systema Vegetabilium* faite à Gottingue par M. Murray en 1774, a été revue et augmentée de lui même.

Ses ouvrages Suédois, particulièrement le voyage de Gothlande, celui de Westrogothie et celui de Scanie, contiennent des observations de toute espèce sur l'histoire naturelle, l'économie et les antiquités de ces provinces. Il fit ces voyages par ordre du Roi et à ses dépens. Ses disciples en ont fait de pareils dans presque toutes les provinces du royaume. On a cru que le premier pas pour rétablir l'économie du royaume est de connaître les productions naturelles du pays et de les cultiver préférablement.

De son mariage avec la fille de M. Moræus, assesseur au Collége des Médecins à Stockholm, et médecin ordinaire de la ville et des environs de Falun en Dalécarlie, il a eu un fils qui est son successeur à la profession dans l'Université d'Upsal, et quatre filles dont l'aînée est mariée à M. Bergencrantz, capitaine d'Infanterie.

Si vous avez besoin, Monsieur, de quelque éclaircissement ultérieur sur la vie et les mérites de feu M. de Linné, je ne manquerai pas de vous le donner a votre première réquisition.

J'ai l'honneur d'être avec la plus haute estime,

Monsieur le Marquis,

Votre très-humble et très-obéissant serviteur,

WARGENTIN.*

À M. LE MARQUIS DE CONDORCET.

* Pehr Wargentin Acad. Scient. Stockholm. Secret.

NOTE.

In communicating the manuscript of this article, comprising the epistolary correspondence of Linnæus with his great-uncle, Bernard de Jussieu, the Editor requested that the proofs should be remitted to Paris for his revision, in order that they might be collated with the original documents, so as to insure the entire accuracy of the transcript. The lamented death of our distinguished Foreign Associate, which occurred about the time that the article was consigned to the printer, has prevented this intention from being carried out. All that could be done, therefore, was sedulously to follow the manuscript, prepared with M. de Jussieu's accustomed neatness and care. The few conjectural emendations that have been suggested are in all cases inclosed in brackets.

The annotations and remarks of the Editor possess the melancholy interest of having been probably the last scientific production of the last of the Jussieus.

Adrien de Jussieu, the grand-nephew of Bernard, the only son of Antoine Laurent de Jussieu (author of the *Genera Plantarum secundum Ordines Naturales disposita*), himself a botanist worthy of such a lineage, — a man admired and beloved by all who knew him, — died, without male heirs, on the 29th of June, 1853, aged fifty-six years; thus closing a line illustrious without a parallel in Botany for nearly a century and a half.

A. GRAY.

Cambridge, Massachusetts, December 31, 1853.

XI.

The Numerical Relation between the Atomic Weights, with some Thoughts on the Classification of the Chemical Elements.

By JOSIAH P. COOKE, Jr., A.M.,

ERVING PROFESSOR OF CHEMISTRY IN HARVARD UNIVERSITY.

(*Communicated February* 28, 1854.)

Numerical relations between the atomic weights of the chemical elements have been very frequently noticed by chemists. One of the fullest expositions of these relations was that given by M. Dumas of Paris, before the British Association for the Advancement of Science, at the meeting of 1851. This distinguished chemist at that time pointed out the fact, that many of the elements might be grouped in triads, in which the atomic weight of one was the arithmetical mean of those of the other two. Thus the atomic weight of Bromine is the mean between those of Chlorine and Iodine; that of Selenium is the mean between those of Sulphur and Tellurium, and that of Sodium, the mean between those of Lithium and Potassium. M. Dumas also spoke of the remarkable analogies between the properties of the members of these triads, comparing them with similar analogies observed in Organic Chemistry, and drew, as is well known, from these facts arguments to support the hypothesis of the compound nature of many of the now received elements. Similar views to those of Dumas have been advanced by other chemists.

The doctrine of triads is, however, as I hope to be able to show in the present memoir, a partial view of this subject, since these triads are only parts of series similar in all respects to the series of homologues of Organic Chemistry, in which the differences between the atomic weights of the members is a multiple of some whole number. All the elements may be classified into six series, in each of which this number is different, and may be said to characterize its series. In the first it is nine, in the second eight, in the third six, in the fourth five, in the fifth four, and in the last three. The discovery of this simple numerical relation, which includes all others that have ever been noticed, was the result of a classification of the chemical elements made for the purpose of exhibiting their analogies in the lecture-room. A short notice of this classification will, therefore, make a natural introduction to the subject.

Every teacher of Chemistry must have felt the want of some system of classification like those which so greatly facilitate the acquisition of the natural-history sciences. In most elementary text-books on Chemistry, the elements are grouped together with little regard to their analogies. Oxygen, Hydrogen, and Nitrogen are usually placed first, and therefore together, although there are hardly to be found three elements more dissimilar; again, Phosphorus and Sulphur, which are not chemically allied, are frequently placed consecutively, while Arsenic, Antimony, and Bismuth, in spite of their close analogies with Phosphorus, are described in a different part of the book. This confusion, which arises in part from retaining the artificial classification of the elements into metals and metalloids, is a source of great difficulty to the learner, since it obliges him to retain in his memory a large number of apparently disconnected facts. In order to meet this difficulty, a classification of the elements into six groups, differing but slightly from that given in the table accompanying this memoir, was made. The object of the classification was simply to facilitate the acquisition of Chemistry, by bringing together such elements as were allied in their chemical relations considered collectively. As the classification has been in use for some time in the courses of lectures on Chemistry given in Harvard University, I have had an opportunity for observing its value in teaching, and cannot but feel that the object for which it was made has been in a great measure attained. The series which is headed The Six Series will illustrate the advantage gained from the classification in a course of lectures, the elements which compose it being among those especially dwelt upon in lectures to medical students, and, generally, very widely separated in a text-book on the science. As Chemistry is usually taught, the properties of the members of this series, Nitrogen, Phosphorus, Arsenic, and Antimony, as well as the composition and properties of their compounds, make up a large body of isolated facts, which, though without any assistance for his memory, the student is expected to retain. Certainly it cannot be wondered at, that he finds this a difficult task. The difficulty can, however, be in a great measure removed, if, after he has been taught that Nitrogen forms two important acids with Oxygen, NO_3 and NO_5, that it unites with Sulphur and Chlorine to form NS_3 and NCl_3, and also with three equivalents of Hydrogen to form NH_3, he is also told, that, if in these symbols of the Nitrogen compounds he replaces N by P, As, or Sb, he will obtain symbols of similar compounds of Phosphorus, Arsenic, and Antimony; for he thus learns, once for all, the mode of combination of all four elements, so that when he comes to study the properties, in turn, of Phosphorus, Arsenic, and Antimony, he has not to learn with each an entirely new set of facts, but finds the same repeated with only a few variations. Moreover, these very variations he will learn to predict, if he is shown that the elements are arranged in the series according to the strength of their electro-negative properties, or, in other words, that their affinities for Oxygen, Chlorine, Sulphur, etc. increase, while those for Hydrogen decrease, as we descend. He will then readily see why it is that, though Nitrogen forms NO_3 and NO_5, it forms only NCl_3 and NS_3, and that this reason is correct he will be pleased to find confirmed when he learns that Phosphorus, which is more electro-positive than Nitrogen, and has, therefore, a stronger affinity both for Chlorine and Sulphur, forms not only PCl_3 and PS_3, but also PCl_5 and PS_5. Again, he will not be surprised, after seeing the affinity of the elements for Hydrogen growing constantly weaker as he descends in the series, to learn that a compound of Bismuth and Hydrogen is not certainly known. Should he inquire why, though NH_3 has basic properties, PH_3, AsH_3, and SbH_3 have not, he can be shown that the loss of basic properties in passing from NH_3 to PH_3 corresponds to a decrease in the strength of the affinity between the elements, and that if in PH_3, SbH_3, or AsH_3, atoms of Methyle, Ethyle, or other organic radicals analogous to Hydrogen, are substituted for the Hydrogen atoms, and more stable compounds thus obtained, strong bases are the result. The other series would afford similar illustrations, and, from my own experience, I am confident that no teacher who will once use the classification of the elements here proposed, or one similar to it, will ever think of attempting to teach Chemistry without its aid.

Classifications of the elements, more or less complete, have been given by many authors; but the fact that no one has been generally received, is sufficient to prove that they are all liable to objections, and would, indeed, also seem to show that a strictly scientific classification is hardly possible in the present state of the science. The difficulty with most of the classifications is, undoubtedly, that they are too one-sided, based upon one set of properties to the exclusion of others, and often on seeming, rather than real resemblances. This is the difficulty with the old classification into metals and metalloids, which separated Phosphorus and Arsenic, Sulphur and Selenium, because Arsenic and Selenium have a metallic lustre, while Phosphorus and Sulphur have not, though there could hardly be found another point of difference. For a zoölogist to separate the ostrich from the class of birds because it cannot fly, would not be more absurd, than it is for a chemist to separate two essentially allied elements, because one has a metallic lustre and the other has not. Yet it is surprising to see how persistently this classification is retained in every elementary work on the science; and if it is sometimes so far modified as to transfer elements analogous to Selenium and Arsenic to the class of metalloids, this is only acknowledging the worthlessness of the principle, without being willing to abandon it. If there were any fundamental property common to all the elements, the law of whose variation was known, this might serve as the basis of a correct classification. Chemistry, however, does not as yet present us with such a property, and we must, therefore, here, as in other sciences, base our classification on general analogies. The most fundamental of all chemical properties is, undoubtedly, crystalline form, but a classification of the elements based solely on the principles of isomorphism is defective in the same way as it is in mineralogy. It brings together, undoubtedly, allied elements, but it also groups with them those which resemble each other only in their crystalline form. The mode of combining seems to be also a fundamental property; but, like crystalline form, it would bring together in some instances elements differing very widely in their chemical properties. A classification of the elements which shall exhibit their natural affinities, must obviously pay regard to both of these properties. It must at the same time seek to group together isomorphous elements, and those which form analogous compounds. Moreover, in such a classification, other less fundamental properties must not be disregarded. There are many properties both physical and chemical, which, although they cannot be exactly measured, and are oftentimes difficult to define, (such properties as those by which a chemist recognizes a familiar substance, or a mineralogist a familiar mineral,) and which on account of their indefinite character cannot be used as a basis of classification, may, nevertheless, render important aid in tracing out analogies. Judging from such properties as these, chemists are generally agreed in grouping together Carbon, Boron, and Silicon, although they cannot be proved to be isomorphous, and are not generally thought to form similar compounds.

It is, however, much easier to point out what a classification should be, than to make one which shall fulfil the required conditions. Indeed, as has been already said, past experience would seem to show that a perfect scientific classification of the elements is hardly possible in the present state of Chemistry. At best, the task is attended with great difficulties, and it cannot be expected that these should be surmounted at once. The classification which is offered in this memoir will, undoubtedly, be found to contain many defects. If, however, it is but one step in advance of those which have preceded it, it will be of value to the science. It was originally made, as has already been said, simply for the purpose of teaching, and never would have been published had it not led to the discovery of the numerical relation between the atomic weights.

On turning to the table which accompanies this memoir, it will be seen that the elements have been grouped into six series. These correspond entirely to the series of homologues of Organic Chemistry. In the group of volatile acids homologues of Formic Acid, for example, we have a series of compounds yielding similar derivatives, and producing similar reactions, and many of whose properties, such as boiling and melting points, specific gravity, etc., vary as we descend in the series according to a determinate law. From Formic Acid, a highly limpid, volatile, and corrosive fluid, the acids become less and less volatile, less and less fluid, less and less corrosive; first oily, then fat-like, and finally hard, brittle solids, like wax. As is well known, the composition of these acids varies in the same way, and the variation follows a regular law, so that by means of a general symbol we can express the composition of the class. This symbol for the volatile acids may be written $(C_2H)O_3$, $HO + n(C_2H_2)$.

This description of the well-known series of the volatile acids, applies, word for word, *nominibus mutantis*, to each of the six series of chemical elements. The elements of any one series form similar compounds and produce similar reactions; moreover, they resemble each other in another respect in which the members of the organic series do not. Their crystalline forms are the same, or, in other words, they are isomorphous. Although this may be true of the volatile acids, yet it cannot be proved in the present state of our knowledge. Still further, many of their properties vary in a regular manner as we descend in the series. In one case, at least, the law of the variation is known, and can be expressed algebraically, though in most instances it cannot be determined. Finally, as one general symbol will express the composition of a whole organic series, so a simple algebraic formula will express the atomic weight, or, if you may be pleased so to term it, the constitution of a series of elements.

These points may be illustrated with any of the series in the table; with the first, for example, which consists of Oxygen, Fluorine, Cyanogen, Chlorine, Bromine, and Iodine. All these elements form similar compounds, as will be seen by inspecting the symbols of their compounds given at the right hand of the list of names, where the similar or homologous compounds are arranged in upright columns. Moreover, they are all isomorphous, as may be seen by referring to the left hand side of the list, where the similar compounds in each upright series are isomorphous, the numbers at the heads of the columns indicating the systems of crystallization, as is described in the explanation accompanying the table. That the properties of these elements vary as we descend, can be easily shown. Oxygen is a permanent gas, as is also Fluorine. Cyanogen is a gas, but may be condensed to a liquid. Chlorine, a gas also, can be condensed more easily than Cyanogen. Bromine is a fluid at the ordinary temperature; and, finally, Iodine is a solid. Moreover, starting from Cyanogen, the solubility of these elements in water decreases as we descend in the series; and, again, the specific gravity of their vapors follows the inverse order of progression, gradually increasing from Oxygen down. The atomic weights vary in the same order, and admit of a general expression, which is $8 + n\,9$, or, in other words, the differences between the atomic weights of these elements are always a multiple of nine. This general formula may be said to represent the constitution of these elements, in the same way that the symbol $(C_2H)\,O_3$, $HO + n\,(C_2H_2)$ represents the composition of the volatile acids before mentioned. In the place of $(C_2H)\,O_3, HO$ we have $8 = O =$ the weight of one atom of Oxygen, and in the place of C_2H_2 we have nine. What it is that weighs nine (for it must be remembered that those numbers are weights) we cannot at present say, but it is not impossible that this will be hereafter discovered. In order to bring the general symbol of the volatile acids into exact comparison with that of the Nine Series, we must reduce the symbols to weights, when the two formulæ become

$46 + n\,14$, where $46 = (C_2H)\,O_3, HO$ and $14 = C_2H_2$;

and $8 + n\;\;9$, where $8 = O$ and $9 = x$.

The numbers 46 and 14 are known to represent the weights of aggregations of atoms. The number 8 represents the weight of one Oxygen atom, but we cannot as yet say what the 9 represents. After this comparison, it does not seem bold theorizing to suppose that the atoms of the members of this series are formed of an atom of Oxygen as a nucleus, to which have been added one or more groups of atoms, the weight of which equals nine, or perhaps one or more single atoms each weighing nine, to which the corresponding element has not yet been discovered. As it will be convenient to have names to denote the two terms of the formulæ which represent the constitution of the different series, we will call the first term, in accordance with this theory, the nucleus, and the number in the second term multiplied by n the common difference of the series.

From what has been said, it will be seen that the idea of the classification is that of the organic series. It is in this that the classification differs from those which have preceded it. Other authors, in grouping together the elements according to the principles of isomorphism, have obtained groups very similar to those here presented.

Indeed, this could not be otherwise, since, as has been already said, the members of each series are isomorphous, while, as a general rule, to which, however, there are many exceptions, no isomorphism can be established between members of different series. These groups, however, have been merely groups of isomorphous elements, and not series of homologues like those in which the elements are here classed.

These general remarks will suffice to indicate the principles upon which the classification has been made, and the character of the numerical relation between the atomic weights which has been established. The details of the classification can be best studied by referring to the table, so that it will be only necessary to speak of those points which are of special interest, or which may require explanation, or in regard to which there may be doubt. The series I have named from their common differences. The first I have called the Nine Series, the second the Eight Series, &c. Let us examine the doubtful points in each, commencing with the first.

The last five members of the Eight Series are connected by so many analogies, that they have been invariably grouped together in the elementary books. There can be no doubt, therefore, in regard to the propriety of placing them in the same series, on the ground of general analogies. Fluorine, it is true, presents some striking points of difference from the rest. Fluoride of Calcium is almost insoluble in water, while the Chloride, Bromide, and Iodide of Calcium are all very soluble. We must, however, remember that we have to do with series, and must not therefore expect to find close resemblances except between adjacent members. If, then, we consider that Oxygen is one of the series, and that Fluorine stands but one step removed from Oxygen, while it is two steps removed from Chlorine, the discrepancy in a measure vanishes, for Lime CaO is but slightly soluble in water. Nevertheless, the difficulty does not entirely disappear, for CaFl is much less soluble than CaO, although it should be more soluble judging from the law of the series and the fact that CaCl is so much more soluble than CaFl.

The solubility of a series of homologous elements or compounds in water, may be regarded as a function of one or more variables. In the case of elements there may be but one variable, but it is easy to see that in the case of compounds there must be several. One of these variables is probably the same which determines the common difference of the series to which the elements or compounds belong; (it will be hereafter shown that the atomic weights of the homologous compounds are related in the same way as those of the elements;) the other variables are perhaps the atomic forces which determine the hardness, density, &c. of the solid. We may, therefore, with justice, compare the relative solubilities of a series of homologues to a curve which should be the same function of the same variables, and what mathematics teaches we ought reasonably to expect in the case of this curve, we ought to expect also in the variations of solubility of these substances. Now every mathematician is familiar with the remarkably rapid changes which a curve undergoes that is a function of several variables, and we cannot be surprised that similarly rapid changes should be observed in the solubility of homologous substances in passing from one to the next in the series. In the curve which corresponds to the relative solubility of CaO, CaFl, CaCy, CaCl, CaBr, and CaI, it would seem that at CaFl there is a singular point where the curve, after rising for some distance above the axis, bends down again towards it. Several of the other series of compounds of these elements present similar anomalies; for example, KO, KFl, KCy, KCl, KBr, and KI. Here the solubility diminishes until we come to KCl, which is less soluble than KCy; then it increases to the last. Here, of course, the singular point is at KCl. With the corresponding compounds of Sodium, the solubility diminishes to NaFl, which is the least soluble of the series, and then increases constantly to the end.

These facts at least seem to show that apparent variations from the law of series in properties, which evidently are unknown functions of several variables, should not be allowed to outweigh strong analogies, and certainly the analogies between Fluorine and the other haloids are very marked. Fluorine itself possesses properties such as we should expect to find in a member of the series above Chlorine. The strong and active affinities of Fluorine might be indeed predicted, after seeing the rapid increase both in the strength and activity of the affinities in passing from Iodine to Chlorine. In passing from Bromine to Chlorine, we pass from a liquid to a gas, permanent under any natural conditions; and we should expect, therefore, in rising still higher in the series, to find in Fluorine a gas less easily reduced to a liquid than Chlorine. Now although, on account of its remarkably active affinities, this fact cannot be demonstrated on the gas itself; it can, nevertheless, be inferred with perfect certainty from its compounds. Finally, the isomorphism of Fluorine and the other haloids may be urged as indicating close analogy. From these considerations, I cannot but think that those chemists who have questioned the propriety of classing Fluorine with the other haloids will, on reviewing the facts, and regarding the haloids in the light of a series, and not simply as a group of elements possessing certain general properties, be led to change their opinion.

Cyanogen, though a compound radical, has been classed with the other haloids, not only from its atomic weight, but also from its other analogies. Its properties are in most cases those which we should expect from an element occupying its position in the series; but in others it presents remarkable variations, owing probably to the fact that it contains a radical which is easily decomposed. As well known, it is perfectly isomorphous with Chlorine.

The propriety of classing Oxygen in this series seems to be placed beyond doubt by the discovery of Ozone, which, though it does not seem to possess such energy as we should expect in an element higher in the series than Fluorine, may, nevertheless, be found to fulfil all anticipations should it ever be obtained in a perfectly unmixed condition. The isomorphism of Oxygen with Chlorine, and therefore with the other haloids, seems sufficiently established by the determination both of Proust and Misterlich of the tetrahedral form of Cu_2Cl. It must, however, be admitted that Oxygen presents as strong analogies with Sulphur as it does with Chlorine; and since, not only from its analogies, but also from its atomic weight, it appears to be the nucleus in all the first three series, I have placed it at the head of each. It may be mentioned here, that in all cases the fact that the atomic weight of an element is included in the general formula of a series, is an argument for classifying it in that series, if the relation between the atomic weights pointed out in this memoir is admitted to be a law of nature; but as I wish to show that the relation is not that of a mere accidental group of numbers, but is connected with the most fundamental properties of the elements, and has, therefore, the claims of a law, I have endeavored to establish the correctness of the classification which conforms to the law, and, indeed, suggested the law on other grounds.

The atomic weights of the numbers of the Nine Series, as determined by experiment, present greater deviations from the numerical law already explained, than are to be found in any of the others. The weights which would exactly conform to the general formula $8 + n9$ are given in the column of the table headed Theoretical, while in the next column at the right are given the weights of experiment. These for the most part (in this as well as in the other series) have been taken from the table of Atomic Weights given in the last volume of Liebig and Kopp's *Jahresbericht* (for 1852), which was supposed to give the most accurate and latest results. In the few cases in which the numbers have not been taken from this table, the initial letter of the name of the observer has been annexed. It will be seen, on comparing the two columns that the greatest deviation from the law is in the case of Fluorine, if we consider the care which was taken both by Berzelius and Louyet in the determination of the atomic weight of this element. It may, however, be remarked, that, as the processes used by both experimenters were essentially identical, any hidden constant source of error would produce the same effect on both results; so that the atomic weight of Fluorine cannot be regarded as yet as absolutely fixed. Nevertheless, it is not possible that so great a difference between the true and observed weights as two units could have escaped detection in the numberless analyses which have been made, by the most experienced chemists, of the Fluorine compounds. It must, therefore, be admitted, and not only in the case of Fluorine, but also in other instances, that there are deviations from the law; but these deviations are not greater than those from similar numerical laws in astronomy and other sciences, and indeed, judging from the analogy of these sciences, ought to be expected.

Those who are not familiar with the amounts of probable error in the determination of the different atomic weights would judge, on comparing together the columns of theoretical and observed values, that the deviations from the law were much greater than they are in reality. It should, therefore, be stated, that, in by far the larger number of instances, the deviations are within the limit of possible errors in the determinations, leaving only a few exceptional cases to be accounted for. It must be remembered that, other things being equal, the amount of probable error is the greater the greater the atomic weight, so that a difference of 1.9 in the case of Iodine is not a greater actual deviation from the law than only 0.5 in the case of Chlorine. Indeed, it is very possible that on more accurate determinations the atomic weight of Iodine will be found to correspond to the law, which cannot be expected of that of Chlorine. It is well known that many of the larger atomic weights, especially those of the rarer elements, cannot be regarded as fixed within several units.

I have calculated, as well as the data I have would permit, the amount of probable error in the determinations of many of the atomic weights, and by comparing together the results from different processes, and by different experimenters, I have endeavored to detect the existence of constant errors, which seem to be the great errors in all these determinations, those accidental errors which are made in the repetitions of the same process by equally careful experimenters being comparatively insignificant. The results of this investigation will be published in a subsequent memoir. It is sufficient for the present purpose to state, that, while they show that, in the greater number of cases, the apparent variations from the law are within the limit of probable error, there are yet several instances, where, after allowing for all possible errors of observation, there is a residual difference. I do not therefore look alone to more accurate observations for a confirmation of the law, but, regarding the variations as ascertained facts, hope that future discovery will reveal the cause. Whether the variations will be found to be a secondary result of the very cause which has determined the distribution of the atomic weights according to a numerical law, as the perturbations in astronomy are a necessary consequence of the very law they seemed at first to invalidate, or whether they are due to independent causes, can of course, for the present, be only a matter of speculation. There are, however, facts which seem to indicate that the variations are not matters of chance, but correspond to variations in the properties of the elements.

From the beautiful discovery of Professor Schönbein we have learnt that Oxygen has two allotropic modifications, and that besides its ordinary condition it is capable of assuming another highly active state when its properties resemble those of Chlorine. Cyanogen is only known in a quiescent state. The other haloids, Fluorine, Chlorine, Bromine, and Iodine are only known in a highly active state. Now it will be seen on examining the table, that the atomic weights of the highly active elements, as determined by experiment, exceed slightly the theoretical numbers, and that where the affinities are the most intense, in Fluorine, the deviation is the greatest. A similar fact may be observed in the atomic weights of the members of the Six Series. Arsenic has been proved to be capable of existing in two allotropic modifications. In its ordinary state, it has a crystalline form belonging to the Rhombic System. In the other condition, in which it may be obtained by sublimation at a low temperature, it crystallizes in regular octahedrons. The other members of this series are probably isodimorphs with Arsenic. The ordinary condition of Phosphorus is its monometric modification, while the rhombic state seems to be the normal condition of Arsenic, Antimony, and Bismuth. Now the atomic weights of the last three are either equal to, or slightly exceed, the theoretical number, while that of the first fall short, perhaps even by a unit. Other facts, which also tend to show that the deviations are not matters of chance, may be found in the affiliations of the series. There are some elements which seem to be most remarkably double-faced, having certain properties which connect them closely with one series, and at the same time others which unite them nearly as closely to another. In such cases we find that the atomic weight either falls naturally into both series, or, not corresponding exactly with the theoretical number of the series to which the element properly belongs, it inclines towards that of the other, and sometimes equals it. Such is the case with Chromium, Manganese, and Gold, as will be seen by referring to the affiliations at the bottom of the Nine Series. These various facts force upon me the conviction, that this relation between the atomic weights is not a matter of chance, but that it was a part of the grand plan of the Framer of the universe, and that in the very deviations from the law, there will, hereafter, be found fresh evidence of the wisdom and forethought of its Divine Author.

The general formulæ for the Eight Series are $8 + n8$ and $4 + n8$. The two nuclei correspond to two different sets of elements, or sub-series, one consisting of Oxygen, Sulphur, Selenium, and Tellurium, the other of Molybdenum, Vanadium, Tungsten, and Tantalum. The atomic weights of the first are all equal to $8 + n8$; those of the second to $4 + n8$. The sub-series exhibit marked analogies, as well as certain differences. They resemble each other chiefly in that the members of both form analogous acids with Oxygen, while they differ in that, though the members of the first sub-series form compounds with Hydrogen, those of the second do not. The isomorphism of the members of each sub-series among themselves, with the exception of Vanadium, is complete; but there seems to be no proof of any isomorphism between the sub-series. Johnston attempted to establish the isomorphism of Chromic and Molybdic Acids from the red variety of Molybdate of Lead from Rezbanya, which he supposed to be a Chromate; but the fact has been disproved by G. Rose, who has shown that the supposed Chromate is a Molybdate mixed with a small amount only of Chromate. There seems, nevertheless, to be some reason for believing that Chromic Acid may replace Molybdic Acid to a certain extent. If this is proved, it establishes another link of connection between the members of the two sub-series, since Chromic Acid is isomorphous with Sulphuric Acid. For the present, however, we must regard them as sub-series, related, but distinct, the second being in a measure supplementary to the first. They are distinguished in the table by printing the names of the second sub-series a little to the right of those of the first, and the fact that their atomic weights are intermediate to those of the first, I have indicated to the eye by giving to the names also an intermediate position.

The analogies between Oxygen and Sulphur are so numerous, that, were we to place Oxygen in but one series, we should place it in this. HO and HS, HO_2 and HS_2, resemble each other very closely, as do also the Oxygen salts the corresponding Sulphur salts. Moreover, there can be no doubt in regard to the isomorphism of the two elements, since it has been established upon the authority both of Mitscherlich and Becquerel, and from two different compounds. The only doubtful case in the series was that of Vanadium, which in some of its properties resembles Arsenic more closely than it does Molybdenum. The reasons for giving it the place which it occupies were the facts that its acids correspond to those of Molybdenum, and that it forms remarkably highly colored oxides which are repeated also in Molybdenum. It is true that the properties of the element itself are not those we should expect from the position which it occupies in our table; yet, if it were placed in the Six Series, it would fall between Phosphorus and Arsenic, which on the whole it resembles less than it does Molybdenum, for although it is combustible, yet neither it nor its oxides are volatile. I consider it, therefore, as a member of the Eight Series, but affiliating very closely with the Six. Its atomic weight favors this hypothesis. Vanadate of Lead has been considered isomorphous with the Phosphate; but as this isomorphism does not rest on any measurement of angles, and as, moreover, the received symbols of the two minerals, Vandinite and Pyromorphite, on whose crystalline forms the isomorphism was determined, show a very different constitution, I have not given much weight to this fact.* The observed atomic weights of the members of this series are almost precisely the same as the theoretical members, and, with the exception, perhaps, of Molybdenum, there appears to be no instance in which the difference is greater than the amount of possible error.

The members of the Six Group form a well-characterized family, so that, with the exception of Oxygen, there can be no doubt in regard to the justice of classifying them together, and any discrepancies will disappear on considering the group in the light of a series. They form acids containing three and five atoms of Oxygen which are completely homologous, and make two series parallel to that of the elements. They form also a remarkable series of compounds with three atoms of Hydrogen. The idea which has been advanced by some authors, that NH_3 is the Nitride of Hydrogen, while PH_3 is the Hyduret of Phosphorus, or, in other words, that Hydrogen is electro-positive with reference to Nitrogen and electro-negative with reference to Phosphorus and those lower in the series, does not seem to me correct, since the remarkable bases which may be formed from PH_3, AsH_3, SbH_3, and BiH_3, by replacing the Hydrogen atoms by organic radicals, seem to indicate that they have the same type as NH_3, and are therefore homologues of it.

The isomorphism of the four lower members of the series is perfect. It has been shown in the table, both by the crystalline forms of the elements themselves, as well as by those of their coumpounds. In the other series, wherever it was possible, the same double proof has been given. The doubt expressed by G. Rose in regard to the dimorphism of Arsenic, as I hope to be able to show in a paper soon to be published, has been removed. In one state Arsenic crystallizes in perfect octahedrons of the regular system, and is therefore isomorphous, not only with Antimony and Bismuth, but also, in its allotropic state, with Phosphorus. Isomorphism, as is well known, is not absolute, except in forms of the regular system. The rhombic angles of the crystals of Arsenic, Antimony, and Bismuth are respectively 85° 41′, 87° 35′, 87° 40′, and therefore conform to the general rule. It will be observed that the angle varies constantly in the same way as we descend in the series. Now, although these few instances do not afford sufficient ground for any general conclusion, yet they show that similar varia-

* See G. Rose's Mineral System.

tions are possible in the other systems, and therefore that we cannot be expected to establish isomorphism in any case except between nearly consecutive members.

The atomic weights of the members of this series, with the exception of Phosphorus, do not present any important deviations from the theoretical numbers, taking into account always, of course, the amount of possible error. The deviation in the case of Phosphorus has already been noticed. Oxygen, it must be admitted, is not connected with the series from any similarity of properties, though the Phosphides, Arsenides, and Antimonides present certain analogies with the Oxides. As has already been said, Oxygen was placed at the head of this, as well as of the last two series, because its atomic weight seemed to be the nucleus of all three.

The Five Series is the shortest of all, consisting of only three members, Carbon, Boron, and Silicon. Of these, the last two are as closely allied as are any two members of the other series, Silicon having precisely the properties we should expect in a homologue of Boron, which was lower in the series; and the same is also true of their compounds. The analogies, however, between these two elements and Carbon are by no means so close, for not only Carbon cannot be proved to be isomorphous with them, but it does not form similar compounds. Carbonic Acid, it is true, presents some points of resemblance to Boracic and Silicic Acids; like them it unites in a large variety of proportions with bases, its alkaline salts give a basic reaction, &c.; but according to the generally received opinion, its symbol is CO_2, while those of Boron and Silicon are BO_3 and SiO_3. In its uncombined state, however, Carbon resembles Boron and Silicon, not only in its outward properties, but also in its action before the blowpipe. Two of the allotropic states of Carbon, Graphite and Charcoal, are probably repeated in Boron, and are known to be in Silicon. The principle of exclusion would also seem to place Carbon in this series, for it certainly presents no analogies with the members of any other. The correspondence of the atomic weights of the members of this series to the law is remarkably close.

The Four Series is by far the largest of all, including the greater number of what are generally known as the heavy metals. The members of the series resemble each other in the following respects. First, they are isomorphous; for although each member cannot be directly proved to be isomorphous with every other, yet isomorphism can be established between consecutive members, which, as has before been said, is all that can be expected. Second, the members of this series all form, by uniting with Oxygen, either Protoxides or Sesquioxides, or both, which, as a general rule, are strong bases. Third, these Oxides are either insoluble, or nearly insoluble, in water. And finally, the elements of the series have all those physical properties which are known as metallic properties.

This series may be naturally divided into two sub-series. The first contains those elements whose protoxide bases are their characteristic compounds, and which do not form acids with Oxygen. The second contains those elements whose characteristic compounds are their sesquibases. They generally unite with two or more equivalents of Oxygen, and form acids. These sub-series are distinguished in the table in the same way as those of the Six Series. Corresponding to these sub-series we have two sets of atomic weights, each having the same common difference, but differing in their starting-point or nucleus. The first set is expressed by the formula $4 + n4$, the second by $2 + n4$.

The sub-series affiliate with each other in a most remarkable manner. Manganese, for example, not only forms a strong protoxide base, but also unites with a larger amount of Oxygen, forming both a sesquibase and acids. Its atomic weight places it in the first group, and it has therefore been classed there, although by its properties it is equally allied to the second. Cobalt and Nickel certainly resemble much more closely the members of the first than of the second sub-series, although their atomic weights place them in the second. With this exception, the subdivision of the series which the atomic weights require does not differ from that suggested by the properties of the elements. The members of this series may of course be still further subdivided into groups according to their special properties, as they are in all works on Chemistry. They are placed together here because the atomic weights form but one numerical series.

The isomorphism of the members of this series will be found well established with the limitations before given. In order to establish the isomorphism of Cobalt and Nickel with Iron, the isomorphism of one atom of Arsenic with two atoms of Sulphur has been assumed. This is generally admitted; but if it is not, no one can doubt in regard to the isomorphism of these three metals, as they constantly replace each other. Glucinum, Zirconium, Lanthanum, Cerium, and Thorium cannot be shown to be isomorphous with the other metals by any of their compounds, but their oxides are known to replace the analogous oxides of the other metals. So also is Ruthenium known to replace Rhodium. There have been doubts expressed in regard to the existence of a monometric form of Zinc; but as we have established its isomorphism with the other members of the series, not only by its own crystalline form, but also by those of its compounds, the fact is of no importance to the present question.

The atomic weights of the members of this series, as determined by observation, very nearly correspond with the theoretical numbers, which is the more remarkable, as the limit of error in the determination of the atomic weights of the greater number, especially of the rarer metals, is quite wide.

The Three (and last) Series is composed of Hydrogen and the metals of the alkalies. The analogies between Lithium, Sodium, and Potassium are very close, as is well known, and there can be no doubt in regard to the propriety of classing them together. It may be said, however, in regard to Hydrogen, that it resembles as closely some of the metals of the Four Series as it does those of the alkalies. Though this cannot be denied, yet the fact that the atomic weight of Hydrogen is the nucleus of the series, and the great solubility of the alkalies in water, may be urged as reasons for placing it at the head of the Three Series.

The isomorphism of Lithium, Sodium, and Potassium is fully established; but I can find no data which prove Hydrogen isomorphous either with them or with the metals of the other group.

The unit of the atomic weights which has been used thus far throughout the table, is the double atom of Hydrogen; but the nucleus of the Three Series is the weight of the single atom, so that the unit in this series is one half of the unit of the weights in all the other series. This fact must be kept in mind in comparing the atomic weights of this with those of the other series. All the weights might have been made uniform by doubling them throughout; but as this would not have changed the relation, and would have been departing from the general custom, it was thought best to confine the doubling to the Three Series, into which alone Hydrogen enters. The general symbol of this series is $1 + n\,3$, where of course the unit is one half of that of the symbols at the head of the other series. The observed atomic weights will be found to correspond very closely with the theoretical numbers; indeed, the two coincide, except in the case of Potassium, where the difference is 0.6. This, however, it must be remembered, is 0.6 of the single Hydrogen atom. Compared with the double atom, as the weight of Potassium is generally given, the difference amounts to but 0.3.

One of the most remarkable points of the classification which has been now explained, is the affiliation of the series. We find in Chemistry, as in other sciences, that Nature seems to abhor abrupt transitions, and shades off her bounding lines. Many of the elements, while they manifestly belong to one series, have properties which ally them to another. Several examples of this have already been noticed. In such cases, we find invariably that there is a similar affiliation of the atomic weight. Of all the elements Chromium and Manganese are the most protean. Two atoms of these elements unite with seven atoms of Oxygen and form acids analogous to Perchloric Acid, and, as has already been shown, the weight of two atoms of either element falls into the Nine Series. Moreover, one atom of Chromium or of Manganese unites with three atoms of Oxygen to form Chromic or Manganic Acid. Chromic Acid is a strong oxidizing agent, and resembles closely Nitrous Acid, and the atomic weight of Chromium falls into the Six Series just below that of Nitrogen. Manganic Acid, on the other hand, resembles Sulphuric Acid, with which it is isomorphous, and the atomic weight of Manganese would place it in the Eight Series. In like manner Osmium in many of its properties resembles Platinum and the other metals with which it is associated in nature; but, unlike them, it forms a very remarkable volatile acid, whose insupportable and suffocating odor as well as composition reminds one of the acids of the Nine Series, and its atomic weight seems to justify the apparent analogy. Gold likewise, though the noblest of metals, yet in some of its chemical relations resembles much more closely the members of the Nine than of the Four Series, and here again its accommodating atomic weight seems to account for its double-sided character. Several other examples of similar affiliations are given in the Table, but do not need explanation.

In the description just concluded of the classification of the chemical elements, which is offered in this memoir, I have not entered into details, for to have done so would have been to write a treatise on Chemistry. I have confined myself almost exclusively to general points, and only referred to those particulars which I thought might present doubts. I hope that I have been able to show, first, that the chemical elements may be classified in a few series similar to the series of homologues of Organic Chemistry; second, that in those series the properties of the elements follow a law of progression; and finally, that the atomic weights vary according to a similar law, which may be expressed by a simple algebraic formula. As already intimated, I have endeavored to prove the correctness of the classification on general grounds, in order that it might appear that the simple numerical relation which has been discovered between the atomic weights is not a matter of chance, but is connected with the most fundamental properties of the elements. I might leave the subject at this point, but the existence of the law which I wish to establish will be proved more conclusively if it can be shown, not simply that the general properties of the members of each series vary in a regular manner, but also if in one or more cases the exact law of the variation can be pointed out.

There are but few properties of the elements which are subjects of measurement, and which therefore can be compared numerically. Such are the specific gravity in the three states of aggregation, the boiling and melting points, the capacity of heat, and a few others. It is easy to see that there are but few of these properties the law of whose variation in the series we could reasonably expect to discover in the present state of science. Most of them evidently depend upon molecular forces with which we are entirely unacquainted. Such in solids is undoubtedly the case with so simple and fundamental a property as specific gravity, and most, if not all, of the other properties of solids belong to the same category. It cannot therefore be expected that we should point out the laws by which these properties vary, although the remarkable investigations of Dana, Filhol, Kopp, Schröder, and others, on the relations between the density of substances and their atomic weights, and those of Kengott on the relation of hardness to atomic volume, give grounds for expecting that even they will before long be discovered. In liquids and gases, however, most of these molecular forces which produce the apparent irregularities in solids have less influence, as we should naturally expect, probably because the atoms are removed out of the sphere of their action. We may therefore hope, on comparing together the properties of the liquid or gaseous states of the elements in any series, to discover some numerical relation between them. Unfortunately, however, we have not sufficient data for making such a comparison except in the case of one property, the specific gravity. The boiling point, which would be a very valuable property for the purpose, is known only in a few instances.

That the specific gravity of the elements in their gaseous state varies in each series according to a numerical law, follows necessarily from what is already known. It is a well-known fact, that the specific gravities of the gaseous states of the elements divided by their atomic weights give quotients which are either equal, or which stand in a very simple relation to each other. For any series, as far as we have data, this quotient is the same for all the elements with only a few exceptions. That is $\frac{\text{Sp. Gr.}}{\text{At. W.}} = p$. But we have found that At. W. may be expressed in general by $a + n\,b$, and substituting this for At. W. in the above equation, it becomes $\frac{\text{Sp. Gr.}}{a + n\,b} = p$, or Sp. Gr. $= p\,a + n\,p\,b$; so that $p\,a + n\,p\,b$ is a general expression for the specific gravity of all the elements of any series, in the same way that $a + n\,b$ is for the atomic weight. The value of p will differ according as the specific gravities used are referred to Hydrogen or Air. Below will be found tables which give the calculated and observed specific gravities of the elements of the Nine and Six Series referred to Hydrogen, which has been taken as the unit instead of Air, as we thus in great measure avoid fractions. In the Nine Series $p = 1$, so that the numbers representing the specific gravities are the same as those representing the atomic weights. In the Six Series it equals two, so that the numbers representing the specific gravities are in this series twice as large as those representing the atomic weights. When the specific gravity has not been observed, the calculated number only is given. The observed numbers are taken from the "Table of Specific Gravity of Gases and Vapors," in Graham's *Elements of Chemistry*, which is a very complete collection of all known data. For the other series, we have only occasional data, so that no complete tables of their specific gravities are possible.

THE NINE SERIES. $\frac{\text{Sp. Gr.}}{\text{At. W.}} = 1.$ Sp. Gr. $= 8 + n\,9.$			THE SIX SERIES. $\frac{\text{Sp. Gr.}}{\text{At. W.}} = 2.$ Sp. Gr. $= 16 + n\,12.$		
Names.	SPECIFIC GRAVITIES.		Names.	SPECIFIC GRAVITIES.	
	Theoret.	Observed.		Theoret.	Observed.
Oxygen	8	16	Oxygen	16	16
Fluorine	17		Nitrogen	28	14
Cyanogen	26	26	Phosphorus	64	64
Chlorine	35	35.5	Arsenic	148	150
Bromine	80	78	Antimony	256	
Iodine	125	126	Bismuth	412	

It is evident, then, that at least one property of the elements varies in the series according to an ascertained numerical law. But, it may be said, this proves nothing, for these specific gravities are connected so closely with the atomic weights that what is true of the one must be to the same extent true of the other. It must be remembered, however, that the specific gravities are a distinct set of observed facts, and that the probability of a law is in exact proportion to the number of facts which accord with it. Moreover, the closeness of the connection is unimportant. Whether the value of p be expressed by a single digit, or by a complicated algebraic formula, is evidently a matter of indifference so far as the confirmation of the law is concerned.

I regret exceedingly that there are not sufficient data in the case of any of the other properties of the elements in the state of gas to allow comparison, as I feel confident that the law which governs their variation in the series might easily be discovered; but I look forward to the time when in the general formula $p\,a + n\,p\,b$ the value of p shall be known, not only for the properties of the elements in their gaseous state, but for every property capable of numerical expression.

In this memoir I have confined myself entirely to the elements, but it is evident that the classification here offered, and the numerical law here explained, may be extended to all compounds. The elements of any one series, by combining, give rise to perfectly parallel series of homologous binaries, some of which are given in the table. The binaries of those series which have the greatest common difference are generally acids; and of those which have the smallest, they are generally bases. These acids and bases unite together and form series of homologous salts. As in Organic Chemistry, many of the series are very incomplete; but they are much more generally perfect than in that newer department of the science, and almost every day fills up some gap.

It will be seen, then, that not merely a plan has been given for classifying the elements, but one which will also embrace all inorganic compounds, and affiliate with the similar classification which has already been established in Organic Chemistry. We have not attempted to develop such a classification, since to do it would require a volume; nor is it necessary, as any one can develop it for himself.

That the atomic weights of the series of homologous compounds follow the same numerical law as those of the elements is easily shown. Take as an example the series of salts homologous with KO, NO_5, which may be expressed in general by KO, RO_5, where R is any member of the Six Series after Oxygen, and whose atomic weight, therefore, equals $8 + n\,6$. The atomic weight of KO, RO_5 must be necessarily $39.5 + 48 + (8 + n\,6)$, or $95.5 + n\,6$. As this symbol differs from that of the Six Series only in the nucleus, the atomic weights of the salts which are represented by it must progress by the same differences as those of the corresponding elements.

The properties of these series of homologous compounds will also be found to vary in a regular manner, and the law of the progression of the specific gravities in the gaseous state can be easily expressed algebraically, since in each series the quotient of the specific gravity divided by the atomic weight is a constant quantity. As an illustration, we may take the series of binaries homologues of water given in the Nine Series of our table. It follows from what has been said, that the atomic weights of these compounds equals $9 + n\,9$. With each $\frac{\text{Sp. Gr.}}{9 + n\,9} = \frac{1}{2}$, therefore Sp. Gr. $= 4.5 + n\,4.5$. We give below a table of the observed or calculated specific gravities, not only of these compounds, but also of those homologues of NH_3 whose specific gravity has been observed.

HOMOLOGUES OF WATER. $\frac{\text{Sp. Gr.}}{\text{At. W.}} = \frac{1}{2}$. Sp. Gr. $= 4.5 + n\,4.5$.			HOMOLOGUES OF AMMONIA GAS. $\frac{\text{Sp. Gr.}}{\text{At. W.}} = \frac{1}{2}$. Sp. Gr. $= 5.5 + n\,3$.		
Symbols.	SPECIFIC GRAVITIES.		Symbols.	SPECIFIC GRAVITIES.	
	Theoret.	Observed.		Theoret.	Observed.
HO	4.5	9	NH_3	8.5	8.5
HFl	9		PH_3	17.25	17.5
HCl	13.5	13.5	AsH_3	39	38.5
HBr	40.5	39.5			
HI	63	63.5			

As the series of compounds give a greater scope for investigating the relations of properties than is presented by those of the elements, we may expect that these relations will be first discovered in the former, and to my conceptions Chemistry will then have become a perfect science, when all substances have been classed in series of homologues, and when we can make a table which shall contain, not only every known substance, but also every possible one, and when by means of a few general formulæ we shall be able to express all the properties of matter, so that when the series of a substance and its place in its series are given, we shall be able to calculate, nay, predict, its properties with absolute certainty; and when our chemical treatises shall have been reduced to tables of homologues, and our laws comprised in a few algebraic formulæ, then the dreams of the ancient alchemist will be realized, for the problem of the transmutation of the elements will have been theoretically, if not practically, solved.

EXPLANATION OF THE TABLE.

The formula at the head of each series is a general expression for the atomic weights of that series. The names of the series are derived from the "Common Differences," which are the numbers multiplied by n in the general formulæ. In the columns headed "Theoretical" are given the atomic weights calculated from these formulæ and the values of n given in the last columns at the right of each division of the table. In the columns headed "Observed" will be found the observed values of the same atomic weights. These have been taken from the table of atomic weights given in the last volume of Liebig and Kopp's *Jahresbericht* (for 1852), with the exception of those against which are placed the initials of the observers. The last were taken from Weber's *Atomgewichts Tabellen.* In some cases the atomic weight is taken at twice its received values, but it is then underlined. The compounds in any one column at the right of the names of the elements are homologous. In the same way, those in any one at the left are isomorphous. The numbers at the head of these last columns indicate crystalline systems as follows: 1. Monometric; 2. Dimetric; 3. Trimetric; 4. Monoclinic; 5. Triclinic; 6. Rhombic. The data from which the table was compiled were drawn from numerous sources, but especially from the following works: Gmelin's *Handbook of Chemistry*, Graham's *Elements of Chemistry*, Phillips's *Mineralogy* by Brooke and Miller, and Gustav Rose's *Krystallo-chemische Mineralsystem.* References have been given only in a few cases, to avoid crowding the tables. For authorities in other cases, the author would refer to the above-mentioned works.

THE NINE SERIES.

8 + n9

Isomorphs 3	Isomorphs 2	Isomorphs 1	Homologues							Atomic Weights Theo.	Observed	n
	$^{*}Cu_2O$		Oxygen	HO						8	8	n = 0
		KFl	Fluorine	HFl						17	18·8B	n = 1
		KCy	Cyanogen	HCy	CyO					26	[illegible]	n = 2
KO,ClO_5	$^{*}Cu_2Cl$	KCl	Chlorine	HCl	ClO	ClO_3	[illegible]	[illegible]	[illegible]	35	35·5	n = 3
		KBr	Bromine	HBr	BrO			Br[illegible]		80	80	n = 8
		KI	Iodine	HI	IO			IO_5	IO_7	125	126·9M	n = 13

AFFILIATIONS

Isomorphs 3	Isomorphs 2	Isomorphs 1	Homologues					Atomic Weights Theo.	Observed	n
	K[illegible]		Chromium				CrO_3	53	26·8	[illegible]
[illegible]	[illegible]		Manganese				MnO_7	53	[illegible]	[illegible]
			Osmium			OsO_4		98	99·6	n = 10
			Gold		AuO_3		AuO_5?	197	197	n = 21

* Mitscherlich, Pogg. Ann. 19, 449.

THE EIGHT SERIES.

8 + n8 or 1 + n8

Isomorphs 6	Isomorphs 4	Isomorphs 3	Isomorphs 2	Isomorphs 1		Homologues					Atomic Weights Theo.	Observed	n
				†PbO	$^{*}Cu_2O$	Oxygen	HO	HO_2			8	8	n = 0
		KO,SO_3	‡FeS_2	PbS	$^{*}Cu_2S$	Sulphur	HS	HS_2	SO_2	SO_3	16	16	n = 1
		KO,SeO_3		PbSe		Selenium	HSe		SeO_2	SeO_3	40	39·5B	n = 4
			PbO,MoO_3			Molybdenum			MoO_2	MoO_3	48	46	n = 5
Te				PbTe		Tellurium	HTe		TeO_2	TeO_3	64	64·1B	n = 7
						Vanadium			VaO_2	VaO_3	[illegible]	68·5B	n = 8
	CaO,WO_3		PbO,WO_3			Tungsten			WO_2	WO_3	92	92	n = 11
	FeO,TaO_3					Tantalum			TaO_2	TaO_3	185	184	n = 23

AFFILIATIONS

Isomorphs 6	Isomorphs 4	Isomorphs 3	Isomorphs 2	Isomorphs 1		Homologues					Atomic Weights Theo.	Observed	n
As		‡Fe(AsS)				Arsenic					14[illegible]	150	n = 18
		KO,MnO_3				Manganese				MnO_3	29	27·6	n = 3

* Mitscherlich, Pogg. Ann. 19, 449. † B[illegible] Ann. Chem. Phys. 31, 305. ‡ G. Rose Krystallochemische Mineralsystem.

THE SIX SERIES

8 + n6

Isomorphs 6	Isomorphs 3			Isomorphs 1	Homologues					Atomic Weights Theo.	Observed	n
					Oxygen					8	8	n = 0
					Nitrogen	$^{*}NH_4$	NH_3	NO_3	NO_5	14	14	n = 1
						PMe_4	PMe_3					
	NaO,PO_5+4HO			P	Phosphorus	PH_4	PH_3	PO_3	PO_5	32	31	n = 4
						$AsMe_4$						
As	NaO,AsO_5+4HO		AsO_3	As	Arsenic		AsH_3	AsO_3	AsO_5	74	75	n = 11
							$SbMe_3$					
Sb		SbS_3	SbO_3		Antimony		SbH_3	SbO_3	SbO_5	128	120	n = 20
							Bi[illegible]					
Bi		BiS_3			Bismuth		BiH_3?	BiO_3	BiO_5	206	208	n = 33

AFFILIATIONS

Isomorphs					Homologues					Atomic Weights Theo.	Observed	n
					Chromium			CrO_3		26	26·7	n = 3
					Vanadium			VaO_3		68	68·5	n = 10

* Only known in combination.

THE FIVE SERIES

6 + n5

Isomorphs 1	Homologues			Atomic Weights Theo.	Observed	n
C	Carbon	CO_2		6	6	n = 0
	Boron		BO_3	11	10·9	n = 1
	Silicon		SiO_3	21	[illegible]	[illegible]

AFFILIATIONS

Isomorphs 1	Homologues			Atomic Weights Theo.	Observed	n
[illegible]	Titanium	T[illegible]		[illegible]	[illegible]	n = 4

THE FOUR SERIES.

4 + n4 or 2 + n4

Isomorphs 4	Isomorphs 1	R	R_2O	RO	R_2O_3	RO,R_2O_3	RO_2	RO_3	[illegible]	[illegible]	Theo.	Observed	n
		GROUP 1.											
		[illegible]		[illegible]	$[illegible]O_3$		[illegible]				28	[illegible]	[illegible]
		[illegible]		[illegible]			[illegible]				56	[illegible]	[illegible]
KCl,[illegible]		[illegible]		SnO			SnO_2				58	[illegible]	[illegible]
KCl,PtCl		[illegible]		PtO			PtO_2				98	98·[illegible]	n = 24
KCl,IrCl		[illegible]		IrO	IrO_3		IrO	IrO			98	99	n = 24
KCl,PdCl		[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		$[illegible]O_4$	98	99·6	n = 24
		[illegible]		[illegible]				$[illegible]O_3$			116	157	n = [illegible]
		GROUP 2.											
	Al_2O_3	Aluminium			[illegible]						14	13·7	[illegible]
	MgO	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		26	[illegible]	n = 6
MnO,SO_3+7Aq	MnO	Manganese		[illegible]	[illegible]	$[illegible]MnO$	[illegible]	MnO	MnO		[illegible]	27·6	[illegible]
FeO,SO_3+7Aq	FeO	Iron		FeO	[illegible]	[illegible]		FeO			28	28	n = 6
CoO,SO_3+7Aq		Cobalt		[illegible]	[illegible]	[illegible]		CoO			30	29·5	n = 7
NiO,SO_3+7Aq*		[illegible]		NiO	Ni_2O_3	[illegible]					30	29·6	n = 7
	CuO	Uranium		UrO	Ur_2O_3	[illegible]					60	60	n = 14
		GROUP 3.											
CuO,SO_3+7Aq*		[illegible]	Cu_2O	[illegible]			CuO_2				32	31·7	[illegible]
		Mercury	Hg_2O	HgO							100	100	n = 24

* Only isomorphous [illegible] with FeO,SO_3+7Aq

THE THREE SERIES.

1 + n3

Isomorphs 6	Isomorphs 5	Isomorphs 3	Isomorphs 1	R	R_2O	RO	RO_2	Theo.	Observed	n
				GROUP 1.						
MgO,[illegible]	MgO,[illegible]+5Aq*			Magnesium		MgO		12·5†	12	n = [illegible]
ZnO,[illegible]	ZnO,SO_3+5Aq*		ZnI	Zinc	Zn_2O	ZnO		32	32·6	n = 31
				Cadmium	Cd_2O	CdO		56	56	n = 37
				GROUP 2.						
[illegible]		CaO,CO_2	CaO,SO_3	Calcium		CaO		20	20	n = [illegible]
		SrO,CO_2	SrO,SO_3	Strontium		SrO	SrO_2	44	43·8	n = [illegible]
		BaO,CO_2	BaO,SO_3	Barium		BaO	BaO_2	68	68·5	n = 45
		PbO,CO_2	PbO,SO_3	Lead	Pb_2O	PbO	PbO_2	104	103·7	n = 69
				GROUP 3.						
				Hydrogen		HO	HO_2	1	1	n = 0
			LiI	Lithium		LiO		6·5	6·5	n = 4
		NaO,SO_3	NaI	Sodium		NaO		23	23	n = 15
		KO,SO_3	KI	Potassium		KO		39·5	39·2	n = 26
		AgO,SO_3	AgBr	Silver	Ag_2O	AgO	AgO_2	108·5	108·1	n = 72

AFFILIATIONS

Isomorphs 6	Isomorphs 5	Isomorphs 3	Isomorphs 1	R	R_2O	RO	RO_2	Theo.	Observed	n
	[illegible]			Copper	Cu_2O	CuO	CuO_2	32	31·6	n = 21
MnO,[illegible]	MnO,[illegible]			Manganese		MnO	MnO_2	27	27·6	n = 18

* [illegible] + Aq. See Rammelsberg, Handbuch der krystallographischen Chemie [illegible]
† The atomic weight [illegible] doubled in order to correspond to 1 + n3.

[illegible] Müller's Supplement [illegible]

XII.

A History of the Fishes of Massachusetts.

By DAVID HUMPHREYS STORER, M. D., A. A. S.

(*Continued from page* 168.)

FAMILY VIII. GOBIDÆ.

Body more or less elongated. Scales small or entirely wanting. The spines of the dorsal fin slender and flexible. Branchial aperture small. Ventrals, when present, placed in advance of the pectorals. Many viviparous.

GENUS I. BLENNIUS, Cuv.

Head rounded and blunt; body smooth, unctuous, compressed; a single elongated dorsal fin; ventral fins placed before the pectorals, and containing generally but two rays, united at their base; teeth slender, in a single row.

Blennius serpentinus, *Storer.*

The Snake-shaped Blenny.

(Plate XVII. Fig. 1.)

Blennius serpentinus, Storer, Proceedings of Bost. Soc. Nat. Hist., iii. p. 30, April, 1848.

Color. Upper part and sides, of a yellowish-brown, with intervening colorless spaces. Abdomen white. The dorsal fins are brownish, with broad, oblique, white bands. Pectorals white, the outer ray brownish. Anal and caudal white with a tinge of yellow. Ventrals white.

Description. Body very much elongated and compressed. Length of head about one tenth the length of the body; convex upon its posterior portion; blunted anteriorly; compressed upon sides. Gape of mouth moderate; upper jaw the longer; a single row of minute teeth in each jaw. Lips fleshy. Nostrils tubular, directly in front of eye. Greatest depth of body about one twentieth its length. Eyes obliquely oblong; their longest diameter equal to one sixth the length of the head.

The first dorsal fin commences on a line above the pectorals, and is continued to the second dorsal, to which it is connected by a membrane, and terminates anterior to the middle of the fish. Its anterior three spines are the shortest. Posterior to the fifth ray, the fin is of a uniform height throughout, with the exception of the two last rays, which are shorter.

The second dorsal, which is of nearly a uniform height throughout, terminates at the fleshy portion of the tail.

The pectorals, when closed, are lanceolate; rounded when expanded. The rays are branched and free at their tips.

The ventrals are situated beneath and in front of the pectorals. The inner ray the longer.

The anal commences on the anterior third of the body, and terminates on a line with the second dorsal.

The caudal is rounded.

The fin rays are as follows: — D. 37 – 50. P. 13. V. 2. A. 66. C. 22.

Length of specimen, sixteen inches.

Remarks. The preceding description is drawn up from the only specimen of this fish that I have ever seen. It was brought me by Captain Nathaniel E. Atwood, who took it from the stomach of a cod-fish in Massachusetts Bay, early in April, 1848.

GENUS II. PHOLIS, Fleming.

Neither cirrhi nor fleshy crests upon the orbits.

Pholis subbifurcatus, *Storer.*

The Radiated Shanny.

Pholis subbifurcatus, Subbifurcated Pholis, Storer, Report, p. 63.
" " *Radiated Shanny,* Dekay, Report, p. 150.
" " Storer, Mem. Amer. Acad., New Series, II. p. 370.
" " " Synopsis, p. 118.

Color. General color of the body, reddish-brown; several lighter-colored circular patches along its upper part, at the base of the dorsal fin; the spaces between the rings darker than the rest of the body, presenting the appearance of bars. From beneath the eye a broad black band, wider at its base, crosses the operculum obliquely; two other bands of the same color extend from behind the eye backwards, in nearly a straight line, the distance of from one to two lines. Body beneath the lateral line lighter colored; abdomen yellowish-white. Head above, brownish; opercula and preopercula yellow. Numerous black spots upon dorsal fin. Those upon the five first rays larger. Pectorals light, with some darker shades. Edge of anal dark-colored. Small dark-colored spots upon caudal.

Description. Length, including tail, five inches five lines; depth across on a line with the anus, one inch; body much compressed. Body smooth, scales very minute. Length of head, from tip of snout to posterior angle of the operculum, is to the entire length of body, as one to three; entire surface destitute of scales; jaws somewhat protractile, armed with prominent sharp teeth; lips large and fleshy; over nostrils a minute filament one third of a line in length; circumference of eye two lines.

The lateral line commences just above the angle of the operculum, and having extended two lines, subbifurcates; passing down in a gradual curve a little more than a line, it is continued in a straight course to the base of the caudal fin; while the upper portion abruptly terminates opposite the fourteenth ray of the dorsal fin.

The dorsal fin, commencing on a line with the posterior angle of the operculum, is continued to the caudal fin; the first five rays of this fin are shorter than the sixth; the rays become again shorter as they approach the tail.

The pectorals are rounded; they arise on a line with the posterior angle of the operculum.

The ventrals are situated two lines in front of the pectorals; the rays are united throughout the greater portion of their extent; extremities free. The anus is situated two and a half inches from the extremity of the jaws.

The anal fin commences just half-way between the tip of the snout and the extremity of the tail.

The caudal fin is rounded.

The number of fin rays are as follows: — D. 43. P. 13. V. 3. A. 30. C. 14.

Remarks. I have seen but a single specimen of this fish; it was found at an unusually low tide among the sea-weed at Nahant, in 1838, and brought to me by my brother-in-law, Thomas M. Brewer, M. D. It was placed in the collection of the Boston Society of Natural History, and has been destroyed, compelling me to introduce here my former description, and preventing me from giving a figure.

GENUS III. GUNNELLUS, Fleming.

Body elongated, much compressed. Head oblong. Mouth small. Teeth velvet-like, or in cards. Dorsal rays spinous throughout. Ventrals excessively small, and reduced often to a single spine.

Gunnellus mucronatus, *Cuv.*

The Butter-fish.

(Plate XVII. Fig. 2.)

Ophidium mucronatum, Spinous Ophidium, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 361, pl. 1, fig. 1.
Le Gonnelle épineux, Gunnellus mucronatus, Cuv., Cuv. et Val., xi. p. 427.
Blennius (Centronotus) gunnellus, Lin., *Spotted Gunnelle*, Rich., Fauna Boreal. Americ., iii. p. 91.
Muræonoides guttata, Spotted Gunnel, Lacep., Storer, Report, p. 65.
Gunnellus mucronatus, American Butter-fish, Dekay, Report, p. 153, pl. 12, fig. 36.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 374.
" " " Synopsis, p. 122.
" " H. R. Storer, Bost. Journ. Nat. Hist., vi. p. 261.

Color. The living fish is of an olive-brown color, with numerous transverse, indistinct, darker bands upon the sides; about twelve black ocelli along the base of the dorsal fin, each surrounded by a yellow ring. Fins yellow; the anal barred with white. Pupils black; irides golden. Abdomen yellowish. An oblique black band passes from beneath the eye to the throat.

Description. Body elongated, compressed, scaleless; and so translucent, that when the fish is held to the light, the vertebral column is distinctly seen. Head about one tenth the length of the body, convex above, blunted anteriorly. Gape of mouth nearly vertical. Jaws equal. Minute sharp teeth upon each jaw, and upon vomer.

The dorsal fin, which is composed of spinous rays entirely concealed, save their points, by the membrane, is but slightly raised above the back, and commences on a line above the posterior angle of the operculum, and is continued nearly to the tail, to which it is attached by a membrane.

The pectorals, which are situated just beneath the posterior angle of the operculum, are small and delicate.

Two small spines, attended each by a delicate filamentous ray, directly in front of the pectorals, take the place of the ventrals.

The anal fin, which is rather higher than the dorsal, commences on the posterior half of the body, and is continued nearly to the tail, to which it is attached by a membrane, as the dorsal. The first two rays are spinous, the remainder flexible.

The caudal is rounded when expanded.

The fin rays are as follows: — D. 75 – 78. P. 11 or 12. V. 1. A. 2, 36 – 40. C. 16 – 18.

Length four to twelve inches.

Remarks. This pretty species is common at Nahant, Provincetown, and Holmes's Hole, and probably along our entire sea-coast. At low tide it is found upon the beaches beneath stones and sand. On account of the mucus with which it is covered it is known as the Butter-fish. From being enveloped in this secretion, it is with difficulty retained in the hand after it is captured. It is frequently found in the stomachs of other fishes. My son has detected it on the shores of Nova Scotia, and thence southward as far as our own waters.

Bay of Fundy (Island of Grand Menan), Nova Scotia, Maine, New Hampshire, H. R. Storer. Massachusetts, Storer. New York, Mitchill, Dekay.

Gunnellus macrocephalus, *Girard.*

The Big-headed Gunnel.

(Plate XVII. Fig 3.)

Gunnellus macrocephalus, Girard, H. R. Storer, Fishes of Labrador, Bost. Journ. Nat. Hist., vi. p. 263.

Color. Marbled, and banded transversely. Base of dorsal with the generic dark spots, in number twelve or more.

Description. Body elongated, compressed, attaining its greatest depth just posterior to opercular angle. Head quite large, abrupt, triangularly prismatic, the base downward, flattened, however, on occiput; its length one eighth that of body, and just equal to greatest depth of body. Cheeks protuberant. Gape of mouth large, obliquely upward, so that lower jaw, projecting when open, does not equal the upper when mouth is closed. Teeth in two rows in front of jaws; the principal row being the inside one on lower jaw, and the outside one on upper jaw. Eyes moderate, their horizontal diameter double the distance between them. Scales moderate, of nearly equal size throughout body; when covered with mucus, giving the appearance of granulation. Lateral line straight, running along middle of body.

The dorsal fin commences above posterior angle of operculum, and is connected to the caudal by a membrane of less height than its own. Its first rays nearly straight, its posterior ones strongly curved. Its height greatest on a line above tips of pectorals. Membrane stoutest posteriorly.

The pectorals are of moderate size, somewhat fan-shaped.

The ventrals are strongly marked, both the spine and filamentary ray, situated anteriorly to pectorals.

The anal commences about on median line, connected with caudal by a low membrane, and is of nearly equal height throughout. First two rays spinous, the anterior the stouter. Its posterior rays longer than corresponding ones of dorsal.

The caudal is quite large, circular when expanded.

Length, eight inches.

The fin rays are as follows: — D. 76. P. 12. V. I. 1. A. II. 41. C. 20.

Remarks. The specimen from which I have drawn the above description was taken alive, in 1848, by Mr. Girard, from a sand-pool on Chelsea Beach at low tide. It is the only specimen of which I have knowledge, and has since been in the possession of Professor Agassiz, from whom I have it. Its specific value was detected by Mr. Girard while comparing the Labrador species of my son, *Gunnellus ingens*, with the *mucronatus* of our own shores. It most nearly resembles the former, of which there is an accurate and beautiful plate in Vol. VI. of the Boston Journal of Natural History, but is clearly distinct from both.

" Its size is nearly that of *G. ingens*, and is consequently much greater than that of the average *G. mucronatus*. It differs from *G. ingens* in having a proportionally larger head, whence a larger mouth and larger teeth. These last are longer than those of *G. ingens ;* their tip is club-shaped in both. Profile of head very convex above eyes, whereas in *G. ingens* the convexity of the head is in advance of the eyes, thus giving to it a more rounded appearance. Body more compressed than that of *G. ingens ;* height also greater. Lateral line straighter than in that species. The vent, placed under the thirty-fifth dorsal ray, is at an equal distance from the snout and the tip of the caudal, whilst it is a little farther back in *G. ingens*, and rather nearer the head in *G. mucronatus*.

" The dorsal and anal are much higher than in either *G. ingens* or *mucronatus*. The dorsal begins a little farther back than in *G. ingens*. The pectorals are larger; their tip reaching beyond a line with the seventh dorsal spine.

" The rays of the anal show the remarkable peculiarity of having at their anterior and convex margin several small rays converging in an acute angle from the tip to the third or half of the length of the principal ray itself, in imitation on a small scale of the finlets of Scomber and Polypterus, with this difference, however, that in these last the additional small rays are on the posterior margin. In *G. ingens* these rays are dichotomized ; in *G. mucronatus* they are simple."

The ventrals also are larger and placed more anteriorly than in the *G. ingens*.

Massachusetts, Girard.

GENUS IV. ZOARCES, Cuv.

Body elongated, and covered with a mucous secretion, in which are imbedded very small scales. Dorsal, anal, and caudal united; no spinous rays in the dorsal, except on its posterior part. Ventrals jugular, small. Vent with a tubercle. Teeth conical, in two or three rows in front, in a single row on the sides; none on the palate or tongue. Branchial rays, six.

ZOARCES ANGUILLARIS, *Storer.*

The Eel-shaped Blenny.

(PLATE XVII. FIG. 4.)

Blennius anguillaris, PECK, Mem. Amer. Acad., II. pt. 2, p. 46, fig.
Blennius labrosus, Large-lipped Blenny, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 375, pl. 1, fig. 7.
Le Zoarces à grosses lèvres, Zoarces labrosus, CUV. et VAL., XI. p. 466, pl. 342.
Zoarces anguillaris, Eel-shaped Blenny, STORER, Report, p. 66.
" " *Thick-lipped Eel-pout*, DEKAY, Report, p. 155, pl. 16, fig. 45.
" " *Eel-shaped Blenny*, STORER, Mem. Amer. Acad., New Series, II. p. 375.
" " " " " Synopsis, p. 123.
" " H. R. STORER, Bost. Journ. Nat. Hist., VI. p. 263.

Color. The living fish is of a light salmon-color, mottled with irregular olive blotches, darker towards the head. The front and top of the head are of a light brown; two indistinct oblique bands upon the operculum, one back, the other in front, of the eye, on each side of the head. Body beneath white; neck flesh-colored. The dorsal fin is almost white, salmon-colored at its edge. The pectorals are of a true salmon-color, lighter at their origin. The ventrals are salmon-colored. The anal fin is flesh-colored at its base, salmon-colored at its edge, with seven distinct white blotches in its length. The dorsal, pectoral, and anal fins are perfectly transparent.

In the dead specimen the colors are deeper; the general tint is a yellowish-brown or fawn color, sprinkled with darker patches. The front and top of the head are livid; the gill-covers are lighter, but rather dull. The dorsal and anal fins are greenish tinged with yellow.

Description. Body very much elongated, tapering to a point, compressed posteriorly. Its entire surface, with the exception of the head, exhibits innumerable minute cup-like depressions. Head large, compressed at its sides, broad and flat above as far as the angle of the eyes, convex at forehead. Cheeks protuberant. Lips exceedingly fleshy; the upper lip is very large, projecting beyond the lower, and in some individuals even an inch beyond it; the under lip is less fleshy than the upper, and is suspended at its angles like those of a mastiff. The upper jaw slightly projects beyond the lower.

The teeth are large and conical; those in the back of the jaw the sharper; a single row from the entire angle of the upper jaw the extent of four teeth; then a double row of three teeth; then to the middle of the jaw a row of three teeth deep; the front teeth of this triple row are the largest in the jaw. From the outer angle of the lower jaw towards the middle, a single row of eight teeth exists; then a double row of five to six teeth to the middle of the jaw; three rows of sharp teeth in the upper pharyngeals; two rows in the lower pharyngeals. Tongue large, fleshy, smooth. Nostrils tubular, situated about half-way between the eyes and the snout; the distance between the eyes is equal to about one sixth the length of the head. The lateral line, which is most perceptible in immature specimens, commences above the operculum, at a distance in front of its posterior angle equal to the distance between the eyes, and, passing just beyond the posterior angle of the operculum, makes a slight curve downwards, and then passes on towards the posterior extremity of the body in a straight course. The fins are all enveloped in a fleshy membrane.

The dorsal fin commences some distance anterior to the posterior angle of the operculum, and is continued to the tail; previous to reaching which, however, about seventeen of its rays lose their fleshy portion, and exhibit only their spinous bases. The first ray of the dorsal is quite low; the succeeding three or four gradually become higher, making the commencement of the fin to appear rounded when expanded; it gradually diminishes in its height, so that the posterior rays are about two thirds the height of the anterior portion.

The pectorals are broad, rounded at their extremities; the extremities of the inferior rays are slightly scalloped.

The ventrals, appearing like little warts, are situated in front of the pectorals; they are composed of two rays, but, being enveloped in a tough membrane, appear as one.

The anal fin is about half the height of the dorsal; terminating in the caudal, it runs off to an acute point; the rays of these two fins cannot be distinguished from each other.

The fin rays, as far as practicable to be counted, are as follows: — D. 118 or 120. P. 19 or 20. V. 2. A. 100.

Length, three feet.

Remarks. As early as the year 1804, Professor Peck wrote a very good description of this species, and accompanied it with a figure, in the Memoirs of the American Academy.

It is occasionally taken at all seasons of the year, but more frequently in the spring and summer. It sometimes attains the size of three and a half feet, and weighs from one to twelve pounds.

It feeds upon the Mollusca and Testacea, and the flesh of the young fish is sweet and very palatable. The following shells I have found in its stomach: *Buccinum undatum*, *Fusus corneus* and *pleurotomarius* and *turricula*, *Turbo inflatus* and *obscurus*, *Natica triseriata* and *consolidata*, *Bulla tritacea*, *Tellina sordida*, *Nucula minuta*, *Trichotropis borealis*, *Turritella erosa*, *Venus gemma*, *Pecten Islandicus ;* and a species of *Pectinaria.*

It is seldom met with in Boston market; occasionally, however, it is brought in by the cod-fishers of Massachusetts Bay, by whom it is known as the *Ling* and *Conger-Eel.*

Captain Atwood informs me that it is not taken so often at Provincetown of late years as formerly.

My son observed it on the coast of Labrador in 1849.

Labrador, H. R. Storer. New Hampshire, Peck. Maine, Massachusetts, Storer· New York, Mitchill, Cuvier, Dekay.

GENUS V. ANARRHICAS, Lin.

Head smooth, rounded, muzzle obtuse; body elongated, covered with minute scales; dorsal and anal fins long, distinct from the caudal; no ventral fins. Teeth of two kinds; those in front elongated, curved, pointed; the others on the vomer, as also on the jaws, truncated or slightly rounded; branchiostegous rays, six.

Anarrhicas vomerinus, *Agassiz*, MS.

The American Wolf-fish.

(Plate XVIII. Fig. 1. { 1. *a.* head in front. 1. *b.* teeth as seen in front.)

Anarrhicas lupus, Sea-Wolf, Mitchill, Amer. Month. Mag., v. p. 242.
" " " Storer, Report, p. 69.
" " " Dekay, Report, p. 158, pl. 16, fig. 43.
" " " Storer, Mem. Amer. Acad., New Series, II. p. 376.
" " " " Synopsis, p. 124.
Anarrhicas vomerinus, Agassiz, MS.

Color. Of a purplish brown, with ten or twelve transverse nearly black bars passing from the abdomen high upon the dorsal fin. Beneath lighter. One large specimen was of a light flesh-color, thickly spotted with moderately sized black ocelli. Rays of dorsal black, intervening membrane dark gray or slate; pectorals and anal leaden-gray; caudal slate-color, reddish at extremity.

Description. Body elongated, subcylindrical, compressed posteriorly, covered with an extremely viscid secretion. Head large, compressed at sides, rounded, slightly flattened above. Length of head more than one fourth the entire length of the body. Rows of circular mucous pores are seen passing from the snout backwards beneath the eye to the occiput; also irregularly distributed upon the cheeks and along the upper portion of the operculum; a few are observed upon the lower jaw. Eyes moderate in size, the distance between the eyes equal to one fifth the length of the head. Nostrils tubular, situated about half-way between the tip of the snout and the eyes. Jaws equal, armed with long, strong, pointed teeth. The six in the intermaxillary above are much the largest, and diverge outwards; back of these on each side are six smaller, conical, sharp-pointed teeth. Four large recurved teeth in the lower jaw; back of these are about half a dozen sharp-pointed teeth of various sizes, irregularly disposed; a double row of rounded molars, some of them having a pointed summit. Vomerine teeth perfectly united together, forming a solid mass. Two rows of palatine teeth, the outer much the larger. Two rows of sharp teeth in the pharynx. Tongue large, fleshy, fuliginous. Lips loose, fleshy.

The dorsal fin arises in front of the base of the pectorals; it is slightly higher at its anterior portion, and is continued nearly to the tail, appearing as if almost united to it by the prolongation of the membrane of the fin.

The pectoral rays are very large; these fins are rounded when expanded, and slightly scalloped at their margin.

The anal fin arises immediately back of the anus, which is very large, and terminates on the same plane with the dorsal; it is about half the height of the dorsal.

The depth of the caudal at its base is less than one third the height of its rays.

The fin rays are as follows: — D. 74. P. 20. A. 46. C. 16.

Length, three to five feet.

Remarks. Mr. Agassiz considers this a distinct species from the European, basing his opinion upon a difference in the number and disposition of the vomerine tubercles.

This ferocious fish, weighing from five to thirty pounds, is captured about rocky ledges at all seasons of the year, although greater numbers are taken in winter than at any other time.

The Cusk rocks between Boston and Cape Ann are one of its favorite resorts. It feeds upon crustaceous animals and shell-fish. Its hideous appearance renders it an object of such disgust, that it is not unfrequently thrown away as soon as caught. By many of our fishermen, however, it is considered very delicate, the smaller specimens weighing from five to ten pounds are quite palatable when fried, boiled, or broiled, the skin having been previously removed. It is also occasionally split and salted, or dried, or smoked, and is said to be, when thus prepared, very good.

Greenland, Fabricius. Maine and Massachusetts, Storer. New York, Mitchill, Dekay.

FAMILY IX. LOPHIDÆ.

Scales usually absent, or replaced by bony plates, or by small grains armed with spines. The two carpal bones elongated, and forming a kind of arm to support the pectoral fin. Branchial aperture round, or a vertical slit behind the pectorals. Suborbital bone wanting, except in the genus Malthea.

GENUS I. LOPHIUS, Artedi.

Head enormously large, broad, and depressed. Mouth large, armed with slender conical teeth on the jaws, palatines, vomer, and pharyngeals. Tongue smooth. Branchial rays, six; branchial arches, three. Dorsal fins, two; the anterior rays distant, detached, forming long filaments supporting fleshy slips.

Lophius Americanus, *Cuv.*

The American Angler.

(Plate XVIII. Fig. 2.)

Lophius piscator, Bellows-fish or Common Angler, Mitch., Trans. Lit. and Phil. Soc. of N. Y., i. p. 465.
Lophius piscatorius, Angler, Frog-fish, Sea-Devil, Goose-fish, Wide Gab, Storer, Report, pp. 71, 404.
La Baudoire d'Amérique, Lophius Americanus, Cuv. et Val., xii. p. 380.
Lophius Americanus, American Angler, Dekay, Report, p. 162, pl. 28, fig. 87.
" " " " Storer, Mem. Amer. Acad., New Series, ii. p. 381.
" " " " " Synopsis, p. 129.

Color. All the upper part of the body, in the living fish, is of a dark-brown color, caused by minute irregular markings somewhat resembling reticulations, which occasionally appear like blotches; breast of a dirty white color. Cirrhi of a light brown. Pupils black, irides yellowish-brown.

Description. Body compressed, orbicular anteriorly, elongated and attenuated posteriorly. Its width in front of the pectoral fins is rather less than one half of its length. The length of the head from the tip of the snout to the occiput is equal to about one fourth the length of the entire fish. Numerous fleshy cirrhi are arranged along the lower jaw, edging it to its angles; beyond these, they are continued to, and upon, and back of, the pectoral fins, to the base of the tail: beneath the jaw these cirrhi are much larger than they are upon the sides of the body; on the posterior portion of the body they are smallest. The branchial apertures are large, and situated under and back of the pectorals. The vertical gape of the mouth, when expanded, is very large; the distance across the head, from the outer angles of the jaws, is less than one third the length of the fish; the tip of the lower jaw projects beyond the upper. The intermaxillary bones are capable of being protruded considerably beyond the maxillaries, and are armed with a single row of small, pointed teeth upon each side, and two rows of much larger teeth in their centre, the innermost row being the larger; one of these is upon the edge, the other within and beneath, very incurved. Upon the upper jaw at its tip is a space of one and a half inches destitute of teeth; on each side of this space is one quite large tooth, and a second much smaller; about half an inch outside of these is a single row of eight or ten teeth, the first three or four of which are much the largest. On each side of the pharynx are three rows of sharp incurved teeth resembling spines; these rows are arranged directly above each other, and are double. The lower jaw has a single row of numerous, very sharp teeth: the tongue has a broad, bony, triangular plate upon each side, armed with two rows of teeth which are recurved. The distance from the margin of the upper jaw to the eye is about equal to the distance between the eyes. Several spines are situated upon the head: two just back of the snout on each side; a bifurcated one over the middle of the eye, and another similar one at its posterior angle; and a small one on a line back of these, at the posterior portion of the head. A spine pointing forwards is situated just back of the angle of the jaws, and three straight spines are seen back of this. The eyes are oval. Just back of the snout are two elongated, naked tentaculæ, of the fineness of bristles, with the extremities free. As the tentaculæ are depressed, directly at their posterior extremities is situated a third, with about half of its extent only naked; all the tentaculæ are capable of being elevated at the pleasure of the animal.

The first dorsal fin is situated a short distance back of the third tentaculum; it is composed of three small rays, the posterior of which is the shortest, connected at their bases by a dark-colored membrane.

The second dorsal fin is composed of stout, fleshy rays; it is rounded posteriorly, and is as long again as high.

The pectorals are rather higher than long, slightly digitated at their extremities, and ciliated.

The ventrals are stout and fleshy; their anterior ray is bifurcated at its base.

The anal fin arises back of the commencement of the second dorsal; its posterior portion is the higher.

The caudal fin is stout, fleshy, and digitated at its extremity.

The fin rays are as follows: — D. 3 – 11. P. 24 or 25. V. 5. A. 9. C. 8.

Length, four feet.

Remarks. This fish, which weighs from fifteen to seventy pounds, is not a common species in Massachusetts Bay, although it is taken throughout its whole extent from Lynn to Provincetown during the months of September, October, and November, and is met with in great numbers at its mouth. It is captured with the hook, while fishing for other species, and also in nets. Among the fishermen in some parts of the Bay, there is a common saying, "When you take a goose-fish, look out for an easterly storm." It is exceedingly voracious, feeding upon all kinds of fish, and the capacity of its mouth enables it to swallow species as large as itself. Captain Atwood, of Provincetown, tells me he has repeatedly seen one swimming towards the shore with another of the same species as large as itself in its mouth. And both he and Captain Nathaniel Blanchard, of Lynn, assure me, that, when opened, entire sea-fowl, such as large gulls, are frequently found in their stomachs, which they supposed them to catch in the night, while they are floating upon the surface of the water. I was informed by Captain Leonard West, of Chilmark, that he had known a goose-fish to be taken having in its stomach six coots in a fresh condition. These he considered to have been swallowed when they had been diving to the bottom in search of food. No use is made of this fish, as its liver contains but little if any oil; and its flesh has no fat. This is a singular fact, as most, if not all, other fish have either fat in their livers or in their flesh. It is seldom that fat is found both in the liver and in other parts of the body of a species. The dog-fish, however, supplies the fishermen with oil from its liver, and its body when dried will burn, to use a fisherman's words, "like fat pine." This is considered a very stupid fish; thousands run ashore at Provincetown every season, and are thus destroyed. They frequently swim towards the shore in the day-time, and if pushed into the water by a passer-by are as likely to turn again to the shore as from it.

Maine, Massachusetts, STORER. Connecticut, AYRES. New York, MITCHILL, CUVIER, DEKAY. Delaware, DEKAY.

GENUS II. CHIRONECTES, Cuv.

Head vertically compressed. Three free rays on the summit of the head. Mouth cleft more or less vertically, opening to the gills by a round aperture behind the pectorals. Tongue edentate. Intermaxillaries, lower jaw, vomer, palatines, and pharyngeals with minute, card-like teeth. Dorsal long.

CHIRONECTES LÆVIGATUS, *Cuv.*

The Smooth Mouse-fish.

(PLATE XVIII. FIG. 3.)

Chironectes lævigatus, CUV., Mém. du Muséum, III. p. 423, pl. 16, fig. 1.
Le Chironectes uni, *Chironectes lævigatus*, CUV. et VAL., XII. p. 399.
Chironectes lævigatus, *Smooth Chironectes*, STORER, Report, p. 73.
" " *Smooth Mouse-fish*, DEKAY, Report, p. 165, pl. 27, fig. 83.
" " STORER, Mem. Amer. Acad., New Series, II. p. 382.
" " " Synopsis, p. 130.

Color. Brownish, with irregularly distributed lighter-colored blotches margined with white. Besides these blotches, numerous yellowish spots are scattered over the entire surface. The markings upon the dorsal, anal, and caudal fins form irregular transverse bands. Pectorals and ventrals marked with white dots.

Description. Body smooth, much compressed laterally, tapering to the tail; thickest at pectorals. Greatest depth less than half its length. Between and above the eyes is situated a dark-colored flexible ray, terminated by a slight filament. Behind this are ten rays connected by a strong membrane, which is continued posteriorly; one of these rays is quite large and stout; a filament is suspended from its extremity. Minute cuticular processes are observed beneath, and along the edge of, the lower jaw; one exists at the base of the ray, between the eyes. Eyes small, circular. Jaws armed with numerous minute teeth. Branchial orifice, a small aperture beneath the pectorals.

The dorsal fin, which is longer than high, commences on a line above the origin of the pectorals, and is continued to the fleshy portion of the tail.

The pectorals are stout, expanded, and digitated at their extremity.

The ventrals are situated in front of the pectorals, and are digitated like those fins.

The anal fin commences opposite the posterior portion of the dorsal; it is higher than long, and is rounded.

The caudal fin is rounded.

The fin rays are as follows: — D. 12. P. 10. V. 5. A. 6. C. 9.

Length, from two to four inches.

Remarks. The only specimens of this species I have known to be taken in this State were sent me several years since from Holmes's Hole, by the late Dr. Yale of that place.

Massachusetts, STORER. New York, DEKAY. South Carolina, CUVIER.

GENUS III. BATRACHUS, Schneider.

Head depressed, broader than body. Ventrals jugular, with three rays; the first elongated. First dorsal small; second low and long. Base of the pectorals elongated. Branchial aperture small, with six rays. Subopercle as large as the opercle, and both spinous. No suborbital. Teeth on the jaws, front of the vomer and palatines.

Batrachus tau, *Lin.*

The Common Toad-fish.

(Plate XIX. Fig. 1, 2, young and adult fish.)

Gadus tau, Lin., Syst. Nat. (twelfth edition), p. 440.
" " Bloch, ii. p. 150, pl. 67, fig. 2 and 3.
" " *Toad Gadus*, Shaw, Gen. Zoöl., iv. p. 159.
Lophius bufo, Toad-fish, Mitch., Trans. Lit. and Phil. Soc. of N. Y., i. p. 463.
Batrachoides variegatus, var. a. b., Lesueur, Journ. Acad. Nat. Sc., iii. pp. 399, 401.
Batrachus variegatus, Toad-fish, Storer, Report, p. 74.
Le Batrachoïde tau, Batrachus tau, Cuv. et Val., xii. p. 478.
Batrachus tau, Common Toad-fish, Dekay, Report, p. 168, pl. 28, fig. 86.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 384.
" " " Synopsis, p. 132.

Color. Yellowish, the entire surface of the head, sides, and abdomen marbled with black spots, which are confluent upon the sides, presenting the appearance of irregular bands. All the fins also barred with black. The dorsal bands oblique, those of pectorals and caudal concentric, five or six in number.

Description. Shape of fish broad anteriorly, laterally compressed posteriorly; its width gradually diminishing to extremity of caudal fin. Length of head one third that of entire fish; its breadth equal to its length. Greatest depth equal to one fourth its length. Body entirely covered by a copious viscid secretion, which flows from numerous mucous pores distributed over its surface, those on the head being much the largest. Head large, compressed above, rounded anteriorly. Mouth very large. Lower jaw the longer. Jaws covered with strong, conical, and distinct teeth, disposed in several rows in front and in a single row behind in each jaw. Teeth also, but smaller and crowded, on intermaxillaries and vomer; none on palatine bones. Tongue scarcely perceptible. Lips large and fleshy. Nostrils double. Four small and blunted cirrhi on chin; on each side of these, along the margin of the lower jaw, a series of five or more larger ones sometimes palmated at tips. Also a very large cirrhus over each eye, preceded by a much smaller one. Eyes moderate, slightly oblique, guarded by a thick, gelatinous membrane. Preoperculum armed with three distinct concealed spines, the middle the smallest. Branchial aperture of same width as base of pectoral fin. The lateral line, marked throughout its whole extent by very distinct mucous pores, arises just back of upper spine of operculum, and runs nearly a straight course high up on the back to the tail.

The dorsal fin arises just back of the head, and is continued to the tail. Its first three rays are spinous, the central one being much the longest; these are united to the fleshy rays by a deeply emarginated membrane. Fleshy portion of nearly uniform height. Rays multifid. Terminates abruptly at base of tail, to which it is connected by a membrane.

The pectorals, stout and fleshy, arise at the lower edge of the branchial opening; rounded and fan-shaped when expanded.

The ventrals, of very irregular shape, originate some distance in front of pectorals; the first ray, which is stout and falciform, is enveloped in a thick, fleshy membrane. Fin tied down to abdomen posteriorly.

The anal fin commences beneath the anterior third of the dorsal, and terminates on a line with the posterior extremity of that fin; the fleshy margin is strongly digitated.

The caudal fin is broad and rounded posteriorly.

The fin rays are as follows: — D. 3 – 27. P. 16. V. 3. A. 24. C. 14.

Remarks. The Toad-fish is an inhabitant of our entire Atlantic coast, extending its residence also even as far as into the Gulf of Mexico, and to some of the West India Islands. It lives generally in shoal water, being seldom taken at any great distance from the shore. The particular situations which it chooses vary with the nature of the coast. Thus along our Southern shores it is found in the shallow bays. The sandy or muddy bottom of these is overgrown with Eel-grass (*Zostera marina*), under cover of which it lives in security, and finds abundant sources of food. Where the coast, on the contrary, is more or less rocky, we meet with it chiefly under stones. Examining the places where the water is but a few inches in depth at low tide, we see that, under many of the stones and smaller rocks, the sand on one side has been removed, leaving a shallow cavity, perhaps a foot in width, and extending back beneath the stone. If we approach this cautiously, we shall probably distinguish the head of a Toad-fish, very much in the position of that of a dog as he lies looking out of his kennel. The fish is at rest, and might be overlooked by a careless observer. A closer attention, however, readily distinguishes the curve of its broad mouth, the delicate laciniated processes with which its jaws and other parts of its head are ornamented, its truly beautiful eyes, and sometimes the anterior portion of its body. At the slightest alarm, it retreats beneath the stone, but presently reappears. It is lying here, perhaps merely as in a safe resting-place, perhaps on the watch for its prey.

But during the months of June, July, and August, we shall in many instances be able to discover another purpose, — it is apparently guarding its eggs or young. We shall then find, on the inferior surface of the stone, the young Toad-fish adhering, to the number of several hundreds. They will be in different stages of development, according to the season of our examination. We may see the eggs, not larger than very small shot; a little later they are increased in size, and the young fish plainly visible through their walls; a little later still, the young have made their escape, but are still attached to the stone. The attachment now, however, is accomplished in a different manner. The yolk, not being yet absorbed, occupies a rounded sac protruding by a narrow orifice from the abdomen, and the part of this sac near its outer border, being constricted, leaves external to it a disc, by means of which, acting as a sucker, the young fish adheres so firmly as to occasion difficulty in detaching it. They remain thus until they have attained the length of half or three quarters of an inch, or until the yolk-sac is entirely absorbed. During this period an adult fish occupies the cavity beneath the stone, and if driven from it speedily returns. That this is, in all cases, the mother of the young ones, and that she is there for the purpose of guarding them, we have no means of determining: we can only infer it. Although the assertion, that fish have no affection for their young, has long been considered universally true, yet exceptions to it are now well known to exist. Our common Cat-fish, or Horned Pout, furnishes an example, and the habit of the Batrachus here described appears to give another illustration bearing on the same point.

During the winter months, in our colder latitudes, the Toad-fish in some instances, perhaps, retire into deep water; it is true, however, that many of them become nearly torpid. They are found buried beneath the mud, in the same manner as the Eels, and are sometimes taken with the spear thrust down in search of their more valued neighbors. One which was caught in this way was nearly as vigorous and capable of motion after twenty-four hours of removal from the water, as when first taken.

The Toad-fish is not commonly employed as an article of food. Its slippery, slimy surface, and its generally repulsive aspect, cause it to be looked on rather with disgust. That its flesh, however, is delicate and good, can scarcely be questioned, though the small size which it attains, — eight inches to a foot in length, — and the fact that it is never taken in any large quantities, prevent it from being of much economical value.

The specific name *tau*, given to this species by Linnæus, is derived from a character not discernible until the fish is dead and his integuments have become dry. The bones on the upper surface of the skull are then seen to present a transverse ridge met by another in a longitudinal direction, thus resembling the Greek letter T (tau).

For the beautiful living specimen, from which my description and drawing have been made, I am indebted to John Manchester Smith, M. D., of Tisbury; and the notes upon the habits of this species were furnished me by my excellent friend, William O. Ayres, M. D., a very accurate observer, of East Hartford, Connecticut, now established in San Francisco, California.

Maine, Massachusetts, STORER. Connecticut, AYRES. New York, MITCHILL, CUVIER, DEKAY. Gulf of Mexico, CUVIER.

FAMILY X. LABRIDÆ.

Body oblong and scaly; a single dorsal is supported in front by spines, each of which is generally furnished with a membranous appendage; the jaws are covered with fleshy lips; there are three pharyngeals, two upper ones attached to the cranium, and a large lower one, all three armed with teeth, sometimes *en pavé*, sometimes in points or laminæ, but generally stronger than usual; an intestinal canal without cœca, or with two very small ones, and a strong natatory bladder.

GENUS I. CTENOLABRUS, VAL.

Body elongated. Preopercle denticulated. A band of velvet-like teeth in front; behind, the conical teeth, in the jaws. Three spinous rays to the anal fin.

CTENOLABRUS CERULEUS, *Dekay*.

The Common Conner.

(PLATE XX. FIG. 1.)

Tautoga cerulea, Blue-fish or Bergall, MITCHILL, Report in part, p. 24.
Labrus chogset, Bergall of New York, MITCHILL, Trans. Lit. and Phil. Soc. of N. Y., I. p. 402, pl. 3, fig.
Crenilabrus burgall, SCHOEPFF, Griffith's Cuv., X. p. 258.
" " *Conner, Blue Perch, Chogset*, STORER, Report, p. 78.
" " " " " AYRES, Bost. Journ. Nat. Hist., IV. p. 263.
Le Ctenolabre chogset, Ctenolabrus chogset, CUV. et VAL., XIII. p. 237.
Ctenolabrus ceruleus, The Common Burgal, DEKAY, Report, p. 172, pl. 29, fig. 93.
Ctenolabre mouché, Ctenolabrus uninotatus, CUV. et VAL., XIII. p. 239.
" " " " DEKAY, Report, p. 174, pl. 29, fig. 90.
Ctenolabrus ceruleus, STORER, Mem. Amer. Acad., New Series, II. p. 386.
" " " Synopsis, p. 134.

Color. This species varies exceedingly in its coloring: some specimens being of a deep-blue color; others, of a uniform brown or rust color; while the ground of others is greenish, with copperish spots; or red, with black points or dots sprinkled over their entire surface, including oftentimes the fins. Irregular bluish lines, appearing like hieroglyphics, are distributed over the head; these are more strongly marked between and in front of the eyes than on the neck. The pupils are black, the irides a beautiful silver.

Description. Form elongated. Its height measured across to the anus, including the dorsal fin, is not quite equal to one third of its length; its thickness is about equal to half of its height, not measuring the dorsal fin. The length of the head to the length of the entire fish is as one to four: it is slightly flattened upon its top, and on the back of the neck, in front of the dorsal fin, is a perceptible convexity. The portion o he head between the eyes, and in front of them to the angle of the jaws, is destitute of scales, as well as the lower portion of the opercula. The scales upon the operculum are larger than those upon the preoperculum. The preoperculum is finely denticulated upon its posterior edge, throughout its whole length: the posterior edge of the operculum is bordered by a fleshy membrane.

The jaws are equal, and are armed with numerous teeth; the six front teeth in either jaw larger than the others; the front teeth in the upper jaw larger than the corresponding ones in the lower. The upper jaw is very projectile. The lips are large and fleshy. The eyes are circular; the diameter of the eye is equal to one fifth the length of the head.

The lateral line arises just back of the superior angle of the operculum, and curves with the body until about opposite the termination of the dorsal fin, whence it pursues a straight course to the tail.

The dorsal fin arises on a line with the posterior angle of the operculum, and terminates within about an inch of the tail. It has eighteen strong spinous rays, the extremities of which are naked; the upper portion of their connecting membrane is free, presenting the appearances of small filaments or tentacles; the eleven posterior rays are membranous. The spinous rays gradually increase in height from the first to the membranous rays, which are still more elevated. The first spinous ray is very short, being only one seventh the height of the last spinous ray. The membranous portion of this fin is rounded when expanded.

The pectorals arise on a line with the dorsal; their height is to their length as three to one.

The ventrals are just back of the pectorals; the first ray is a strong spine. The length of these fins is to their height as one to three.

The anal fin has three spinous rays; from the extremities of these spines, as well as from that of the ventral fins, filaments are suspended as in the dorsal fin.

The caudal fin is nearly even at its posterior extremity; its rays are longer than high.

The fin rays are as follows: — D. 18 – 11. P. 15. V. 6. A. 12. C. 16.

Length, from six to fourteen inches.

Remarks. This very common species is taken from the middle of June until late in October, and is brought to market in immense quantities. Being considered an excellent fish for the table when fried, it meets with a ready sale. It is caught with the hook along our entire coast, from the rocks and bridges and boats; and is taken along the shores of the islands in great numbers in nets. It is kept alive for the market in large cars, which are located in the neighborhood; these cars, which are about three feet deep and twelve or fifteen feet in length, are closed beneath, and latticed at their sides; being anchored in deep water, the tide is constantly flowing through them and changing the water. Sometimes as many as five thousand fish will be contained in a single car; this car will be daily called upon for the supply needed in the market, and is replenished each week or fortnight, as may be required.

Newfoundland, Cuvier. Maine, Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Cuvier, Dekay.

GENUS II. TAUTOGA, Mitch.

Jaws with a double row of teeth. Opercle and preopercle without spines or denticulations, and with few or no scales.

Tautoga Americana, *Dekay.*

The Tautog.

(Plate XX. Fig. 2.)

Labrus Americanus, Bloch, Schn., p. 261.
Tautoga niger, Mitchill, Report in part, p. 23.
Labrus tautoga, Black-fish or Tautog, Mitchill, Trans. Lit. and Phil. Soc. of N. Y., i. p. 399.
Labrus Americanus, Black-fish or Tautog, Storer, Report, p. 76.
" " " " Ayres, Bost. Journ. Nat. Hist., iv. p. 263.
Le Tautogue noir (*Tautoga nigra*, Mitch.), Cuv. et Val., xiii. p. 293.
Tautoga Americana, New York Tautog, Dekay, Report, p. 175, pl. 14, fig. 39.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 389.
" " " Synopsis, p. 137.

Color. This species varies considerably in its markings. Generally, however, it is of a bluish-black above, diversified with bands and blotches, mottled with darker spots towards the abdomen, which is whitish. Pupils black, irides silvery.

Description. The body is regularly arched from the tip of the snout to the extremity of the dorsal fin; its height across the base of the ventrals, not including the dorsal fin, is about equal to the length of the head. The length of the head, to the posterior angle of the operculum, is equal to about one fourth the length of the body, including the tail. The head is naked, with the exception of a patch of small scales upon the upper part of the operculum, and a vertical band of similar scales upon the preoperculum, just back of the eyes. The lips are large and fleshy; the jaws have two rows of conical teeth: those of the first row are strong, the front teeth being the largest; those of the second row scarcely project above the flesh of the jaws. Teeth in the pharynx. The eyes are circular, the diameter equal to half the distance between them. The nostrils, which are small and double, are situated in front of and above the anterior angle of the eyes. The lateral line arises just above the operculum, and curves with the body.

The dorsal fin rises just back of the pectorals; the first seventeen rays terminate in naked spines, at the base of which are small floating tentaculæ; the posterior, fleshy rays of this fin are nearly as high again as the spinous rays, and this portion of the fin is of a rounded form. This fin extends to within a short distance of the tail. The base of the rays is scaled.

The pectorals commence just in front of the posterior angle of the operculum; they are rounded at their extremities. Their length to their height is as one to three.

The ventrals are situated a short distance back of the pectorals; their length is equal to about one fourth of their height. The outer ray is spinous, and is about half as high as the middle ray.

The anal fin arises opposite the last spinous ray of the dorsal fin, and terminates on the same plane with that fin; the first three rays are spinous; the fleshy portion is of the same form as the corresponding portion of the dorsal fin; this fin is longer than high.

The caudal fin is even at its extremity; its rays are covered with scales for about one half of their height.

The fin rays are as follows: — D. 28. P. 15. V. 6. A. 11. C. 15.

Length, six to eighteen inches.

Remarks. Although a few years only have passed since this species was brought into Massachusetts Bay, it is now taken along a large portion of the coast. At Plymouth, Nahant, and Lynn, at some seasons, it is found in considerable numbers, and is frequently caught from the bridges leading from Boston. A specimen was taken from one of these bridges a year or two since which weighed eleven pounds and three quarters. The Boston market is for the most part supplied by Plymouth and Wellfleet. At the former place they are taken at Monument Point. I am told that two or three families reside at Billingsgate Point, Wellfleet, who pursue no other avocation than that of taking Tautog, and are thus enabled to support themselves. Many of the fish are carried to New York from Wellfleet.

The Tautog fishery continues from April to November, and the fish is taken by the hook alone. Besides the large number of Tautog sold in the recent state, they are also pickled, and may be kept in a weak brine for a long time. In this state they are considered by epicures a great delicacy. When fresh, this species sells in the market for from eight to twelve cents per pound. Its ordinary size is from one to two pounds, although they often exceed that weight. Mr. Henry Blood, of New Bedford, informed me that a specimen of this fish was taken in Rochester harbor which weighed fourteen pounds and three ounces. The largest individual of which I have any accurate knowledge weighed sixteen pounds. Dekay states that he had "heard of one which weighed twenty pounds, but the largest he had seen did not exceed twelve pounds."

Maine, Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Cuvier, Dekay. South Carolina, Dekay.

ORDER II. MALACOPTERYGII. SOFT-RAYED.

All the fin rays soft and cartilaginous, with the exception sometimes of the first in the dorsal and the first in the pectoral fins. These rays are of an articulated structure, and generally more or less branched at their extremities.

ABDOMINALES.

The ventrals behind the pectorals, and not attached to the humeral bone.

FAMILY XI. SILURIDÆ.

Skin naked, and covered with a mucous secretion. In some genera the body is nearly covered by osseous plates. Head depressed, and generally enlarged, with several fleshy filaments. A second adipose dorsal often present. The intermaxillaries, suspended under the ethmoid bone, form the edge of the upper jaw. First ray of the dorsal and pectoral fins usually a strong, articulated spine, with a complicated movement.

GENUS I. PIMELODUS, Cuv.

Palate smooth and without teeth. Barbels varying from six to eight. Casque occasionally present.

Pimelodus atrarius, *Dekay.*

The Horned Pout.

(Plate XX. Fig. 3.)

Pimelodus nebulosus, Storer, Report, p. 102.
Pimelodus catus, Storer, Mem. Amer. Acad., New Series, II. p. 402.
" " " Synopsis, p. 150.
Pimelodus atrarius, Dekay, Report, p. 185, pl. 36, fig. 116.
" " Storer, Mem. Amer. Acad., New Series, II. p. 404.
" " " Synopsis, p. 152.

Color. The living fish is of a fuliginous color, darker upon the head and back, approaching to black; lighter upon the sides, which are tinged with a cupreous shade; white beneath in front of the ventrals; yellowish beneath the lower jaw and the under portion of the branchiæ. Irides silvery. Pupils blue. All the fins are dark-colored, In the dead specimen the coloring matter readily rubs off; and the individual, even if untouched, rapidly becomes of a lighter color.

Description. Body elongated, compressed posteriorly; head flattened above; a convexity anterior to the dorsal fin. Length of the head to the posterior angle of the opercular spine, to the entire length of the fish, about as one to four. Greatest width of head equal to about one sixth the length of the fish; greatest depth of the fish greater than the width of the head. Upper jaw the longer, both jaws furnished with numerous small teeth; eight cirrhi about the head; that at the angle of the upper jaw, on each side, much the longest. Two others are situated back of, and above these, on each side; beneath the lower jaw are also four cirrhi, two on each side of its middle, the outer the longer; all the cirrhi of the same color. The eyes are circular and very small; distance between the eyes equal to about one half the length of the head. Two blunted spines or processes on the humeral bones, the upper much the smaller. The lateral line arises above the posterior angle of the operculum, and runs a very slightly curved course to the tail.

The dorsal fin is situated on the anterior third of the fish; its length is equal to half its height. Its first ray is spinous, and shorter than the central rays. A small adipose fin is situated within a short distance of the tail.

The pectorals arise on a line a short distance in front of the posterior angle of the operculum; their length is equal to about one third their height; their outer ray is spinous and serrated upon its outer edge; it is naked at its point, and shorter than the first fleshy rays. When taken, great caution is necessary in removing this species from the hook, it having the power to erect this spine to defend itself.

The ventrals arise on a line just back of the dorsal fin; the length of these fins is equal to about one third their height. Anus large, oblong, beneath the posterior half of the ventrals.

The height of the anal fin is equal to about half its length.

The caudal fin is concave; the upper lobe slightly the longer.

The fin rays are as follows: — D. 1 – 6. P. 1 – 8. V. 8. A. 20. C. 19.

Length, seven to nine inches.

Remarks. This is quite a common species in the ponds throughout the State, and is familiarly known as the *Horned Pout* and *Minister.* Specimens are occasionally taken weighing three quarters of a pound. By many, it is highly esteemed as an article of food, and preferred to any other fresh-water fish save the Pickerel. It is generally fried, the skin having been previously removed.

Maine, New Hampshire, Massachusetts, Storer. Connecticut, Ayres. New York Mitchill, Cuvier, Dekay.

FAMILY XII. CYPRINIDÆ.

Mouth moderately or but slightly cleft, terminal, subterminal, or inferior; upper margin formed by the intermaxillaries. Jaws rather weak and without any teeth. A pharyngeal arch of curved and sometimes hooked teeth, disposed upon one or a double row. Branchial rays not very numerous. Top and sides of head generally smooth, and always without any scales. Body scaly. No great disparity in the fins between the sexes. Stomach without cul-de-sac; no cœcal appendages to the pylorus. Least carnivorous of all fishes.

GENUS I. CYPRINUS, Lin.

Body covered with large scales; a single elongated dorsal fin; lips fleshy; mouth small; teeth in the pharynx, but none on the jaws; branchial rays, three.

Cyprinus auratus, Lin.

The Golden Carp.

(Plate XXI. Fig. 1.)

Cyprinus auratus, Lin., Syst. Nat.
" " Bloch, III. pl. 93, 94.
" " *Gold Carp*, Pennant, Brit. Zoöl., III. p. 490.
" " *Golden Carp*, Jenyns, Brit. Vert., p. 403.
" " *Gold Carp*, Yarrell, Brit. Fishes (2d edit.), I. p. 361.
" " *Golden Carp*, *Gold-fish*, Griffith's Cuv., x. p. 377.
" " " " Storer, Report, p. 82.
" " " " Dekay, Report, p. 190.
Le Carpe dorée, *Cyprinus auratus*, Cuv. et Val., XVI. p. 101.
" " Storer, Mem. Amer. Acad., New Series, II. p. 407.
" " " Synopsis, p. 155.
Carrassius auratus, Heck., in Russ. Reise, II. p. 1014.

Color. All the upper part of the body a bright orange; sides lighter; beneath, silvery. Fins color of the back. Occasionally the larger species are dark-colored above, and the fins are margined with black.

Description. Body convex in front of dorsal fin. Its greatest depth is equal to rather less than one fourth its length. Scales large, striated. The lateral line pursues nearly a straight course to the tail. The head is flattened between the eyes; its length is equal to the greatest depth of the fish. Eyes prominent; their diameter is equal to one half the distance between them. Mouth small, very projectile. Nostrils large.

The dorsal fin commences on the anterior half of the body, and is as long again as high. The first two rays are spinous; the first is very short and slightly roughened behind; the second is much longer, and is strongly serrated posteriorly. The first two membranous rays are higher than the others, which gradually diminish in height to its posterior extremity.

The pectorals arise just back of the opercula, and extend beyond the origin of the ventrals.

The ventrals commence on a line beneath the origin of the dorsal fin, and are of the same length as the pectorals.

The anal fin is higher than long; its first two rays are spinous, serrated behind like those of the dorsal.

The caudal fin is deeply lunated.

The fin rays are as follows: — D. 15. P. 15. V. 9. A. 7. C. 18.

Length, six to ten inches.

Remarks. This beautiful species, which is a native of China, was introduced many years since into this country, and is now extensively known among us. It thrives in quite a number of ponds in the neighborhood of Boston, connected with country-seats, bearing well the rigors of our winters, and breeding freely. This species varies exceedingly in its appearance in different individuals. Yarrell, in his "History of British Fishes," observes: "M. de Sauvigny, in his *Histoire Naturelle des Dorades de la Chine*, published at Paris in 1780, has given colored representations of eighty-nine varieties of the Carp, exhibiting almost every possible shade or combination of silver, brilliant orange, and purple." It is a very common circumstance to observe an abnormal condition of one or more of the fins in this fish. Yarrell says: "These fishes are sometimes seen with double anal fins, and others with triple tails; when this occurs, it is generally at the expense of the whole or part of some other fin: thus the specimens with triple tails are frequently without any portion of the dorsal fin, and such specimens have been figured by Bloch and others.' Among two dozen Gold-fish for sale in London, were some with dorsal fins extending more than half the length of the back; some, on the contrary, had dorsal fins of five or six rays only, and one specimen without any dorsal fin whatever."

Massachusetts, STORER. New York, DEKAY.

GENUS II. LEUCOSOMUS, HECK.

Body very much compressed, flattened laterally, and deepest at the middle of its length. Head proportionally small, and compressed like the body. Mouth small, terminal, unprovided with cirrhi or barbels of any kind. Eyes very large. Caudal fin forked. Body covered with large scales appearing higher than long when observed imbricated, but which are in fact as long as high and even longer than high when examined in an isolated state. Lateral line forming a very open curve upon the abdomen, convex downwards. Dorsal and anal fins without strong and spiny rays at their anterior margins. Insertion of ventrals in advance of the anterior margin of the dorsal. Pharyngeal teeth conical, pointed, and slightly curved at tip, and disposed upon a double row.

This genus is allied to *Hypsolepis*, from which it differs by its flattened body, small head and mouth, the shape of its scales, and the insertion of the ventral fins.

LEUCOSOMUS AMERICANUS, *Girard.*

The Shiner.

(PLATE XXI. FIG. 2.)

Cyprinus Americanus, LACEP., v. pl. 15, fig. 3.
" " *American Carp*, SHAW, Gen. Zoöl., v. p. 204.
Cyprinus chrysoleucas, *New York Shiner*, MITCH., Trans. Lit. and Phil. Soc. N. Y., I. p. 459.
Leuciscus chrysoleucas, STORER, Report, p. 88.
Stilbe chrysoleucas, *New York Shiner*, DEKAY, Report, p. 204, pl. 29, fig. 91.
Leuciscus Boscii, *L'Able de Bosc*, CUV. et VAL., Hist. Nat. Poiss., XVII. p. 313.
Leuciscus Americanus, STORER, Mem. Amer. Acad., New Series, II. p. 408.
" " " Synopsis, p. 156.
Leucosomus chrysoleucas, HECK., in Russegger's Reise, II. p. 1042.
Leucosomus Americanus, GIRARD, in Lit.

Color. General color of the back and upper part of sides greenish. Scales with golden reflections; lower portion of sides golden. Abdomen, yellowish-white; opercles golden. Pectorals reddish-yellow. Ventrals and anal red, tinged with black. Dorsal and caudal yellowish-brown. Pupils black, irides golden.

Description. Body very much compressed; its greatest depth rather less than one fourth its entire length; the length of the head equal to about one sixth the length of the body. Head naked, above somewhat depressed. Eyes circular, their diameter equal to one fourth the length of the head.

The lateral line, consisting of about fifty-six scales, commences just back of the superior angle of the operculum, and, passing obliquely down over about eighteen scales, opposite the posterior extremity of the pectoral fins very gradually passes up again towards the posterior extremity of the body, assuming nearly a straight course, which is pursued to the middle of the caudal rays.

The dorsal fin, which is situated upon the middle of the dorsum, is triangular and partly shuts into a groove at its base when not expanded. The first two rays are simple, the remainder multifid. The first ray is very short; the second is as long as the head.

The pectorals commence at the posterior inferior angle of the operculum; they are less high than the dorsal.

The ventrals are fan-shaped, and their rays are multifid.

The anal is quadrangular, and commences on a line opposite the termination of the base of the dorsal; it is emarginated above. Its first three rays are simple.

The fin rays are as follows: — D. 9. P. 17. V. 9. A. 13 – 16. C. 19 – 22.

Length, seven inches.

Remarks. This species is very common in the ponds throughout the State. It is seldom found in Boston market, although it is said to be a delicate fish for the table. It is generally used as bait for Pickerel, and is considered the best bait for that fish.

Massachusetts, STORER. New York, MITCHILL, DEKAY. Ohio River, KIRTLAND. Pennsylvania, South Carolina, CUVIER.

GENUS III. HYPSOLEPIS, BAIRD, MS.

Body rather short, compressed, much the deepest upon the middle of its length. Head very large, sub-conical. Mouth of medium size and terminal; no cirrhi nor barbels of any kind. Jaws equal. Eyes large. Tail tapering. Caudal fin forked. Body covered with very large scales, much higher than long. Lateral line running beneath the middle of the flanks, very conspicuous from the head to the base of caudal fin, and slightly bent downwards upon the abdomen. Dorsal and anal fins without strong and spiny rays at their anterior margins. Insertion of ventrals beneath the anterior margin of dorsal. Pharyngeal teeth disposed upon a double row; external row composed of a few teeth only. Skull twice as broad upon the occiput as between the eyes.

HYPSOLEPIS CORNUTUS, *Girard.*

The Red-fin.

(PLATE XXI. FIG. 3.)

Cyprinus cornutus, Red-fin, or Rough-head, MITCH., Amer. Month. Mag., II. p. 324.
Leuciscus cornutus, Red-fin, STORER, Bost. Journ. Nat. Hist., IV. p. 182.
" " " " Mem. Amer. Acad., New Series, II. p. 409.
" " " " Synopsis, p. 157.
" " " DEKAY, Report, p. 207, pl. 29, fig. 92.
Hypsolepis cornutus, GIRARD, in Lit.

Color. Above, blackish-brown with metallic reflections. Sides brilliant, cupreous. After death, the appearance of a broad longitudinal band upon sides. Dorsal and caudal fins dark brown, sometimes mottled with darker color; ventrals and pectorals light-colored; all the fins and the opercles margined with crimson.

Description. Body cylindrical, quite deep anterior to dorsal fin. Greatest depth of fish more than one fifth its entire length. Lateral line commences at the posterior superior angle of operculum, and, curving downwards to posterior extremity of pectorals, pursues thence a straight course to tail, including in its course fifty scales. Length of head equal to one fifth the length of the fish. Head naked upon its sides, covered upon its top, the sides of the snout, and along the edge of the lower jaw, with numerous pointed horny tubercles, broad at their bases, and acute at their tips, which are larger along the edge of the jaw and quite small upon the top of the head. Very small asperities are felt back of the occiput, upon the dorsum, which to the eye appear like minute white dots.

Eyes moderate, circular; beneath them a series of mucous pores. Nostrils large, tubular; the posterior much the larger. Gape of mouth moderate; the lips slightly project when the mouth is closed. Scales upon sides of body large, very small beneath pectorals. Eight scales in an oblique line above lateral line, and seven below it.

The dorsal fin is situated upon the anterior half of the body; it is quadrate, rather higher than long; the first rays the highest.

The pectorals are broad, rounded when expanded.

The ventrals are fin-shaped; they commence on a line just back of the dorsal fin.

The anal fin is slightly emarginated.

The caudal fin is forked.

The fin rays are as follows: — D. 8. P. 15. V. 8. A. 9. C. 19.

Length, five inches.

Remarks. This beautiful little species is found in many of the streams throughout the State.

GENUS IV. CHEILONEMUS, Baird, MS.

Body elongated, subfusiform, compressed. Head stout; its shape being that of a truncated cone, owing to the bluntness of the snout. Mouth very large, subterminal, the snout slightly protruding beyond the tip of the lower jaw. A minute barbel at the angle of the mouth. Eyes of medium size. Tail tapering; caudal forked. Body covered with very large scales, which are a little longer than high, subrounded or irregular in their outline. Lateral line conspicuous for the whole length of the body, and slightly inflexed downwards upon the abdomen, and nearer to the insertion of the ventrals than to the base of the dorsal. Dorsal and anal without stout and spiny rays at their anterior margins. Insertion of ventrals situated a little in advance of the anterior margin of the dorsal. Pharyngeal teeth as in the *Hypsolepis*. Skull proportionally broader between the eyes than in the latter.

CHEILONEMUS PULCHELLUS, *Girard.*

The Beautiful Leuciscus.

(PLATE XXII. FIG. 2.)

Leuciscus pulchellus, *Beautiful Leuciscus*, STORER, Report, p. 91.
" " STORER, Mem. Amer. Acad., New Series, II. p. 412.
" " " Synopsis, p. 160.
" " *Roach Dace*, DEKAY, Report, p. 208.
" " *L'Able gentil*, CUV. et VAL., Hist. Nat. Poiss., XVII. p. 320.
" " AYRES, Proc. Amer. Assoc. Adv. Sc., II. p. 402.
" " HECK., in Russ. Reise, II. p. 1039.
Leuciscus Argenteus, *Silvery Leuciscus*, STORER, Report, p. 90.
" " *Silvery Dace*, DEKAY, Report, p. 208.
Leuciscus Storeri, *L'Able de Storer*, CUV. et VAL., Hist. Nat. Poiss., XVII. p. 319, pl. 505.
Leucosomus argenteus, HECK., in Russ. Reise, II. p. 1043.
Cheilonemus pulchellus, GIRARD, in Lit.

Color. Above, of a dark brown; upper portion of sides brassy green; lower portion of sides and abdomen of a beautiful flesh-color, tinged with golden reflections. Head black above; gill-covers cupreous, with flesh-colored tints, and edged posteriorly with a brown, membranous prolongation. Color of dorsal fin similar to that of the back, the firmest portion of the rays reddish. The pectorals are of a reddish-brown above, lighter beneath. The ventrals above are the color of the abdomen.

Description. Body elongated, dorsum slightly arched in front of dorsal fin. Scales upon the body large, transparent, rounded at their summit, truncated at their base, exhibiting numerous striæ; at the base of each scale is seen a dark-colored membrane, which, projecting as far as the apex of the preceding scale, gives the appearance of indistinct oblique bands across the fish; scales smaller upon the back, and smallest upon the throat. The lateral line commences at the superior angle of the operculum, and, curving downwards nine scales, pursues nearly a straight course to the tail. The lateral line is composed of fifty-one scales; nine are situated above the lateral line in an oblique line from the origin of the dorsal fin, and six below the lateral line.

The head is naked; its length is less than one fourth the length of the fish. Diameter of eye about one sixth the length of the head; distance between the eyes equal to one third the length of the head. Nostrils situated in front of the eyes; the posterior orifice the larger, the anterior tubular. Jaws without teeth; the upper jaw projects slightly over the inferior.

The dorsal fin, which is subquadrangular, arises on the anterior half of the body. The first two rays are simple, the others multifid. The first ray is one fourth the height of the second.

The pectorals arise beneath and just anterior to the posterior angle of the operculum.

The ventrals, which are fin-shaped, arise opposite the origin of the dorsal fin. They are not as high as the pectorals.

The anal fin arises opposite the posterior extremity of the dorsal fin when it is closed; it is similar in form to the dorsal. Its first two rays are simple, the remainder multifid. The first ray bears the same proportion to the length of the second, as the first ray of the dorsal to its second ray.

The caudal fin is large, deeply forked. The height of its middle rays is equal to half the height of the outer rays. Width of the tail at extremities when expanded, to height of middle rays, is as three to one.

The fin rays are as follows: — D. 9 – 10. P. 16 – 17. V. 8. A. 9 – 10. C. 20 – 22.

Length, fourteen inches.

Remarks. This beautiful species is found in many of our rivers, and is known under the names of Roach, Dace, Chivin, and Cousin Trout. It attains the length of about fourteen inches, although the specimens usually met with are much smaller.

GENUS V. ARGYREUS, Heck.

General physiognomy resembling that of *Catostomus.* Snout more or less protruding beyond the upper jaw, thus giving the mouth an inferior position. The mouth itself is rather small, bordered with quite narrow and smooth lips, and provided at its angles with a small barbel, not always easily recognizable, especially in immature specimens preserved in alcohol. The pharyngeal teeth are disposed upon a double row.

This character of a barbel at the angle of the mouth, as well as the structure of the lips and the disposition of the ventral fins, which are inserted in advance of the anterior margin of the dorsal, indicates in these fishes a much greater affinity with *Cheilonemus* than with *Catostomus.* Indeed, the only conspicuous generical differences which can be traced between *Argyreus* and *Cheilonemus* consist in a more cylindrical body and very small mouth in *Argyreus*, and the tendency of the snout to elongate and project in some instances considerably beyond the jaws.

ARGYREUS ATRONASUS, *Heck.*

The Black-nosed Dace.

(PLATE XXI. FIG. 4.)

Cyprinus atronasus, Brook Minnow, MITCH., Trans. Lit. and Phil. Soc. of N. Y., I. p. 460.
" " *Black-nosed Dace,* DEKAY, Report, p. 205, pl. 33, fig. 69.
Leuciscus atronasus, L'Able à Nez noir, CUV. et VAL., Hist. Nat. des Poiss., XVII. p. 376, pl.
" " STORER, Mem. Amer. Acad., New Series, II. p. 408.
" " " Synopsis, p. 156.
Rhinichthys atronasus, AGASSIZ, Lake Sup., p. 354.
Argyreus atronasus, HECK., in Russ. Reise, II. p. 1040.
" " GIRARD, in Lit.
Argyreus rubripinnis, Mus. Par. fide Heck. in Russ. Reise, II. p. 1040.

Color. Above, of a reddish brown; abdomen of a silvery white with minute brown blotches. A broad black band, commencing at the snout, passes through the eyes along the whole length of the fish and is lost upon the caudal fin. A narrow lighter line arises at the operculum and runs along the upper edge of the former. Pupils black. Irides golden. The dorsal and caudal fins are of a dark-brown color. The anal is nearly colorless. The pectorals are orange.

Description. Body oblong, tapering to the tail. The greatest depth of this species is equal to the length of the head. Head flattened above; the length of the head is equal to about one sixth the entire length of the fish. The eyes are moderate. The nostrils are large. The upper jaw projecting.

The dorsal fin, which is situated upon the middle of the dorsum, is subquadrangular and emarginated above.

The fan-shaped pectorals are situated just beneath the posterior angle of the operculum.

The ventrals are very delicate.

The caudal fin is deeply forked.

The fin rays are as follows: — D. 8. P. 14. V. 8. C. 19.

Length of fish three inches.

Remarks. This pretty little species, which seldom if ever exceeds three inches, is found in many of our rivers.

Massachusetts, STORER. New York, MITCHILL, DEKAY.

Argyreus nasutus, *Girard.*

The Long-nosed Dace.

(Plate XXII. Fig. 1.)

Leuciscus nasutus, Ayres, Bost. Journ. Nat. Hist., iv. p. 299, pl. 13, fig. 3.
" " Storer, Mem. Amer. Acad., New Series, ii. p. 415.
" " " Synopsis, p. 163.
Rhinichthys nasutus, Agassiz, Lake Sup., p. 354.
Argyreus nasutus, Girard, in Lit.

Color. Dorsum and upper part of sides dark brown. Beneath, white. Dorsal and caudal fins brownish. Pectorals lighter than dorsal. Ventrals and anal colorless.

Description. Body elongated; cylindrical in front of the dorsal fin, compressed posteriorly; its greatest depth equal to about one eighth of its entire length. Head equal in length to one fifth of the fish; flattened above and destitute of scales, terminating in an obtuse snout, having the mouth beneath. Eyes circular, equal in diameter to one sixth the length of the head. The nostrils are directly in front of the eyes, the posterior the larger. The lateral line pursues nearly a straight course to the caudal fin.

The dorsal fin is situated on the anterior half of the dorsum, and is subquadrangular.

The pectorals are just beneath the posterior angle of the operculum; they are large and rounded.

The ventrals arise opposite a line just in front of the dorsal fin.

The anal fin is of a similar form with the dorsal, and arises opposite the termination of that fin.

The caudal fin is lunated.

The fin rays are as follows: — D. 8. P. 16. V. 9. A. 8. C. 19.

Length, four inches.

Remarks. This species was first described by William O. Ayres, M. D., in the Boston Journal of Natural History. He had received specimens from West Hartford, Connecticut, from Mr. Charles P. Turner of Hartford, and others from Blanford in this State, from Mr. C. H. Olmstead. From this latter gentleman, we learn that "they inhabit rapid streams, hiding most commonly under stones, from which they often dart out with great speed." When taken, "they struck at the bait with all the quickness and vigor of Trout, and might be taken in almost any numbers." It has also been found by Mr. S. F. Baird in Nichols Brook, a tributary of the Connecticut River.

Massachusetts, Olmstead, Baird. Connecticut, Ayres.

GENUS VI. CATOSTOMUS, Lesueur.

Back with a single dorsal fin. Gill-membrane three-rayed. Head and opercula smooth. Jaws toothless and retractile. Mouth beneath the snout, lips plaited, lobed, or caruneulated, suitable for sucking. Throat with pectinated teeth.

Catostomus Bostoniensis, *Lesueur.*

The Sucker.

(Plate XXII. Fig. 3.)

Cyprinus catostomus, Foster, Mem. Amer. Acad., II. pt. 2, p. 55, pl. 2, fig. 4.
Catostomus Bostoniensis, Lesueur, Journ. Acad. Nat. Sc., I. p. 106.
" " Storer, Report, p. 84.
Le Catostome Bostonien (*Catostomus Bostoniensis,* Les.), Cuv. et Val., XVII. p. 432.
" " Storer, Mem. Amer. Acad., New Series, II. p. 423.
" " " Synopsis, p. 191.

Color. Above of a light-brown; the sides of a reddish-brown, presenting beautiful metallic reflections; opercula golden. Head, dark-olive above; beneath, white. Pupils black, irides golden. The pectorals, ventrals, and anal fin are reddish-yellow; the dorsal and caudal fins are brown; the latter fin is the darker.

Description. Body subcylindrical, elongated; rounded in front of the dorsal fin, compressed posteriorly; the dorsum is broad in front of the dorsal fin. The scales on the anterior portion of the body are quite small; they increase in size towards the posterior portion, and back of the dorsal fin are much larger; they exhibit at their exposed extremity a few very distinct longitudinal striæ, which are crossed by minute concentric lines; more numerous longitudinal striæ are seen at the concealed extremity, which is rounded at its centre.

Head naked; its length is rather less than one fifth the length of the body. A series of mucous pores extends across the occiput to the gill-covers on each side, and from the termination of this series a second passes forward to the posterior superior angle of the eye, downward back of the eyes, then curves forward and is lost about the snout. Another series passes forward, from the occipital series between the eyes, which extends to the snout. Eyes moderate in size, oblong; distance between the eyes equal to less than one third the length of the head. Mouth small, very protractile, lips carunculated. Lower lip bilobate. Nostrils double, the anterior quite small, the posterior much the larger and partially covered by a fleshy valve. The lateral line, which seems to be a continuation of the series of mucous ducts upon the head, commences at the posterior superior angle of the operculum, and, curving downwards and backwards a few scales, pursues a straight course to the tail.

The dorsal fin is subquadrangular; it arises at the middle of the body, not including the caudal fin. The first rays are simple.

The pectorals are just back of the inferior posterior angle of the operculum; their height is less than the length of the head.

The ventrals are situated beneath the middle of the dorsal fin; they are as high as the pectorals.

The anal fin is equal in height to the pectorals; it is rounded when expanded. The first two rays are simple; the others are branched; the posterior rays are the shortest.

The caudal fin is deeply lunated; the rays are articulated.

The fin rays are as follows: — D. 14 – 16. P. 18. V. 10. A. 9. C. 18.

Length, fifteen inches.

Remarks. During the spring and autumn this species is frequently met with in Boston market, and in a mild winter they may be found there at almost any time. They are most commonly brought here from Charles River, Watertown; and sometimes attain the weight of five pounds. They are of but little value. Occasionally they are brought into the city by the cart-load, and sold as the Mullet.

New Hampshire, PECK. Massachusetts, LESUEUR, STORER. New York, Pennsylvania, CUVIER.

CATOSTOMUS GIBBOSUS, *Lesueur.*

The Chub Sucker.

(PLATE XXII. FIG. 4.)

Catostomus gibbosus, Chub Sucker, LESUEUR, Journ. Acad. Nat. Sc., I. p. 92, fig.
" " *Gibbous Sucker,* STORER, Report, p. 88.
" " CUV. et VAL., Hist. Nat. Poiss., XVII. p. 443.
" " STORER, Mem. Amer. Acad., New Series, II. p. 420.
" " " Synopsis, p. 168.
Labeo gibbosus, Gibbous Chub Sucker, DEKAY, Report, p. 194, pl. 32, fig. 101.
Catostomus tuberculatus, LESUEUR, Journ. Acad. Nat. Sc., I. p. 92, fig.
" " STORER, Report, p. 85.
" " *Horned Sucker,* DEKAY, Report, p. 199, pl. 31, fig. 97.
" " CUV. et VAL., Hist. Nat. Poiss., XVII. p. 444.

Color. The back and upper portion of the sides of this species, when first caught, are of a dark-brown, which, after death, changes to a greenish hue. Head of a dark slate-color above; opercula, a pale dull yellow. Sides of a greenish-yellow, with golden reflections. Abdomen in front of ventrals nearly white, towards anal fin slightly pinkish. Body marked with four or five faint transverse bands. Dorsal and caudal fins color of the back. Pectorals and ventrals reddish, edged with dark-brown. Anal fin in some individuals color of pectorals and ventrals, in other specimens of a bluish or purplish brown.

Description. Body compressed laterally, convex in front of dorsal fin; this convexity commences suddenly at the occiput, and is greatest at the origin of the dorsal. Greatest depth of fish equal to about one fourth its length. Scales with very distinct striæ; when plucked from the fish, they are quadrangular and exhibit concentric lines passing across the striæ; exceedingly delicate concentric lines are seen over the entire scale. The head, which is smooth, is less than one fifth the length of the fish. Snout short, rounded. Eyes moderate. Nostrils double, separated by a loose membrane, the posterior the larger. Mouth small, lunated. At some seasons of the year, between the eyes and snout on each side of the head are four prominent spines having broad fleshy bases; the upper anterior prominences the largest, and the upper posterior the smallest. Beneath the first spine a smaller one is seen; and directly back of it a third nearly as large as the first. These first three form a triangle. Just above the third prominence and in front of the upper anterior angle of the eye, and between the nostrils and the eye, is a fourth prominence smaller than the others. In some individuals, the spinous parts are removed and the bases remain as hard tubercles; sometimes the bases themselves are removed, and while the points from which they were thrown off in some specimens are scarcely perceptible, in others a distinct excavation is seen. Sometimes one or more tubercles are missing in the same individual. Dekay remarks that this species has "three to five tubercles on each side." I have never met with more than four.

The quadrangular dorsal fin commences upon the anterior half of the body.

The pectorals arise just back of the posterior inferior angle of the operculum; they are rounded when expanded.

The ventrals, which are very nearly as high as the pectorals, are situated opposite the anterior half of the dorsal fin.

The anal fin is deeply emarginate; its third and fourth rays are the longest.

The lower lobe of the caudal fin is slightly longer than the upper.

The fin rays are as follows: — D. 16. P. 16. V. 9. A. 10. C. 18.

Length, seven to twelve inches.

Remarks. This species, which is known under the name of "Barbel" and "Chub Sucker," is found in many of the ponds throughout the State.

Massachusetts, LESUEUR, STORER. New Hampshire, Connecticut, New Jersey, DEKAY. Pennsylvania, LESUEUR.

FAMILY XIII. CYPRINODONTIDÆ.

The mouth is constructed upon the same plan as in the Cyprinidæ; but there are teeth upon the jaws. Instead of a pharyngeal arch, bearing recurved and hooked teeth, the Cyprinodonts have the surface of the posterior portion of the hyoidal apparatus paved with short teeth; and opposite to the latter, in the back part of the roof of the mouth, there are patches of velvet-like teeth. There are neither vomerine nor palatine teeth. The upper surface of the head is generally covered with scales to the tip of the snout. The dorsal fin, in most instances, is situated upon the posterior half of the body, and opposite the anal fin.

GENUS I. FUNDULUS, LACÉP.

Upper surface of head, structure of mouth, and maxillary teeth similar to the same parts in *Hydrargyra.* Lower pharyngeal teeth sub-conical, more slender than in the latter. Branchial rays five on either side. Dorsal similarly opposed to the anal. Caudal posteriorly rounded. Upper surface and sides of head covered with scales as in *Hydrargyra.*

The genera *Fundulus* and *Hydrargyra* are closely allied. The chief differences are, a more flattened head in *Hydrargyra*, giving it some resemblance to *Pœcilia* or *Molinesia;* six branchial rays instead of five; the pharyngeal teeth shorter and stouter, with a more conspicuous crown. Finally, the caudal is sub-truncated posteriorly, instead of being rounded as in *Fundulus*, — a character, however, of minor importance, since we find in the same family genera including species with a rounded, and others with a truncated, caudal fin.

FUNDULUS PISCULENTUS, *Cuv. et Val.*

The Ornamented Minnow.

(PLATE XXIII. FIG. 3. Male. 4. Female.)

Esox pisculentus, *White-bellied Killifish*, MITCH., Trans. Lit. and Phil. Soc. of N. Y., I. p. 441.
Esox pisciculus, *Yellow-bellied Killifish*, MITCH., Trans. Lit. and Phil. Soc. of N. Y., I. p. 441.
Esox zonatus, *Banded Killifish*, MITCH., Trans. Lit. and Phil. Soc. of N. Y., I. p. 443.
Fundulus fasciatus, VAL., in Humboldt and Bonpland, II. p. 162, pl. 62, fig. 1, 4, 5.
Fundulus viridescens, *Big Killifish*, DEKAY, Report, p. 217, pl. 31, fig. 99.
Fundulus zebra, *Barred Killifish*, DEKAY, Report, p. 218.
Hydrargyra pisculenta, AYRES, Bost. Journ. Nat. Hist., IV. p. 267.
Hydrargyra fasciata, AYRES, Bost. Journ. Nat. Hist., IV. p. 266.
" " STORER, Mem. Amer. Acad., New Series, II. p. 432.
" " " Synopsis, p. 180.
Hydrargyra ornata, LESUEUR, Journ. Acad. Nat. Sc., I. p. 131.
" " *Ornamented Minnow*, STORER, Report, p. 94.
" " DEKAY, Report, p. 221.
" " STORER, Mem. Amer. Acad., New Series, II. p. 433.
" " " Synopsis, p. 181.
Fundulus pisculentus, CUV. et VAL., Hist. Nat. Poiss., XVIII. p. 190.
" " GIRARD, in Lit.
Fundulus zonatus, CUV. et VAL., Hist. Nat. Poiss., XVIII. p. 190.

Color. Female of a uniform brown color.

Male, lighter at intervals upon the sides, the appearance being presented of transverse bands. Dorsal and anal fins with black dots. Anal fin slightly emarginated posteriorly.

Description. Body oblong, stout, compressed posteriorly. Top of head and back flattened. Head one fourth the entire length of the fish. Scales upon top of head very large. Diameter of eyes equal to one fourth the length of the head. Eyes distant from each other. A series of mucous pores on each side of head above eyes, extending also in front of eyes to the anterior inferior edge; a series is also seen along lower edge of operculum. The nostrils are situated just in front of the anterior superior edge of the eye. Mouth protractile, vertical when jaws are closed. Very minute, numerous teeth in both jaws.

The dorsal fin is situated upon the posterior half of the body; it is rounded above.

The pectorals are broad and fan-shaped.

The anal fin is situated beneath the dorsal.

The ventrals are small, their rays are multifid.

The caudal fin is broad, rounded posteriorly.

The fin rays are as follows: — D. 12. P. 15. V. 6. A. 9 – 10. C. $20\frac{3}{3}$.

Length, one to five inches.

Remarks. This is the most common Minnow found in the salt marshes around Boston, and is known generally by the boys under the name of *Cobler*. It is taken in large quantities with hand nets, being excellent bait for other fishes, more particularly for Smelts.

I have also seen a flock of the domestic duck swallowing it with the greatest avidity when thrown to them in the same manner as grain, with other species of Killifish.

Massachusetts, Storer. Connecticut, Ayres. New York, Mitchill, Dekay. Delaware river, Lesueur. Carolina, Dekay.

Fundulus nigrofasciatus, *Cuv. et Val.*

The Banded Minnow.

(Plate XXIII. Fig. 1.)

Hydrargyra nigrofasciata, Lesueur, Journ. Acad. Nat. Sc., I. p. 133.
" " *Banded Minnow*, Storer, Report, p. 94.
" " Dekay, Report, p. 221.
" " Storer, Mem. Amer. Acad., New Series, II. p. 434.
" " " Synopsis, p. 182.
Fundulus nigrofasciatus, Cuv. et Val., Hist. Nat. Poiss., XVIII. p. 193.
" " Girard, in Lit.

Color. Above, yellowish-green, with numerous minute black dots; beneath, silvery white. From ten to fourteen narrow black bars cross the sides transversely; the anterior pass to the abdomen, the posterior cross the fleshy portion of the tail entirely; opercula cupreous; a yellow spot exists at the origin of the base of the dorsal fin. Pupils black, irides silvery. In the male fish, the bars are broader.

Description. Head compressed above; its length is equal to one fourth the length of the fish. The eyes are small and circular. The distance between the eyes is equal to one half the length of the head. Jaws projectile.

The dorsal fin is situated upon the posterior portion of the body.

The pectorals are just back of the opercula.

The ventrals are very small.

The anal fin is similar in form to the dorsal, and situated opposite that fin.

The caudal fin is slightly rounded.

The fin rays are as follows: — D. 12. P. 18. V. 6. A. 12. C. 17.

Length, two to three inches.

Remarks. This species is much less common than the *pisculentus.* It is found in the vicinity of Boston, in Fresh Pond, Cambridge.

Massachusetts, Storer. Rhode Island, Lesueur.

FUNDULUS MULTIFASCIATUS, *Cuv. et Val.*

The Barred Minnow.

(PLATE XXIII. FIG. 2.)

Hydrargyra multifasciata, LESUEUR, Journ. Acad. Nat. Sc., I. p. 131.
" " *Barred Minnow*, DEKAY, Report, p. 220.
" " STORER, Mem. Amer. Acad., New Series, II. p. 433.
" " " Synopsis, p. 181.
Fundulus multifasciatus, CUV. et VAL., Hist. Nat. Poiss., XVIII. p. 200.
" " GIRARD, in Lit.

Color. The living fish is of an olive upon its whole upper portion; the sides are lighter; the lower portion of the opercles silvery; the throat and posterior portion of the abdomen are of a bluish-gray color; the body is transversely marked with numerous bluish bands, and dotted with darker minute points; the pupils are black, the irides silvery. When dead this species changes to a yellowish-green, darker above; and the transverse bands are scarcely perceptible.

Description. Body cylindrical anteriorly, more compressed posteriorly; dorsum slightly convex just anterior to the dorsal fin; its greatest depth equal to one sixth its length. The head is broad and flattened above. Its length is greater than the greatest depth of the fish, and less than one third its entire length. The distance between the eyes is equal to one third the length of the head. The eyes are large, somewhat oblong. The jaws are equal, and are armed with very minute teeth. The nostrils are large, and are situated just anterior to the upper edge of the eyes.

The indistinct lateral line is nearly straight.

The dorsal fin, which is quadrangular, commences upon the anterior half of the body.

The pectorals are fan-shaped, and are equal in height to the length of the dorsal fin. They extend just beyond the origin of the ventrals.

The ventrals are small; they commence on a line with the posterior extremity of the pectorals; their third ray is the longest.

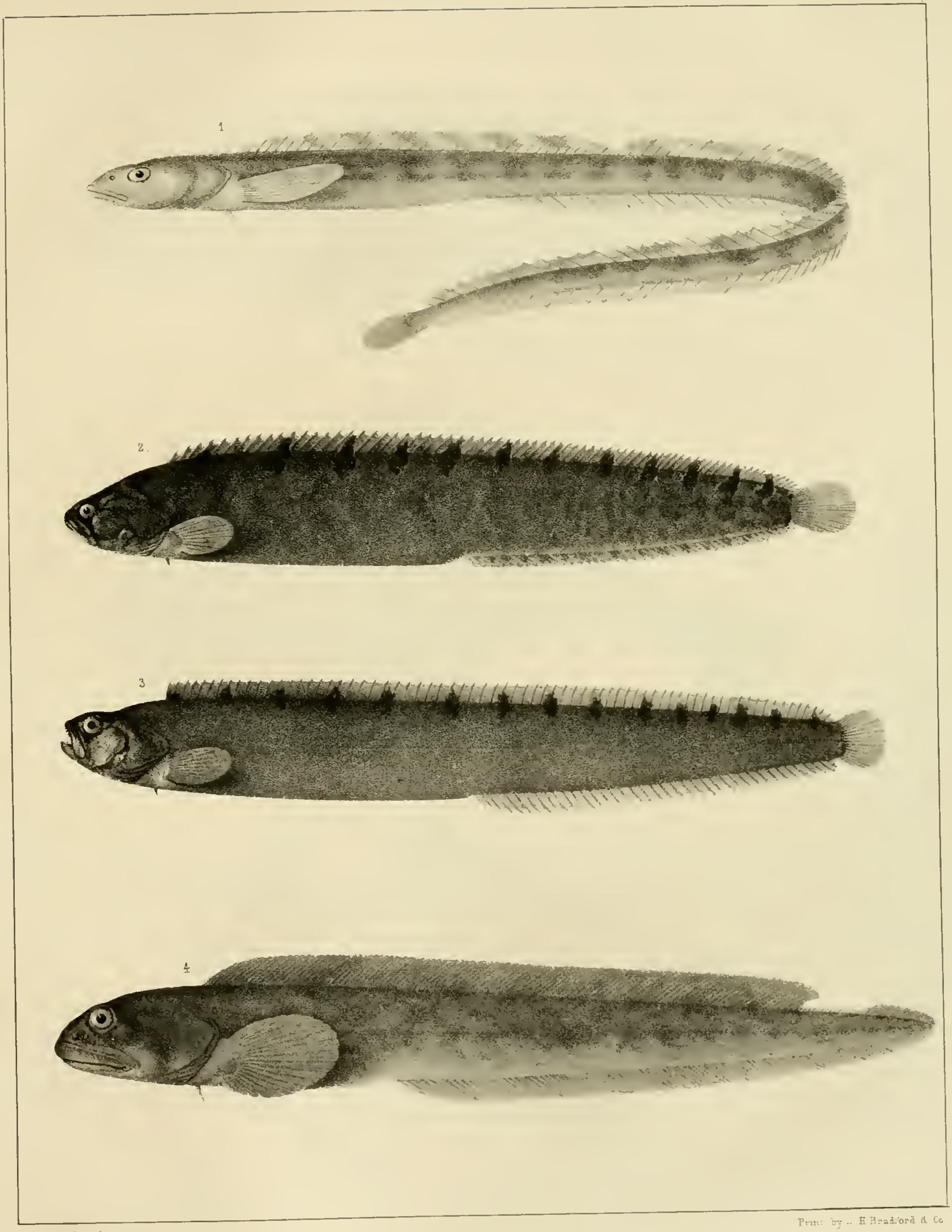
The anal fin is shorter than the dorsal, and terminates just in front of the posterior extremity of that fin.

The caudal fin is broad, and nearly straight at its termination.

The fin rays are as follows: — D. 13–14. P. 18. V. 5. A. 12–13. C. 16.

Remarks. Professor Agassiz kindly lent me a specimen of this fish taken at Concord; and a second taken at Lowell has been sent me by my friend, Mr. Charles Girard, of the Smithsonian Institute, to whom I would express my most grateful acknowledgments for his invaluable aid in the preparation of the Cyprinidæ for the press.

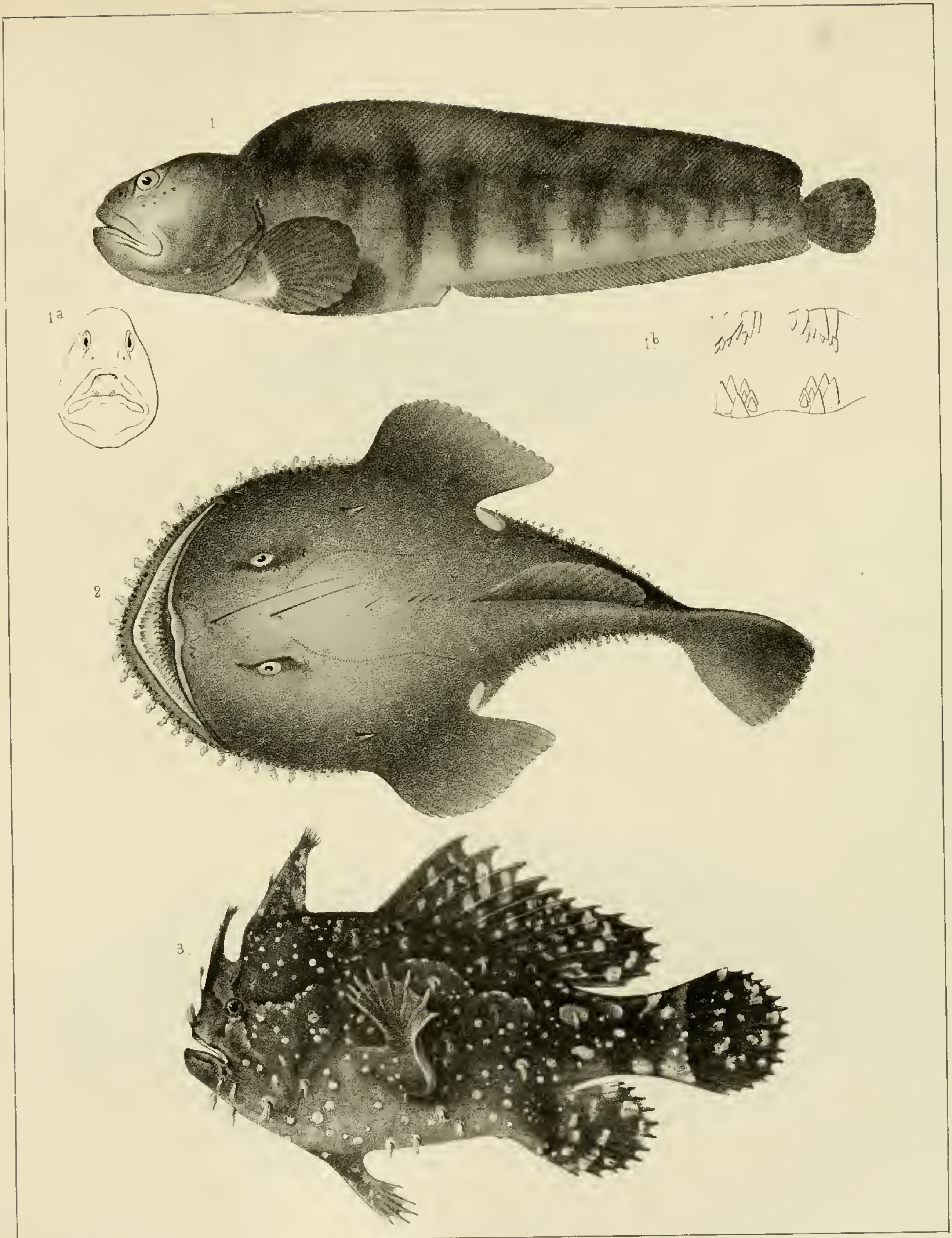
Massachusetts, AGASSIZ, GIRARD. New York, LESUEUR.



Tappan & Sourel

Print by J. H. Bradford & Co

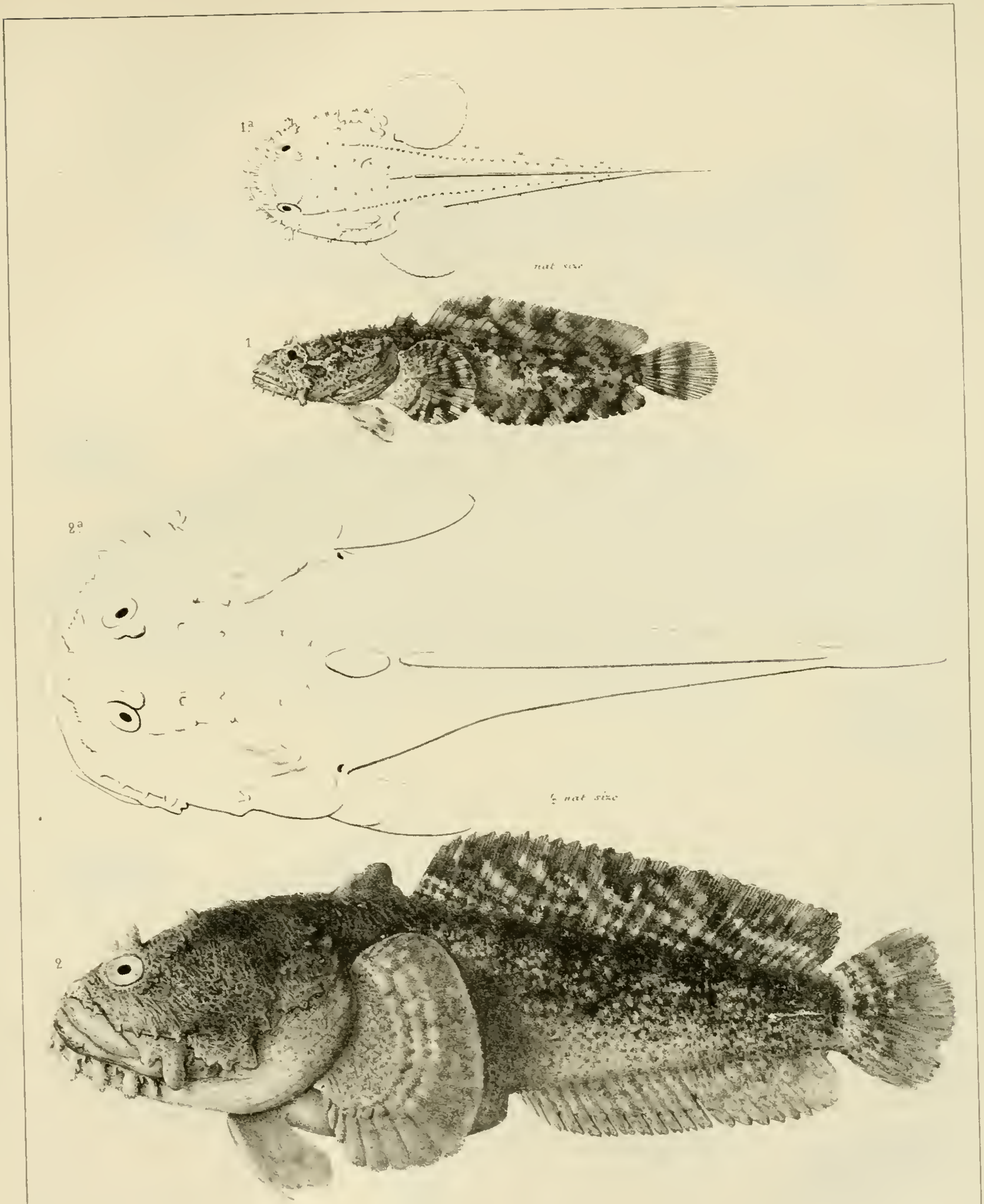
1. BLENNIUS SERPENTINUS, Storer. 2. GUNNELLUS MUCRONATUS Cuv.
3. G. MACROCEPHALUS Girard 4. ZOARCES ANGUILLARIS. Storer



Tappan & Sonrel

Print by H I Bradford & Co

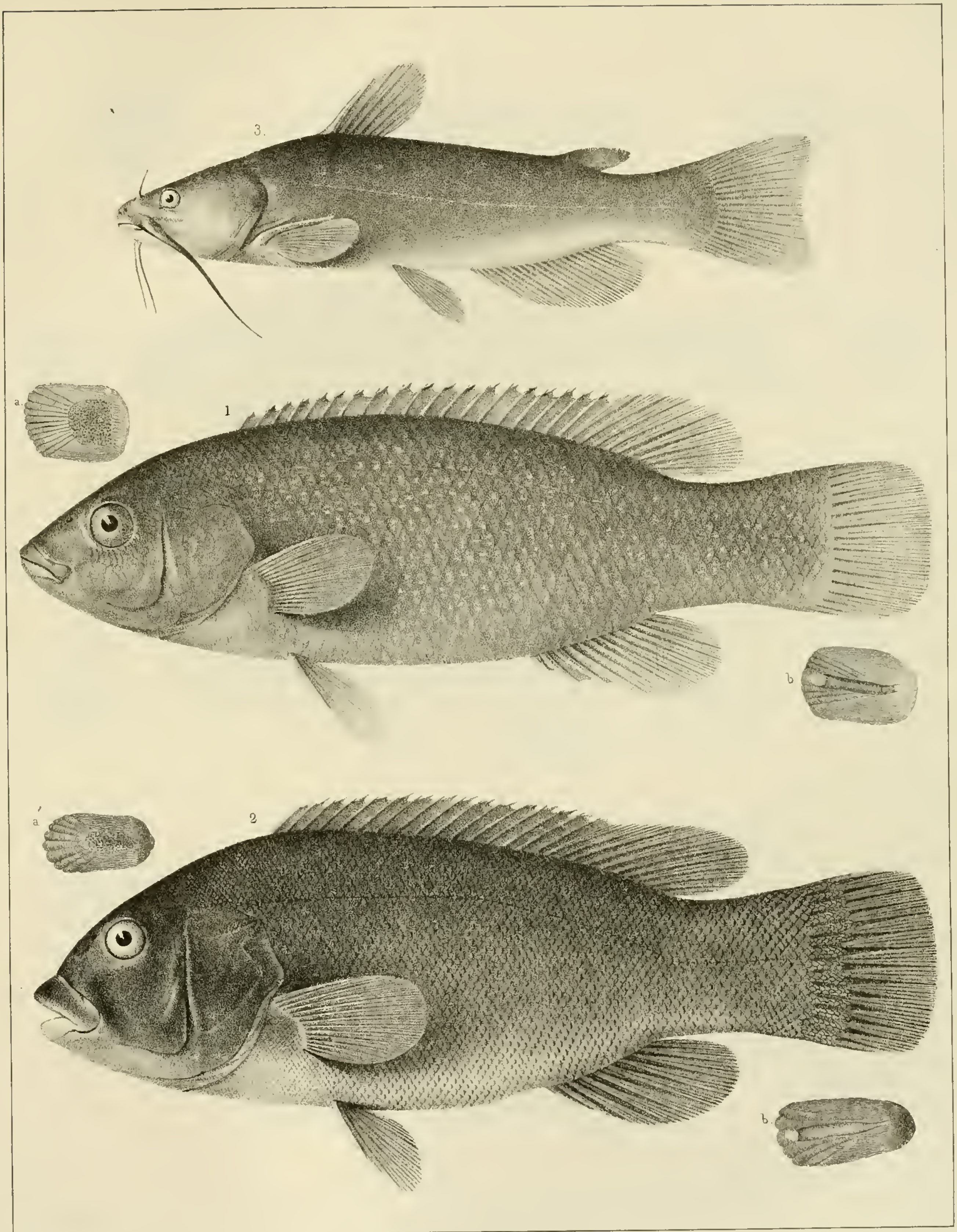
1. ANARRHICUS VOMERINUS, Agass. 2 LOPHIUS AMERICANUS, Cuv. 3 CHIRONECTES LAEVIGATUS Cuv



A. Sonrel on stone from nat.

Tappan & Bradford's lith.

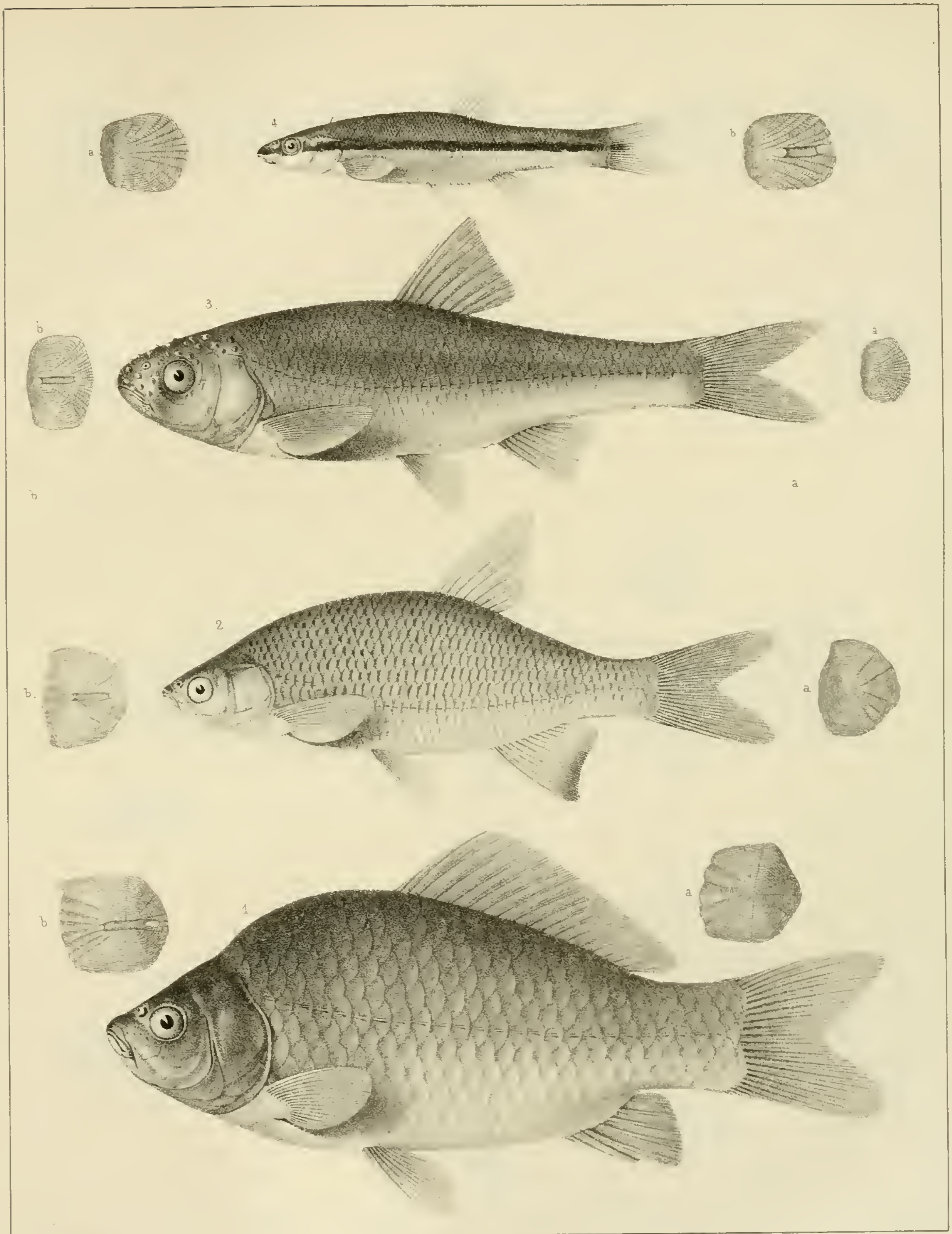
BATRACHUS TAU, Linn.



A. Sonrel

Print by L. H. Bradford & Co

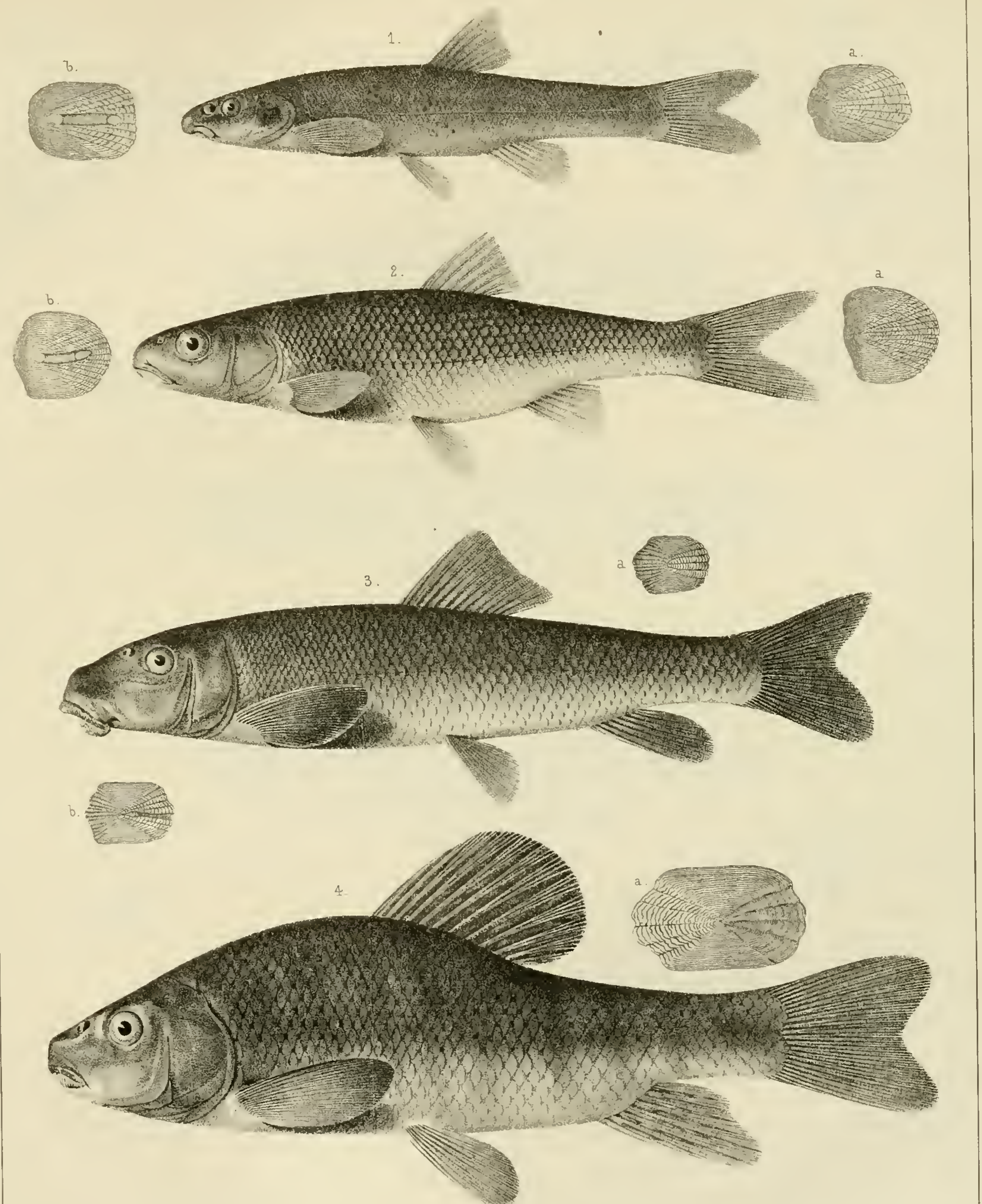
1. CTENOLABRUS CERULEUS Dekay. 2. TAUTOGA AMERICANA, Dekay. 3. PIMELODUS ATRARIUS, Dekay.



A. Sonrel

Print. by J. H. Bufford & Co

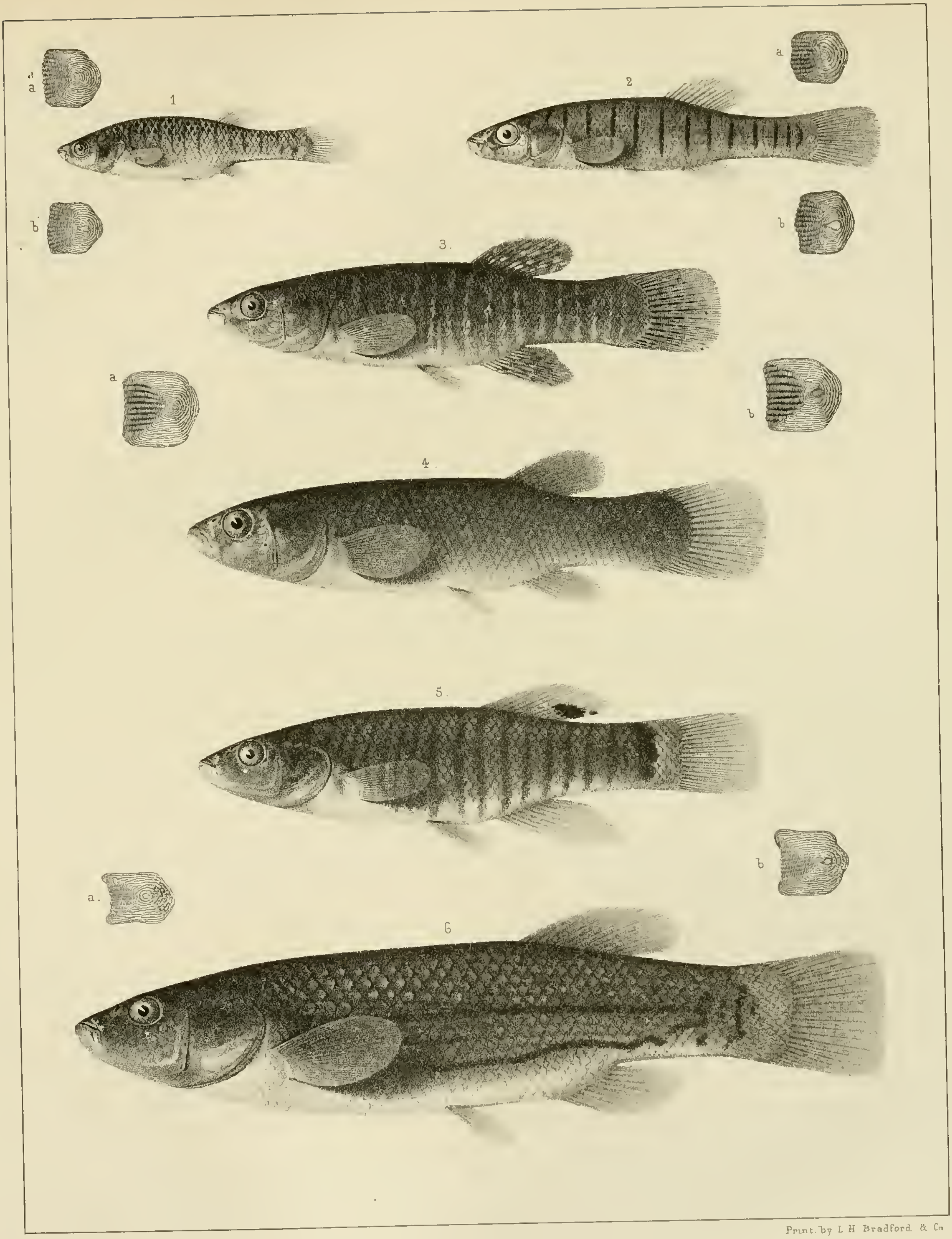
1. CYPRINUS AURATUS, Lin. 2 LEUCOSOMUS AMERICANUS, Girard.
3. HYPSOLEPIS CORNUTUS, Girard 4 ARGYREUS ATRONASUS, Heck.



A. Sonrel.

Print by L. H. Bradford & Co

1. ARGYREUS NASUTUS, Girard 2. CHEILONEMUS PULCHELLUS, Girard
3. CATOSTOMUS BOSTONIENSIS, Lesueur 4. CATOSTOMUS GIBBOSUS Lesueur



A Sonrel

Print. by L H Bradford & Co

1. FUNDULUS NIGROFASCIATUS, Cuv & Val. 2. F. MULTIFASCIATUS, Cuv & Val.
3 & 4. F. PISCULENTUS, Cuv & Val. 5 & 6 HYDRARGYRA FLAVULA, Storer

XIII.

Plantæ Novæ Thurberianæ: *The Characters of some New Genera and Species of Plants in a Collection made by* George Thurber, Esq., *of the late Mexican Boundary Commission, chiefly in New Mexico and Sonora.*

By ASA GRAY, M. D.

(*Communicated to the Academy, August* 9, 1854.)

In the progress of the late Boundary Commission for fixing the line between the territories of the United States and Mexico, botanical collections were made, at various times, by Dr. C. C. Parry and Mr. Schott, under the command of Colonel Emory; by Mr. Thurber and Dr. J. M. Bigelow, attached to the immediate party of Mr. Commissioner Bartlett; and by Mr. Charles Wright, who, having formerly made, at his own charges, a botanical exploration from Eastern Texas to El Paso, through a region till then unvisited by any naturalist, was about to revisit New Mexico, when, in the spring of 1851, he was attached by Colonel Graham to his surveying corps.

A large portion of Mr. Wright's collections has been elaborated by myself, and published in two memoirs, by the Smithsonian Institution.* The plants gathered by Dr. Parry, Mr. Schott, and the more extensive collections made by Dr. Bigelow, were consigned to the able hands of my friend Dr. Torrey; and a detailed account of the whole is expected to make an important part of Colonel Emory's general report of the scientific results of this boundary survey.

Not a few of the new plants described by me from Mr. Wright's collection were gathered at the same time, or in some cases even previously, by Dr. Bigelow or by Mr. Thurber: but, as Dr. Bigelow's plants were not communicated to me, except in a few cases, where his name is mentioned in connection with them, and as all of Mr.

* Plantæ Wrightianæ Texano-Neo-Mexicanæ. Part I. 1850-52. Part II. 1853.

Thurber's collections were still in New Mexico, it has unavoidably happened tha Mr. Wright's name alone appears as the discoverer or collector of such novelties, in the pages of the work above referred to. A full enumeration of the plants of Mr. Thurber's collection would bring to view this priority in many instances, and would show how largely he has subserved the interests of science by his extensive observations and collections, no small part of which were made under circumstances of great privation and hardship. This is particularly the case in respect to the plants gathered by him in the western part of Sonora, into which no other of our collectors had penetrated, and on the Gila River and the Californian desert beyond its mouth, a region which Colonel Emory and others had traversed, plucking here and there a scanty specimen; but in which no one except Mr. Thurber can be said to have botanized. Consequently these districts will be found to have furnished the principal new genera and species characterized in this communication. Figures of the most remarkable of these plants are in preparation: these it is thought best should be published in Colonel Emory's final report, along with other illustrations of the botany of our Mexican boundary, elaborated from the ample store of materials to which various collectors have from time to time contributed. Meanwhile, as this extended report is not likely to be completed and published for some time, I have the privilege of making known to the scientific world the following new genera and species, which I have been able to examine and to characterize.

To give some idea of the geographical situation, features, and characteristic vegetation of the region in which these plants were collected, Mr. Thurber has, at my request, furnished a series of brief notes, which are subjoined; and to which I have appended a few botanical remarks in the form of foot-notes.

"The route from Eastern Texas to the Rio Grande was traversed in the months of October and November, a season affording little of interest to the botanist.

"The winter of 1850 and 1851 was passed at El Paso, or more properly at Magoffinsville, a new settlement upon the 'American' side of the river and opposite the Mexican town. The latitude of this place is 31° 46′ 5″ and its elevation above the sea level about 3,800 feet. During the winter, vegetation was completely suspended; snow, ice, and sleet were frequent, and upon one occasion the mercury fell to 2° Fahr. The first indications of returning spring were seen early in March, in the sheltered ravines of the neighboring mountains, where *Rutosma Texanum*, *Draba micrantha*, *Œnothera chamænerioides*, and *Œ. primiveris* were collected; and a little later the same localities furnished *Glossopetalon spinescens*,* *Vesicaria purpurea*, &c., while large tracts in the valley were covered with the bright yellow flowers of *Actinella Richardsonii*. Towards the end of March an excursion was made to the Hueco Mountains, about thirty miles east of the Rio Grande. The country between is an undulating sandy plain, with but scanty vegetation. A few miles before reaching the mountains occur what are termed the Hueco Tanks; these are huge piles of granite boulders rising abruptly from the plains. They are in two unequal masses, between which the northern road from San Antonio passes. These 'tanks' are of importance to travellers by that route, as they are the only watering-place, though a precarious one, for a long distance. Large quantities of water collect during the rainy season in the interstices of the rocks, where, being sheltered from evaporation, it often lasts through the dry summer. About the 'tanks' grew the Texan *Ungnadia speciosa*, just coming into flower; *Pentstemon Fendleri*, *Corydalis aurea*, besides the plants common about Magoffinsville. In a sheltered corner a few specimens of *Dryopetalon runcinatum*, Gray, were gathered. A visit to the mountain beyond afforded little beside what grew at the 'tanks.' *Cymopterus montana*, *C. Fendleri*, *Townsendia sericea*, and a few other species, were collected here.

"In April the party moved from Magoffinsville to the Copper Mines. From the former place to Doña Ana, a distance of sixty miles, the road lies along the valley of the Rio Grande, crossing an occasional spur of table-land. *Dithyrea Wislizeni*, *Astragalus triflorus*, *Sophora sericea*, and *Nasturtium obtusum* were abundant. The road crosses the Rio Grande some twenty miles above Doña Ana. This portion of the route is over an exceedingly barren country. A stunted variety of *Delphinium azureum*, *Oldenlandia humifusa*, and the ever-present *Larrea Mexicana*, were observed. The latter plant is common everywhere upon sterile table-lands; it is first met with low down in Texas, and continues beyond the Colorado of the West. The disagreeable odor it emits has given it the name of 'Creasote Plant' among Americans; and it receives the merited epithet of *Hideondo* (Stinking) from the Mexicans. It is used by the latter for heating their large mud ovens; the great quantity of resin it contains causing it to burn with a fierce flame, while the air of the whole neighborhood is filled with a stench, which, to one unaccustomed to it, is almost insupportable.

"At the new settlement of Santa Barbara, about fourteen miles from the crossing, we leave the valley of the Rio Grande. The road thence to the river Mimbres is tor-

* The fruit of this plant is follicular, being dehiscent down the ventral suture only. The seeds examined were all destitute of an embryo, as in the specimens gathered by Mr. Wright and Dr. Bigelow. — A. G.

tuous, on account of the mountain ranges to be avoided: it passes over sterile, low, rounded hills, strewed in places with fragments of chalcedony. Among the plants collected on this portion of the route were *Berberis pinnata*, *Œnothera albicaulis*, *Œ. Wrightii*, *Dalea Jamesii* and *D. nana*, *Krameria lanceolata*, &c. Near the camp on the Mimbres grew *Œnothera Hartwegii*, var., and a fine *Astragalus*, which has been dedicated to Dr. J. M. Bigelow, an enthusiastic botanist, and the surgeon to the Commission.

"Soon after arriving at the Copper Mines an excursion was made to the Mimbres, striking it at a point several miles above the crossing: it is reached in a distance of eight miles by following a narrow trail through the mountain. In this mountain pass *Lonicera dumosa*, Gray, was found in flower (it was described in Plantæ Wrightianæ from fruiting specimens only): the flowers are yellowish and inodorous. *Fendlera rupicola* grew in abundance upon the sides of the mountain. This would be a very ornamental shrub in cultivation, bearing a profusion of white flowers, with which the pink unexpanded buds appear in marked contrast. A new *Robinia* was met with here just in flower; it is hoped that some future collector will obtain the seeds, as its low stature, neat habit, and abundant rose-colored flowers render it a desirable addition to our ornamental shrubs. The valley of the Mimbres at this point is broad, and covered with luxuriant grass. Traces of former inhabitants were seen. The ground-plan of houses was distinctly visible, and fragments of pottery, of quality and markings similar to those collected afterwards among the so-called Aztec ruins, were abundant. *Fraxinus velutinus*, Torr. and *Negundo aceroides* grew along the margin of the river. Among the gravelly knolls which border the bottom *Lupinus pusillus*, *Astragalus Missouriensis* and *A. tephrodes*, *Erigeron divergens*, var. *cinereum*, *Diplopappus ericoides*, and several *Nyctaginaceæ*, were collected.

"In the latter part of May a trip was made into the State of Sonora as far as Arispe, its former capital. The wagon route of Colonel Cooke was followed as far as Agua Prieta or Black-Water Creek. The country is generally desert-like, consisting of broad, rolling sandy plains, with isolated ranges of equally barren mountains. *Baileya*, *Riddellia*, and other yellow Compositæ, were abundant; as also were *Eschscholtzia Californica*, var., *Ionidium lineare*, and *Malvastrum leptophyllum*. Occasional large tracts were passed where the vegetation had a singularly dreary aspect, being made up of tall Yuccas, *Dasylirion*, and *Opuntia arborescens*. Of the latter, fine specimens were seen, attaining the height of ten or twelve feet. When covered with its crimson flowers and lemon-yellow fruit it is a truly beautiful object. Near the dry bed of a lake (Las Playas, of the maps of that region), *Cleome Sonoræ*, *Cleomella longipes*, and

Sidalcea malvæflora, var. *albiflora*, were abundant. At a camping-place near the Sierra de los Animos a new *Stephanomeria* was collected.

"The Sierra Madre, the back-bone of Mexico, was crossed by the Guadalupe Pass, through which the persevering Colonel Cooke first took a wagon-train. The descent in a few miles is about a thousand feet. The pass afforded *Arctostaphylos pungens*, *Rhus microphylla*, *Baccharis ramulosa*,* *Fouquiera splendens*, *Ceanothus Greggii*, and several *Pentstemons*. The small stream at the bottom of the pass is thickly bordered by *Platanus Mexicanus* and *Fraxinus velutinus*.

"The town of Fronteras was reached by striking off from Agua Prieta in a southerly direction. Upon the low hills between these two points were larger and more abundant specimens of *Fouquiera splendens* than were seen in any other place. A valley called Mabibi or Mababi, which lies between Fronteras and Bacuachi afforded several new plants, among them an undescribed *Ranunculus*, an *Astragalus*, and a Papilionaceous undershrub which has been doubtfully referred to *Daubentonia:* also *Rubus trivialis!* and the exquisitely beautiful *Aquilegia leptocera*, var. *flava*.

"From Bacuachi to Arispe the course of the Sonora River was followed. Shortly after leaving the former place, it passes through a narrow cañon, the rocky walls of which rise perpendicularly for several hundred feet on either side. The whole pass was brilliant with the intensely scarlet flowers of a fine *Erythrina*, which projected from almost every crevice.† In this cañon was first noticed a new

* *Baccharis ramulosa* = *Aplopappus ramulosus*, DC., and *Linosyris* (*Aplodiscus*) *ramulosa*, Gray, Pl. Wright. 2. p. 80. Mr. Thurber appears to have gathered the male plant only; and this alone occurs in Wright's and other collections. But I have seen female specimens, collected by Dr. Bigelow or Dr. Parry, which show, what was not before suspected, that this is a real *Baccharis*. In Thurber's specimens the bristles of the pappus are clavellate-barbellate at the summit, which is scarcely noticeable in the original plant of herb. Martius: but Wright's No. 1400 is intermediate. — A. G.

† This *Erythrina* is also in Gregg's Mexican collection, No. 586 (without fruit); from Paso de Gallinero, near Dolores, in Queretaro? It accords so nearly with the imperfect character of *E. coralloides*, DC., that I venture to apply that name to it; although the petioles are often somewhat aculeolate, and the pods are minutely cinereous-pubescent. According to Dr. Gregg's notes, it forms a shrub or small tree, from five to ten feet high. Mr. Thurber remarks that the trunk is a foot in diameter, but subterranean. The short and stout prickles are solitary under the leaves. The foliage, branchlets, &c. are minutely tomentose-pubescent when young, at length glabrate. Leaflets dilated-ovate or deltoid-ovate, truncate at the base, 2 or 2½ inches long and 2½ to 3 inches wide, subcoriaceous. Raceme short and dense. Flowers 2 inches long. Calyx 3 or 4 lines long, truncate, a little oblique. Corolla "brilliant scarlet"; the vexillum linear-oblong, straight; the wings and keel included in the calyx. Stamens 10. Pods 5 or 6 inches long, torose, cinereous-puberulent, few-seeded, tipped with a cuspidate point of an inch in length, while the similar attenuated base tapers into a stipe of the same length, tardily dehiscent. Seeds oval-oblong, a little over half an inch in length, bright red, with a narrow and pale hilum. — A. G.

Cereus,* which was afterwards met with more abundantly and of larger growth in other parts of Sonora. The only flower seen was secured, and from it the description by Dr. Engelmann, in Silliman's Journal for May, 1854, was taken.

"Arispe, the terminus of the journey, is situated near the thirtieth parallel. Here the pomegranate and fig attain great perfection, and here we first saw *Opuntia Tuna* cultivated for its fruit.

"A rapid return march was made to the Copper Mines, where our time was too much occupied by preparations for a longer journey, to allow me to make many collections. In a visit to the pine woods near the mines, however, a new *Potentilla* with blackish-purple flowers, *Astragalus humistratus*, and a small Potato resembling *Solanum tuberosum*, were collected.

"In August the expedition for the survey of the Gila left the Copper Mines to join the Mexican Commission, then near the San Pedro River; from which point a party proceeded to the town of Santa Cruz. This section of the journey, especially the vicinity of Santa Cruz, afforded a rich harvest of new plants, most of which have been noticed in the publication of the collection of Mr. Charles Wright; that excellent collector having accompanied the expedition as far as to this point.

"Santa Cruz is situated near the source of a small stream of the same name, in a narrow valley, bounded by high and rounded hills, the ravines of which abound in interesting plants. A new *Perezia*, not met with by Mr. Wright, was collected among the hills; and a curious *Melampodium* was found on the margin of the river.

"Failing to procure the provisions, in search of which Santa Cruz was visited, a small party, which I accompanied, proceeded to Ures, the present capital of Sonora, taking the road by Magdalena, Cucurpe, Rayon, and other small towns. In a cañon near the deserted mission of Cocospera, *Cereus giganteus* was first met with. The first specimen brought the whole party to a halt. Standing alone upon a rocky projection, it rose in a single unbranched column to the height of some thirty feet, and formed a sight which seemed almost worth the journey to behold. Advancing into the cañon, specimens became more numerous, until at length the whole vegetation was, in places, made up of this and other Cactaceæ. Description can convey no adequate idea of this singular vegetation, at once so grand and dreary. The *Opuntia arborescens* and *Cereus Thurberi*, which had before been regarded with wonder, now seemed insignificant in comparison with the giant Cactus which towered far above them. In this cañon an old Texan acquaintance, *Sesbania macrocarpa*, was observed. *Kosteletzkya*

* *Cereus Thurberi*, Engelm.; a species allied to *C. giganteus*, Engelm. — A. G.

Virginica was abundant, in company with a beautiful plant of the same order, which proves to be the type of a new genus allied to *Thespesia*. Near the town of Rayon several trees of *Fouquiera spinosa*, H. B. K., were found just coming into flower (in October), while the leaves were beginning to fall. The habit of the tree is quite unlike that of *F. splendens*: the trunk rises three or four feet before throwing out its straggling and crooked branches. The bark of the old branches is yellowish-green; the flowers are crimson.

"The country between Magdalena and Rayon is mountainous and impassable by wagons. Between the latter place and Ures, the sombre, rounded gravel hills appear again, and in the valleys between them are large groves of palms. Specimens sufficient for the identification of the species were not secured; the fruit, which contains a sparing sweetish pulp, is gathered in large quantities by the Mexicans. Among these hills an undescribed *Guaiacum* was found: also a variety of *Hiræa septentrionalis*,* and a narrow-leaved *Jacquinia*. At Ures all botanical collections for the year were suspended. Causes which it would be out of place here to mention had brought the party thus far into the interior of Sonora; and a series of untoward events detained it for many weeks at this place.

"Christmas at length found us again at Santa Cruz, *en route* for the Gila. The journey thence to San Diego, on the Pacific, was one of toil and disaster. Portfolios, paper, and everything that could relieve the starving animals, were abandoned, and at length the whole party were making the dreary march across the Colorado desert on foot. Near the western edge of this desert several early (February) flowers were noticed, of which a few scanty specimens were preserved in a pocket note-book; among them were two new Compositæ, one a new Asteroid genus, the other a third *Psathyrotes*.

"The considerable collections made while in California were mostly of well-known plants. The return journey to the Rio Grande was commenced in May, 1852. At San Isabel, a new suffruticose, silvery-canescent *Hosackia* was found upon the rocks.

* Hiræa septentrionalis, Adr. Juss. Monogr. Malp. 2. p. 309: var. *foliis minoribus sæpissime oblongo-lanceolatis.* — *H. Coulteri*, Planch. in Herb. Hook. ined. "Called *Gallineta*: the root said to be a specific in syphilis." — This is the same plant as No. 856 of Coulter's Mexican collection, from Sonora Alta, which is named, I believe, by Dr. Planchon, in the Hookerian herbarium, *Hiræa Coulteri*, n. sp. And indeed the specimens seem at first view sufficiently distinct from *H. septentrionalis*. But I find no satisfactory character to distinguish them; and Coulter's No. 860 is intermediate. Perhaps it is also De Candolle's *H. macroptera*, founded on one of Moçino and Sesse's drawings. The inflorescence inclines to be cymose and trichotomous. The wings of the fruit are very broad and thin, nearly equal, often more or less confluent at the base, sometimes slightly so, as they appear to be in some fruits of the true *H. septentrionalis*, or even distinct.

"At San Felipe, a miserable Indian village, the country begins to put on a barren aspect, and oaks and other trees are no longer met with. The sterile table-lands bear only stunted Mezquit, *Larrea*, and other plants characteristic of the dry North-Mexican flora. At this place a new *Zizyphus*, with a very large and woody fruit, was collected. This was also sent home by Dr. Parry, and will be described by Dr. Torrey in the forthcoming account of that gentleman's collections. A plant, which proves to be a new genus in Eriogoneæ, a new *Porophyllum*, *Thamnosma montanum*, Torr.,* and *Simmondsia*, Nutt., were also found in the same locality.

"The desert was crossed in the night, to avoid the heat of the sun, and no opportunity was afforded for noticing its scanty vegetation. The Colorado River, near the junction of the Gila, presents little variety as to the vegetation, which is chiefly of Willows, Cotton-wood, Mezquit, a few species of *Baccharis*, and *Tessaria borealis*. The latter plant is exceedingly abundant. The quarters at Fort Yuma were built of frames of poles, covered with the long and straight stems of the *Tessaria;* beneath this shelter the tents were pitched, and protection was thus afforded from the otherwise insupportable sun.

"The distance from the confluence of the Gila and Colorado to the Pimo Villages is about two hundred miles. The valley of the Gila, the general direction of which is followed by the road, is narrow, and bordered by high table-lands, which sometimes extend quite to the margin of the river. Isolated ranges of rugged mountains, without trees or verdure, are seen in all directions, and the whole region has a desert-like character. The route is almost entirely destitute of grass; and the only food for animals is the pulpy pods of the Mezquit (*Algarobia glandulosa*). These at the season of our journey (June) were in perfection; and the animals belonging to the party not only subsisted, but really improved in condition, during the time it was almost their sole food. Among the new plants furnished by this region is a curious *Dalea*, a very spinose shrub of four or five feet in height, with light greenish bark and deep indigo-blue flowers. Another shrubby species, *Dalea Emoryi*, which was mentioned by Dr. Torrey in Colonel Emory's Report, but not characterized, owing to the want of sufficient materials, grew in the ravines. A singular parasite was observed upon some specimens, which proves to be a new species of *Pilostyles*. In the bottom near Independence Rock (Johnston's Report), a remarkable new genus in Loasaceæ (*Petalonyx*) was discovered. Along the margins of the river several Cyperaceæ, yet unexamined,

* This plant, which was imperfectly characterized, from a poor specimen, in Fremont's Second Report, proves to be nearly, if not wholly, congeneric with the *Rutosma Texanum*, Gray, Gen. Pl. t. 155, an herbaceous, Texan and North-Mexican, truly Rutaceous plant, which was published considerably later.

were gathered, and *Erigeron Canadense* and *Oligomeris glaucescens* were common. *Cereus giganteus* occurs frequently along the table-lands, and near the villages of the Pimos becomes very abundant. It was our good fortune to find this species both in fruit and flower, affording materials for the completion of its history, which has been done by Dr. George Engelmann in a paper before referred to. The fruit of this Cereus is an important article of food among the Indians of this region, who collect it in large quantities and roll it into balls, which keep well without other preparation. The seeds from portions of this *conserve*, brought home, have promptly germinated, so that this remarkable species is secured for our green-houses.

"A visit was made to the Salinas River, which, coming from the northeast, joins the Gila below the Pimo villages. Its valley is broader than that of the Gila, but its general character is the same. Specimens of two undetermined Leguminous trees were collected, in fruit only, upon the table-lands, between the two rivers; and a curious thorny shrub, forming the new genus *Holacantha*, was found in the same vicinity.

"The party left the Gila in July; and from that time until its arrival at El Paso, in the middle of August, scarcely a day passed without severe rains. The route, which was by the way of Tucson, Santa Cruz, Janos, and Corralitas, produced few novelties. A new *Malvastrum*, however, was collected in Santa Cruz valley, and one or two specimens of a new genus in Compositæ Senecioneæ. Between Corralitas and El Paso, *Amoreuxia Schiedeana** was abundant upon the sandy prairies, and in the medanos, or sand-hills, through which the road passes near El Paso, along with *Pentstemon ambiguum* and *Dalea scoparia*.

"Late in 1852, the party made a journey from El Paso, through the States of Chihuahua, Durango, Cohahuila, and Nuevo Leon, to Camargo, on the lower Rio Grande. The route was almost precisely that taken by Dr. Wislizenus, to whose excellent account of the features of the country little can be added. From the lateness of the season, only a few botanical specimens were made. Among them, however, occurs *Tridax bicolor*; † an unpublished *Dalea* (*D. Greggii*, Gray), which was common along

* The corolla, according to Mr. Thurber's memoranda, is "deep orange, with a brownish spot in the centre"; approaching so nearly to De Candolle's phrase, "*flores rubelli*," as to render it altogether probable that the *A. Schiedeana* of Planchon is the original *A. palmatifida*, DC. — A. G.

† *Tridax bicolor*, Gray, Pl. Fendl., p. 104. Bachimba, Chihuahua, among rocks; November. A single specimen was gathered, of a taller plant than that of Wislizenus, from which the species was characterized, being a foot or two in height; the head larger than in *T. procumbens*, and with rose-purple rays. The lower leaves are opposite; but all the upper alternate, and on very long petioles. The pappus, in the specimen, is not tinged with purple. — A. G.

the road, and had already been gathered at the same place by the late Dr. Gregg; a truly shrubby *Argemone*, which was found only with mature fruit; and a new *Acacia*, so far as can be judged from the flowers, with remarkably thick and coriaceous leaves. The two latter were met with only in the mountain pass of La Peña, near the town of Parras." (G. Thurber.)

NEW GENERA AND SPECIES.

Ranunculus hydrocharoides (sp. nov.): glaberrimus; caulibus floriferis erectis (spithamæis) foliosis stolonibusque repentibus validis; foliis longe petiolatis integerrimis orbiculari-cordatis ovato-rotundis ovalibusque, caulinis sensim oblongis basi attenuatis seu spathulatis; petiolis basi scarioso-dilatatis; pedunculis oppositifoliis unifloris folio paullo brevioribus; petalis 5 – 8 obovatis (luteis) sepala subduplo superantibus glandula semilunari crassa instructis; carpellis pauciusculis lævibus stylo brevissimo apiculatis in capitulum subglobosum acervatis. — In wet marshes, Mabibi, Sonora; June. Perennial. Stems, and also the long stolons, stout, striate, fistulose. Leaves rather fleshy, diverse in shape, the lowest usually rounded and more or less heart-shaped, 6 to 15 lines long; the larger cauline $1\frac{1}{2}$ inch long, these gradually becoming narrower and tapering into the long petiole. Sepals orbicular. Petals $2\frac{1}{2}$ to 3 lines long, obtuse, tapering into a conspicuous broad claw, at the summit of which a thickened gland, with a small sinus above it, takes the place of the ordinary scale. Stamens 20 or more. Carpels 15 to 20, in a globular head of only 2 lines in diameter. — This belongs to the same group, apparently, with *R. salsuginosus*, *Cymbalaria*, &c., but is very different from any described species.

Argemone fruticosa (sp. nov. Thurber, in litt.): glaberrima, valde glauca; ramis patentibus lignosis undique foliosis inermibus; foliis crassis oblongis sinuatis margine spinosis; floribus inter folia sessilibus; capsula ovata echinato-spinosa. — In the mountain pass of La Peña, Cohahuila; November, 1852; in fruit. — Hazardous as it always is to propose new species of *Argemone*, especially upon incomplete materials, yet there would seem to be little room for doubt in respect to this plant; which forms a stunted shrub, of $1\frac{1}{2}$ to $2\frac{1}{2}$ feet in height, with its rigid and divergent branches woody almost to the growing tips, the older ones squarrose with the crowded and salient scars of fallen leaves, the younger strongly glaucous-white, as are the thick leaves. The latter are only an inch or an inch and a half long, smooth and glabrous, nearly veinless, their short teeth armed with long and stout fulvous prickles, and one or two smaller ones occasionally appear on the midrib. The specimens are wholly past flowering. The dehiscent capsules scarcely exceed half an inch in length, are mostly five-valved, and armed with short prickles with tuberculate-dilated bases, but glabrous. Seeds globular, with less salient reticulations than in *A. Mexicana*. The wood of the branches is hard and close-grained.

Malvastrum Thurberi (sp. nov.): pube brevi stellata scabrido-pubescens; foliis subcordato-rotundis crenatis nunc subtri-quinquelobis (lobis obtusissimis) subtus cinereis; floribus fere sessilibus glomeratis, glomerulis plurifloris remotiusculis secus ramos superne aphyllos spicam interruptam efficientibus; bracteolis minimis; calyce fulvo-tomentoso, lobis late triangulari-ovatis tubo paullo brevioribus; corolla (majuscula) purpurea; coccis 10 – 12 muticis fere glabris. — In a valley near Santa Cruz, Sonora; July, 1852. Also found near San Diego, California, by Dr. Parry. — Stem 3 to 5 feet high, herbaceous; the base not seen. Leaves 2 inches or less in length, mostly glabrate above; the floral ones soon reduced to small bracts. Flowers about as large as in *M. coccineum*, densely glomerate, and as if falsely verticillate, along the upper and nearly leafless portion of the flowering stems. Mature cocci glabrous, except at the summit, two-valved.

Abutilon Thurberi (sp. nov.): humile; caulibus gracilibus cum petiolis pedunculisque pilis longis patentibus hirsutissimis; foliis cordatis crenato-serratis acuminatis membranaceis utrinque viridibus glabratis; pedunculis gracilibus axillaribus folio brevioribus unifloris seu ad apicem ramorum subcorymbosis; calycis laciniis ovatis acuminatis petalis aureis dimidio brevioribus; capsula pentacocca, coccis membranaceis demum patentibus bivalvibus longe aristatis trispermis. — Magdalena, Sonora; in shady places; October, 1851. — Stems a foot high, erect or spreading. Leaves about an inch and a half in diameter, thin, when young beset with a few hairs. Peduncles 6 to 9 lines long. Flowers rather smaller than those of *A. crispum*. Calyx beset with the same long and slender hairs as the peduncles, and also somewhat viscous. Mature carpels with the body glabrate, ovoid, or oblong, not bladdery, about the length of the calyx, abruptly tipped with an exserted and slender, at length two-parted, sparsely hirsute awn, which is fully half as long as the cell. Seeds 2 or 3, superposed.

It may be well to notice that specimens of *Abutilon crispum* in this collection, and also of *A. Texense*, in this and in some of Mr. Wright's specimens, have their foliage beset with the remarkable *Uromyces pulcherrima* of Berkeley and Curtis, which was originally sent from Texas by Mr. Wright.

Near Ures in Sonora, Mr. Thurber gathered a specimen of what is probably a variety of *Abutilon Sonoræ*, Gray, Pl. Wright.: but the branches, petioles, &c. are wholly destitute of the long and shaggy hairs of Mr. Wright's plant; the leaves are not lobed, and the carpels are almost muticous. Future collectors in this region must determine whether these characters are constant.

Mr. Thurber's collection also contains specimens of the small-flowered *Anoda* mentioned under *A. hastata* in Pl. Wright. 2, p. 23. Were the petals "ochroleucous" instead of "bluish-white," it would well accord with the *A. parviflora*, Cav. or *A. crenatiflora*, Ort. The carpels are equally few and muticous; but the ripe fruit is not yet known.

THURBERIA, Nov. Gen. Malvacearum.

Involucellum triphyllum, persistens. Calyx cupuliformis, repando-truncatus, unguibus petalorum patentium brevior. Tubus stamineus columnæformis, superne filamenta plurima filiformia exserens: antheræ reniformes. Ovarium triloculare; loculis 6–8-ovulatis verticaliter incomplete bilocellatis, semisepto tenui mox in lanam soluto. Stylus terminalis, indivisus: stigma clavatum, elongatum, tricostatum. Capsula coriacea, trilocularis, loculicide trivalvis; loculis biseriatim 5–8-spermis; valvis margine lanigeris, medio septa seminifera gerentibus; columella centrali nulla. Semina obovata, angulata; testa crustacea, epidermide membranacea tenuissime lanata. Albumen nullum. Embryo conduplicatus; cotyledonibus foliaceis nigro-punctatis maxime complicatis radiculam inferam fere includentibus. — Herba elata, speciosa, glabra; ramulis gracilibus floribusque punctis nigricantibus conspersis; stipulis caducis; foliis petiolatis tripartitis summisve bifidis vel integris, lobis lanceolatis acuminatis integerrimis; pedunculis axillaribus et terminalibus unifloris medio articulatis; corolla alba post anthesin rosea.

THURBERIA THESPESIOIDES. — Sonora; in a cañon, between Cocospera and Barbasaqui; October, 1851. — An herbaceous, doubtless perennial herb, 4 to 10 feet high, copiously branched; the branchlets slender, somewhat angled, marked at the insertion of the leaves by the scars of the stipules, which must be truly caducous, as they have fallen even from the uppermost nodes. Petioles about an inch and a half long, slender. Leaves thin; their divisions 2 to 4 inches long, 6 to 12 lines wide towards the base; the ribs dotted underneath (like the branchlets, calyx, corolla, &c.), that of the middle division usually bearing a linear excavated gland near the base: the uppermost leaves often either unequally two-parted or entire, and ovate-lanceolate. Peduncles about an inch long. Leaflets of the involucel narrowly lanceolate, entire, 3 to 5 lines long, nearly twice the length of the cup-shaped and truncate entire calyx. Corolla of five spreading, dilated-obovate petals, which are convolute in æstivation, an inch in length; their claws woolly-pubescent at the margin, united at the base by means of the stamineal column. The latter is considerably shorter than the petals, and its upper half is antheriferous quite to the apex, which is divided into five subulate sterile filaments. Style longer than the andrœcium; the exserted part gradually thickened upwards, and triangular, the salient angles stigmatose for nearly their whole length; the apex undivided. Ovary globose; the three cells at first vertically divided in the middle by a nearly complete, but thin and delicate, spurious partition, projecting from the back of each cell, which, however, as the ovary enlarges after anthesis, is soon broken up into long and delicate horizontal shreds or hairs, that persist even in the ripe pod, stretching from the dorsal suture almost to the axis, between the two rows of seeds. Ovules ascending, nearly anatropous, biserial. Capsule ovoid, half an inch long, obtuse and pointless, or nearly so, the base subtended by the persistent disc-shaped calyx and the involucel. Seeds 2 to 2½ lines long, sparingly and minutely woolly. Albumen none, or a mere pellicle lining the membranaceous tegmen. Cotyledons large and broad, incumbent on the radicle, transversely contortuplicate, and also longitudinally plicate and folded around the radicle.

This genus, it will at once be perceived from the characters here assigned to it, belongs to the tribe *Hibisceæ*, and is most nearly related to *Thespesia*, having the same calyx, involucel, andrœcium, &c. It is well distinguished, however, by its trimerous gynœcium, and its dehiscent (three-valved) capsule, with the false dissepiments reduced to a mere fringe of delicate woolly hairs; to which may be added the persistent involucel, the more complicate embryo, apparently without any albumen, and the habit of the plant. Founded as the genus is upon perhaps the most elegant plant of the valuable collection of Mr. Thurber, who alone appears to have met with it, I have great satisfaction in dedicating it to the discoverer, himself well known as a meritorious botanist, long before he engaged in the service of the Mexican Boundary Commission; — in the course of which, besides fulfilling the proper duties of an arduous and responsible office, he has been able largely to increase our knowledge of the botany of the whole desert frontier.

HOLACANTHA, Nov. Gen. Simarubacearum.

Flores abortu dioici. *Masc.* Calyx brevis, 7–8-partitus, lobis in alabastro juniore imbricatis. Petala 7–8, hypogyna, oblonga, concava, æstivatione imbricata, cito decidua. Stamina 12–16, sæpius numero petalorum dupla, margini 12–16-crenato disci clypeati vel subcyathiformis inserta, brevia: filamenta inappendiculata, crassa, fusiformia, gibbosa, villosissima: antheræ oblongæ, biloculares, basifixæ, introrsæ, mox deciduæ, loculis longitudinaliter dehiscentibus. Ovarii abortivi vestigium parvum in fundo disci. *Fœm.* Calyx et corolla? maris. Stamina abortiva 7–8, filamentis subulatis villosis, antheris inanibus. Ovaria sæpius 6, gynophoro brevissimo imposita, conniventia, basi tantum mediante columna centrali brevissima connata, uniovulata: styli totidem terminales, ima basi subcoaliti, deinde radiato-divergentes, intus prorsus stigmatosi. Ovulum semianatropum, sutura ventrali infra medium insertum, adscendens, micropyle tenui supera. Drupæ siccæ 4–6, sessiles, stellatæ, ovatæ, demum e carpophoro brevi 4–6-fido secedentes; epicarpio tenui; putamine crustaceo lævi. Semen ovatum, acuminatum; testa tenui; rhaphe brevissima. Embryo intra albumen carnosum parcum; cotyledonibus obovatis planis subfoliaceis; radicula breviuscula supera.—Frutex orgyalis, aphyllus, spinis validis horridus; ramis adscendentibus; floribus parvis secus ramulos spinescentes glomeratis.

Holacantha Emoryi.—On the desert between the Gila River and Tucson; and on the table-lands near the river Salinas, north of the Gila (the latter in July, 1852, in flower.)—Shrub 5 to 8 feet high, leafless, so far as known; but the ascending branchlets furnished with a few small and alternate, oblong or linear, entire scales or bracts, of a line or two in length, which are soon deciduous. The wood of the branches is moderately hard; the bark smooth and light green, on the younger parts cinereous with a close and soft pubescence. The alternate, terete, and rigid branchlets are all produced into stout and sharp thorns. Flowers apparently diœcious (at least the male and female flowers occur on different specimens in the collection), glomerate on the sides of the branchlets, which they sometimes nearly cover, so as to form a kind of spike or spiciform thyrsus, subsessile or occasionally on short pedicels. *Male.* Flower-buds globose-oblong, a line and a half in diameter; both the calyx and the corolla canescently pubescent externally. Sepals 7 or 8, about half the length of the corolla in the full-grown flower-bud, triangular-ovate, united at the base. Petals as many as the sepals and alternate with them, imbricated in the bud, when they are concave and somewhat carinate, their margins and inner surface apparently greenish-white, inserted on or underneath the margin of the hypogynous, or nearly hypogynous, clypeate and concave disc, apparently deciduous nearly as soon as they expand. Stamens sometimes 12 or 13, usually 14 or 16, inserted in the crenatures of the edge of the disc, scarcely longer than the petals: filaments fusiform, very much thickened in the middle, oblique, very villous except at the tapering apex, destitute of any appendage or scale. Anthers linear-oblong, erect, smooth, emarginate at both ends, introrse, early falling away from the less deciduous filaments; the cells opening longitudinally for their whole length. A minute, 5 – 6-radiate vestige of the abortive gynœcium occupies the concave centre of the disc. *Female* calyx and probably the corolla as in the male flowers; but only fertilized flowers occur in the specimens, from which the petals have fallen, if there were any. Stamens apparently 7 or 8, with smaller and slightly thickened filaments, and imperfect anthers. Ovaries commonly 6, verticillate and connivent on a very short and depressed disc or gynophore, semiovate, glabrous, closely sessile, united only at the very base, by means of a short central column: styles arising from the apex of the ovaries, slightly united at their origin, but immediately distinct and spreading, or radiately divaricate, shorter than the ovaries, deciduous after anthesis, their whole inner or upper face stigmatic. Ovule solitary, attached by a broad but extremely short funiculus to the ventral suture between the middle and the base of the cell, ascending, ovate-lanceolate in form, semianatropous, but the rhaphe very short, the summit tapering into the slender micropylar apex. Fruit of several dry drupes, usually 4 or 5 ripening, stellately spreading, each 3 or 4 lines long, ovoid, slightly compressed laterally, blunt, when they fall separating from as many slender and ligneous divisions of the short central axis with which the inner angle toward the base was coherent: epicarp thin, at first fleshy: putamen crustaceous, almost bony, indehiscent, smooth and even. Seed filling the cell, ascending, almost erect, a very short rhaphe connecting the hilum with the large and orbicular basal chalaza; the integument very thin; the micropyle pointed. Albumen fleshy, in small quantity, inclosing the large embryo, which occupies nearly the whole length and breadth of the seed. Cotyledons straight and flat, thin, between foliaceous and fleshy. Radicle superior, not retracted, about one fourth the length of the cotyledons.

This curious shrub, or small tree, was first noticed by Colonel Emory, who, however, obtained only naked branches, one of which is figured (Fig. 14) on one of the plates of *Cacteæ*, &c., appended to his Report. In the notes Dr. Engelmann suggested that it might prove to be another species of *Kœberlinia*, which, indeed, it resembles in its whole habit. The flowers and fruit, now made known by Mr. Thurber, are very different from those of *Kœberlinia;* but yet not essentially unlike those of the order

(*Rutaceæ*, including *Zanthoxylaceæ*) to which this anomalous genus has been provisionally referred. The nearest relative of our plant, however, is found in the adjacent small family of *Simarubaceæ*, namely in *Castela*, of Turpin; — a genus formerly annexed to the *Ochnaceæ*, but lately and more properly placed in *Simarubaceæ* by Planchon, in his revision of this group.* *Castela* and the present genus, however, make a close approach to the *Zanthoxyleæ*, from which they mainly differ in the uniovulate carpels, the dotless leaves, and the want of aromatic qualities. The habit of *Holacantha* is much the same as that of *Castela*, except that the leaves, so far as known, are reduced to minute and deciduous bracts; and the Quassia-like bitterness is also apparent in the bark, but hardly in the wood. The essential floral differences are merely the 7 – 8-merous (instead of tetramerous) flowers, the thickened filaments in the male blossoms, and the insertion of the ovule at a point so near the chalaza that this organ, as well as the seed, is truly ascending instead of pendulous. The name chosen for the genus, from ὅλως, wholly, and ἄκανθα, a thorn or thorn-bush, alludes to its perfectly spinous branches throughout.

Guaiacum Coulteri (sp. nov.): stipulis parvis spinescentibus; foliolis 3 – 5-jugis lineari-oblongis mucronatis basi inæqualibus; capsula breviuscule stipitata 5-cocca, coccis ovalibus dorso acute carinatis. — On hills between Rayon and Ures, Sonora; October, 1851. — The specimens bear ripe fruit only. They are said by Sir William Hooker to accord with No. 779 of the Mexican collection of the late Dr. Coulter. The petiole and rhachis together are an inch or less in length, and slightly pubescent when young. Leaflets opposite, 6 to 8 lines long, minutely veiny. Flowers not seen. Capsule half an inch in length, and of somewhat greater breadth, very deeply 5-lobed, or by abortion 4-lobed, retuse at both ends, raised on a stipe of a line and a half in length, the summit tipped with a short point; the turgid lobes abruptly and sharply keeled on the back. Cotyledons with their margins directed to the axis of the fruit.

372. Astragalus (Phaca) Thurberi (sp. nov.): perennis, cinereo-pubescens, demum glabratus; caulibus subpedalibus striatis; stipulis triangularibus basi imo petiolo adnatis; foliolis 6 – 7-jugis carnosulis lineari-oblongis retusis; pedunculis brevibus cum spica 10 – 20-flora folio vix longioribus; floribus ochroleucis? (3 lineas longis) brevissime pedicellatis; calycis pubescentis dentibus subulatis obtusiusculis tubo cam-

* In *Lond. Jour. Bot.*, 5, p. 567. — Planchon attributes appendiculate filaments to Castela: but there are certainly no squamulæ in C. Nicholsoni.

panulato paullo brevioribus; leguminibus parvis (3 lin. diametro) globosis inflatis vix apiculatis chartaceo-membranaceis glabellis oligospermis, suturis haud introflexis. — Near Fronteras, &c., Sonora; on dry plains; June, 1851. — Stems rather rigid, erect or ascending, 6 to 10 inches high, leafy. Leaflets crowded, 4 or 5 lines long. Peduncles half an inch or an inch long; the rather close spike of about the same length. Pods not stipitate. Ovules 8 or 10. — An inconspicuous, but well-marked species, quite different from any known to me.

Daubentonia? Thurberi (sp. nov.): frutescens; 1–2-pedali; ramis petiolisque dense viscoso-hirtellis; stipulis lanceolatis acuminatis striatis deciduis; foliolis 9–12-jugis ovalibus subretusis venosis glabris margine ciliolatis; racemis laxe paucifloris; calyce glabro bracteolis 2 caducis stipato, tubo cyathiformi basi obliquo longius angustato, limbo 5-fido, lobis subæquilongis, 2 superioribus oblongis acutiusculis, 3 inferioribus ovalibus obtusissimis; ovario pubescente longe stipitato. — Hill-sides, Mabibi, Sonora; June, 1851. — This must belong to the Galegeæ, near *Sesbania*, to which genus, in the absence of the fruit, I should have doubtfully referred it, except that the stigma is obtuse and terminal, and the ovary, neither much elongated, nor containing more than 10 or 12 ovules, is raised on a slender stipe, and manifestly shows, in the most advanced flower examined, two sharp edges at each suture, which I take to be the rudiments of four wing-like margins. On the latter account I provisionally place the species in *Daubentonia;* although the calyx differs widely from the known species of that genus. The calyx is four lines long, with an attenuated and oblique turbinate base of considerable length; and the lobes ($1\frac{1}{2}$ lines long) are broad, venulose, and three of them very obtuse; their margins sparingly glandular or ciliolate. The (yellow) corolla is fully as large as in the Texan *Daubentonia.* Bractlets as long as the narrowed base of the calyx, oblong, obtuse, faintly striate, caducous, as are the similar bracts. Stipules 2 or 3 lines long. Rhachis of the abruptly pinnate leaves 4 or 5 inches long, including the short proper petiole. Leaflets thin, half an inch in length.

Leguminosa. — I may notice, for the purpose of directing towards it the attention of future explorers, an undetermined Leguminous tree called *Tesota* by the Mexicans, and said by Mr. Thurber to be common on the table-lands of the lower part of the Rio Gila. But no one appears to have preserved specimens of it except Mr. Thurber, who found it only with unripe fruit, in July, 1852. From the vegetation one would incline to refer the plant to the suborder Cæsalpineæ; but the withered remains of the andrœcium found in one instance sheathing a sterile pistil, no less than the incurved embryo, prove it to be papilionaceous and probably of the subtribe Galegeæ. The branches, with the foliage, &c., are minutely canescent when young. They are armed with straight, mostly geminate, and apparently infra-stipular spines. Leaves often fascicled in former axils, simply and abruptly pinnate, very short-petioled, the leaflets occupying the rhachis almost down to the base: these are oblong or obovate, from 3 to 5 lines long, obtuse, pale and cinereous, minutely petiolulate, and veiny. Flowers apparently few in short axillary racemes. Pedicels as long as the calyx, nodding in fruit. Calyx canescent, two-lipped; the upper lip emarginate-two-lobed, the lower three-parted: lobes obtuse. Filaments diadelphous, 9 and 1. Ovary linear, one-celled, many-ovuled, glandular, nearly terete, sessile. Style after anthesis inflexed, villous above, often persistent on the legume: stigma terminal, capitellate. Legume indehiscent? thick and fleshy, about an inch long, somewhat compressed, sometimes two-seeded, when it is constricted between the seeds, more commonly one-seeded, when it is often lageniform, the seed being near the summit of the pod and the long base contracted and terete. Seed large, oval, not strophiolate. Cotyledons thick and fleshy, but flat, accumbent on the incurved and slender radicle.

Robinia Neo-Mexicana (sp. nov.): aculeis stipularibus subrecurvis; foliolis ellipticis oblongisve; pedunculis hispidiusculis calycibusque (dentibus subulato-lanceolatis) glanduloso-pubescentibus; racemis brevibus confertifloris; corolla rosea. — Dry hills on the Mimbres, New Mexico; May, 1851: in flower. (Western New Mexico, Dr. Woodhouse, in herb. Torr.: foliage only.) — "Shrub from 4 to 6 feet high." The racemes are short and many-flowered, like those of *R. viscosa*, and the flowers of about the same size. The peduncles are only minutely hispid, as in some forms of *R. hispida*, but the teeth of the calyx are proportionally shorter and less pointed than in that species. The branches exhibit none of the clammy exudation of *R. viscosa;* and the stipular spines are often three lines long, very sharp, and rather stout. The fruit is not yet known.*

Dalea Greggii (sp. nov.): suffruticosa, undique tomentoso-sericea, canescens; ramis floridis decumbentibus vel diffusis demum nunc glabratis glanduliferis; foliis bre-

* As this sheet is passing through the press, flowering specimens of this *Robinia*, gathered on the Mimbres by Dr. Henry, have come to hand; also fruiting specimens collected in the mountains east of the Rio Grande by Dr. J. M. Bigelow. The latter have nearly the foliage and exactly the pods of *R. viscosa*, — to which they might be referred except that there is no trace of the clammy exudation.

vissimis 2–3-jugis; foliolis confertis (sesquilineam longis) obovatis; spica brevi densissima; calyce cum bractea oblongo-lanceolata acuminata æquilonga sericeo-villosissimo, dentibus subulatis tubo æqualibus corolla flavo-purpurea brevioribus; vexillo dilatato-reniformi parvo. — (Dry hills, near Buena Vista, Cohahuila, *Dr. Gregg.*) Cerro Gordo, Cohahuila; November, 1852. — Of this I have long possessed imperfect specimens, gathered by Dr. Gregg in March, 1847. Mr. Thurber's specimens from the same district enable me to give its characters. It is a small, depressed or diffuse, suffruticose species; the ascending, decumbent, or even creeping flowering branches varying from 2 or 3 inches to a foot in length, slender, and minutely tuberculate with sparse glands, which are more apparent when the tomentum wears away. Leaves often fascicled; the rhachis with the short petiole only 2½ or 3 lines long. Leaflets usually 7, barely a line and a half long, densely tomentose-silky both sides, not perceptibly glandular. Spike terminal, sessile or short-peduncled, mostly capitate, less than an inch long, thick. Flowers about 3 lines long. Stamens 10. — This may be placed next to *D. mollis* in the arrangement of the North American species given in Pl. Wright. 2. p. 41.

Dalea Emoryi (sp. nov.): fruticosa, ramosissima, pube brevi mollissima cano-tomentosa, glandulis parvis punctata; foliolis 1–3-jugis anguste oblongis cum impari duplo longiore lineari; spicis brevibus densis plurifloris; calycis villosi dentibus subulatis tubo brevioribus; "corolla purpurea." — On the desert table-lands of the Gila, June, 1852. — This was first gathered by Colonel Emory, to whom the species is accordingly dedicated, and is the second species mentioned by Dr. Torrey, in Emory's Report, p. 139.* Mr. Thurber's specimens are past flowering. It should probably stand near *D. scoparia.* The orange-colored or reddish glands are nearly concealed by the fine white wool; on the calyx they are in rows between the ribs.

Dalea spinosa (sp. nov.): fruticosa, ramosissima, parce glanduloso-pustulata, pube minuta appressima canescens; ramulis rigidis intricatis in spinas pungentes abeuntibus; foliis simplicissimis sparsis anguste cuneatis vel sublinearibus emarginatis subsessilibus crassiusculis; floribus secus ramulos ultimos laxe spicato-congestis subpedicellatis patentibus folio seu bractea parva caduca stipatis; calycis dentibus late ovatis obtusissimis tubo turbinato 10-costato dimidio brevioribus; corolla pulchre violacea seu in-

* The first species there mentioned, and partly described, is the *Dalea mollis*, Benth. Bot. Voy. Sulph., which, however, is not shrubby.

digotica, vexillo dilatato obcordato alisque ovalibus carina brevioribus; fructu calycem excedente. — Arroyos on the Gila; and on the Californian desert west of the Colorado, where it was also gathered by Fremont, in 1849, without flowers or fruit. — A remarkable species, allied to the New-Mexican *D. scoparia.* It is a much branched, spinescent, shrubby plant, of 4 or 5 feet in height; the branches glabrate with age, and naked. Leaves 6 to 9 lines long, from half a line to two lines wide, obscurely striate in the dried state. Flowers scattered or rather crowded and spicate along a mostly spinescent branchlet or rhachis. Calyx three lines long, including the very short pedicel, cinereous-pubescent like the rest of the plant, usually bearing a circle of large and brown pustular glands near the summit of the tube. Corolla large and much exserted, of a deep violet or indigo blue, as in *D. scoparia*; no glands found on the petals. Stamens 10. Fruit turgid, obliquely ovoid or oblong, pointed, canescent, beset with glands four lines long.*

HOSACKIA (SYRMATIUM) ARGOPHYLLA (sp. nov.): suffruticosa, undique dense sericeo-tomentosa, incana; ramis elongatis decumbentibus; foliolis 3–5 obovatis obtusis; capitulis brevissime pedunculatis plurifloris foliolo unico bracteatis; dentibus calycis

* The characters of two more shrubby species, gathered in nearly the same region by Colonel Fremont, in his second expedition, are subjoined.

DALEA FREMONTII (Torr. ined.): fruticosa, ramosissima, parce glanduloso-punctata, sericeo-puberula; foliis petiolatis simplicibus obovato-spathulatis vel plerisque trifoliolatis, foliolis obovatis; floribus secus ramulos subspinescentes sessilibus laxe spicato-confertis patentibus singulis aut folio aut sæpius bractea parva subulata stipatis; dentibus calycis acutissimis tubo campanulato vix costato subæquilongis, 2 superioribus triangulatis, cæteris subulatis; corolla purpurea; vexillo obcordato alis et carina fere æqualibus. — Mountains of the Pah-Utah country, S. W. California; on rocks; May, *Fremont.* — Apparently a low or depressed shrub, with copious reddish-purple flowers, of 4 or 5 lines in length. Calyx minutely silky-pubescent, like the other young parts of the plant, beset with many inconspicuous glands. Rhachis beset with a few minute setæ. Leaflets, or blade of the occasionally simple leaf, three lines long, shorter than the petiole.

DALEA ARBORESCENS (Torr. ined.): ramosissima, fere eglandulosa, subspinescens; ramis adultis glabratis, novellis cum foliis calycibusque cano-tomentosis; foliolis bijugis cum impari approximatis obovatis; floribus in spicam densam brevem congestis; bracteis parvis subulatis; dentibus calycis acuminatis tubo campanulato æquilongis, 2 superioribus oblongo-triangulatis, cæteris angustioribus lanceolatis; petalis (purpureis?) fere æqualibus. — Mountains of San Fernando, a southern branch of the Sierra Nevada, California; April, *Fremont.* — "A small tree!" Glands scarcely any; a few minute tubercular ones occasionally found on the branchlets when denuded of the dense woolly covering. Leaves petioled; the leaflets only 2 or 3 lines long. Spikes ovate or oblong. Flowers 5 or 6 lines long; the calyx large in proportion; the tube obscurely striate. Vexillum obcordate. — A remarkable species, especially for the size of its stem.

subulatis obtusis tubo dimidio brevioribus; legumine canescente. — San Isabel, California, on rocks; May, 1852. Also gathered by Fremont, on the eastern side of the Sierra Nevada. — Decumbent branches or stems two feet long, densely white-tomentose. Stipules obsolete. Leaves and calyx clothed with a very dense, appressed, silvery and silky tomentum: leaflets 3 to 6 lines long, all roundish-obovate. Flowers (as large as in *H. tomentosa*) in nearly sessile or very short-peduncled axillary capituli, which are crowded along the upper part of the virgate branches, so as to form a kind of interrupted spike, the clusters mostly exceeding the subtending leaf. Pedicels none. Corolla yellow. Legume falcate, compressed, rostrate, containing one large and oblong seed. — The *Hosackia tomentosa* of Bentham, which is probably that of Hooker and Arnott (who perhaps wrote "folium" in place of *foliolum* in describing the bract, and also the *Syrmatium tomentosum* of Vogel), is incorrectly said to have the calyx-teeth shorter than the tube, nor are the "flowers much smaller than those of *H. decumbens*" as stated in Torr. and Gray, Fl. N. Amer. The corolla, however, is decidedly shorter in proportion to the calyx; the teeth of which are very slender, or subulate-setaceous, and for the most part fully as long as the tube. In the present species the teeth are very much shorter and blunter, and the whole calyx, like the foliage, is densely clothed with a very different silvery-silky tomentum; the stems are woody at the base, &c. *Syrmatium*, Vogel (the *Drepanolobus* of Nuttall) is too closely connected with *Hosackia* to be generically separated. The whole genus, augmented by several still unpublished species, greatly needs a thorough revision.

829. Acacia? crassifolia (sp. nov.): fruticosa, aculeis sparsis et substipularibus vix recurvis armata; ramis foliisque glabris glaucescentibus; pinnis unijugis glandula petiolari interposita; foliolis unijugis pro genere maximis (sesqui-bipollicaribus) dilatatis cuneato-rotundis impetiolulatis crasso-coriaceis utrinque consimilibus flabellato-7-nerviis et reticulato-venosis; pedunculis generalibus axillaribus et terminalibus folia excedentibus racemoso-capituliferis, partialibus solitariis sæpiusve binis vel ternis pubescentibus ultra medium obsolete unibracteolatis; capitulis globosis; lobis corollæ infundibuliformis calyceque paullo breviore canescenti-pubescentibus. — In the mountain pass of La Peña, Cohahuila; November, 1852. — The specimen of this most anomalous *Acacia*, as it appears to be, is in flower only. It is said to belong to a shrub of 6 to 10 feet in height. Branches armed with a few scattered, rather stout prickles of 2 or 3 lines in length, and usually with a pair of similar ones subtending the petiole. The latter a quarter or half an inch long, occasionally armed with a solitary prickle underneath, and at its apex above, between the pinnæ (which are reduced to a single pair),

furnished with a depressed and concave gland. The two partial petioles are about the length of the main petiole, and are terminated by a single pair of leaflets, of a thick and firm texture, and of an extraordinary size for this genus, being often an inch and a half in length, and $1\frac{1}{2}$ to 2 inches in breadth, and with their strong and salient nerves, as well as their branching veins, equally conspicuous on both sides. The foliage, inflorescence, and general habit of the plant would refer it rather to *Pithecolobium* than to any other genus. But the stamens are ochroleucous and not monadelphous: they are barely three lines long, and less than twice the length of the corolla. The tube of the latter is glabrous where it is covered by the somewhat turbinate and five-toothed calyx. Ovary oval-oblong, short-stipitate, glabrous, containing several ovules. Unless the fruit furnishes some peculiar characters, the plant must remain in the genus *Acacia*.

POTENTILLA THURBERI (sp. nov.): multiceps, viridis, subpubescens; caulibus e rhizomate crasso adscendentibus (pedalibus et ultra) plurifloris; foliis glabellis membranaceis, radicalibus digitatis 5–7-foliolatis, petiolo patentim piloso, foliolis sessilibus obovato-oblongis grosse serratis, caulinis parvulis subsessilibus trifoliolatis; stipulis 2–3-dentatis; floribus laxe cymoso-paniculatis longiuscule pedicellatis; segmentis calycinis accessoriis oblongo-lanceolatis sepala æquantibus petalis atro-sanguineis obcordato-rotundis vel emarginatis paullo brevioribus; receptaculo conico breviter villoso; acheniis glabris vix rugulosis; stylo fere terminali. — Near Santa Rita del Cobre, New Mexico; August, 1851. — This remarkable species, which appears not to have been seen either by Mr. Wright or Dr. Bigelow, — who largely collected in the same region, — is one of those which invalidate the genus *Comarum*. It is manifestly allied to the Mexican *P. comaroides*, of Humboldt, though very distinct from it, and belongs to the *Herbaceæ*, *Multicipites*, *Ser.* 2, *Multifloræ*, *Rectæ*, of Lehmann's recent arrangement. Petioles of the radical leaves about 3 inches long; the leaflets $1\frac{1}{2}$ to 2 inches long, green both sides, coarsely and obtusely serrate almost to the base. Leaflets of the lowest cauline leaves nearly similar; the others with fewer teeth; the uppermost reduced to small and cuneate three-toothed bracts. Inflorescence minutely pubescent. Pedicels 5 to 12 lines long. Calyx sparingly pilose. Petals about 3 lines long. Stamens 25 to 30, with slender and subulate filaments. Disc nearly as in *P.* (*Comarum*) *palustris*. Receptacle enlarged in fruit, and scrobiculate.*

* Specimens of this striking *Potentilla* have just come to hand, collected by Dr. Henry, of the United States Army, on the Rio Mimbres, and by Dr. Bigelow, I believe from the mountains east of the Rio Grande.

PETALONYX, Nov. Gen. Loasacearum.

Calyx tubo breviter cylindraceo cum ovario connato; limbo 4 – 5-diviso, segmentis linearibus tubum adæquantibus deciduis. Petala 4 – 5, disci epigyni margini inserta, calycis segmentis alterna, iisdem duplo longiora, decidua, longissime unguiculata; ungui filiformi sursum marginato laminam parvam ovato-spathulatam gerente. Stamina 4 – 5, cum petalis inserta, iisdem alterna et longiora: filamenta capillaria: antheræ didymæ, basi fixæ, biloculares, inappendiculatæ. Stylus capillaris: stigma simplex. Ovarium uniloculare. Ovulum unicum, ex apice loculi suspensum, anatropum. Fructus parvus, utriculatus, haud angulatus, fragilis, semine obovato repletus. Testa lævis membranacea, basi chalaza orbiculari notata: endopleura tenuis. Embryonis exalbuminosi cotyledones ovales, crassæ, carnosæ: radicula brevissima supera. — Herba erecta, pube brevi cinerea aspera undique hirtello-scabra; radice perenni? foliis alternis sessilibus ovatis parvulis subintegerrimis; floribus parvis folioso-bracteatis in capitulas vel spicas breves ramos terminantes congestis; petalis albidis.

Petalonyx Thurberi. — Valley of the Rio Gila; June, 1850. — An herb of a foot or two in height, probably from a perennial root, brittle; the stems bearing numerous short and simple flowering branches above, cinereous throughout, as are the leaves, &c., with a fine and short, appressed (on the stem retrorse) pubescence, composed of simple and sharp-pointed hispid hairs, the surface of which is shown to be very rough under a lens; thus the foliage and branchlets are somewhat adhesive in the manner of *Mentzelia*. There are no larger bristles, as in that genus. Leaves (the lower fallen) three fourths of an inch long, decreasing on the branches until they become only 3 lines in length, ovate or triangular-ovate, thickish, brittle in the dried state, one-nerved, and with one or two rather obscure lateral veins on each side, entire or very obscurely 2 – 4-toothed. Spikes or heads about half an inch long, dense; the bracts similar to the rameal leaves, but becoming pale and apparently scarious, often toothed at the base, each subtending a single sessile flower, or sometimes three such flowers. Bractlets 2, at the base of the decided calyx, small, linear. The flowers are stated to be white or whitish, but in soaking they impart a yellow tinge to the water. Æstivation of the calyx and corolla not determined. Calyx 2 or $2\frac{1}{2}$ lines long, including the slender lobes, minutely hispid; the tube wholly connate, the limb being divided quite down to the summit of the ovary. Disc small and flat, crowning the abrupt summit of the ovary. Claws of the petals 2 lines or more in length, sparingly hispid outside;

their lamina less than a line long, ovate, sometimes appearing subcordate by the inflection of the margins of the claw at its summit, but when explanate it is found to be ovate-spatulate, with a tapering base, the surface minutely veined. Filaments attaining the length of half an inch, glabrous: anthers small, with no apparent connective. Style resembling a filament, terminated by a minute and simple stigma. Ovary not ribbed, angled, nor appendaged, ripening without much change, or any considerable enlargement, into a thin and fragile hispid-scabrous utricle, $1\frac{1}{2}$ or 2 lines long, from which the calyx-lobes fall, and which at length breaks in pieces irregularly. Seed filling the cell, obovate, pointed at the hilum, smooth. Cotyledons thick, plano-convex; radicle short, acute.

Botanists will recognize in this plant a very interesting addition to the tribe or suborder *Gronovieæ*, composed of those *Loasaceæ* which have the ovules reduced to a single one, suspended from the summit of the cell, and the seed destitute of albumen. The present genus is especially remarkable for the very long-clawed petals; from which character the name is derived. It forms in some respects a connecting link between *Gronovia* and *Cevallia;* while the anthers are those of a *Mentzelia.* Professor Fenzl would probably recognize the petals of *Petalonyx* as homologous with the inner series of the perianth of *Cevallia*, unless, indeed, on comparing them with the stamens of the latter genus, surmounted by petaloid tips, these slender petals were regarded as an external series of stamens transformed into staminodia. But I can draw no line of distinction between true petals and an external series of sterile, anantherous stamens, alternate with and next within the sepals.

EREMIASTRUM, Nov. Gen. Compositarum.

Capitulum multiflorum, heterogamum, heterochromum; fl. radii uniserialibus ligulatis fœmineis; disci tubulosis hermaphroditis. Involucri subbiserialis squamæ lineari-lanceolatæ, laxæ, æquilongæ, foliaceæ, marginibus hyalinis fimbriatis alatæ. Receptaculum hemisphæricum, nudum. Ligulæ circiter 20, elongatæ. Corollæ disci subcylindricæ, tubo proprio brevissimo, limbo 5-lobo. Styli rami plani, appendice brevissima obtusissima. Achenia compressa? hirsuta, binervia. Pappus in radio et disco conformis, brevis, duplex; exterior e paleis 10 – 12 oblongo-cuneatis setoso-palmatifidis; interior e setis totidem rigidis scabris inæqualibus, nempe, 5 – 6 paleas bis superantibus corollæ disci dimidio brevioribus, et 5 – 6 alternis minoribus. — Herba pumila, monocarpica, cinereo-hispida; foliis alternis lineari-spathulatis; ramis capitulum majusculum basi foliosum gerentibus; ligulis albis.

Eremiastrum bellioides. — On the Californian desert, not far west of the Colorado; January, 1852. — A single flowering specimen was picked up by Mr. Thurber, while crossing this desert on foot. The plant is two inches high, from a slender annual root; the first head borne when only an inch high; the slender branches probably attaining several inches in length in the course of the season. Leaves half an inch long; the uppermost crowded and as if involucrate round the head. Scales of the involucre three lines long, acuminate, hispid outside. Ligules three lines long, oblanceolate; the tube a little hairy. Mature achenia not seen. — I unwillingly add another to the two already known North American genera of De Candolle's subdivision *Bellieæ*; namely, *Distasis* (*Diplostelma*, Gray, Pl. Fendl.) and *Chætopappa*, each of a single species. The present plant is pretty well distinguished from these in habit and character; but on the other hand it makes perhaps too near an approach to those species of *Erigeron*, such as *E. concinnum*, which exhibit rather few bristles and manifest squamellæ in the pappus. The generic name alludes to the habitat of this plant; namely, an Asteroid plant of the desert.*

Melampodium longicorne (sp. nov.): annuum, hispidulum, diffuse ramosum; foliis lanceolatis obtusis integerrimis; pedunculis e dichotomiis ortis gracilibus monocephalis; involucri squamis internis fructiferis 7–10 nervoso-striatis dorso vix muricatis apice in cornu longissimum extus sericeo-puberulum apice circinnato-revolutum productis; ligulis (flavis) minimis. — Near Santa Cruz, Sonora; September, 1851. — Excepting the long horns, which are so conspicuous in this species (being a quarter of an inch in length, while the fructiferous body of the involucral scale is only two lines long at maturity), and the longer peduncles in the lower forks, this much resembles the *M. hispidum*, H. B. K., or at least the No. 1205 of Mr. Wright's collection, which was gathered in the same region with the present plant, and at nearly the same time. In Mr. Wright's plant, moreover, the fructiferous scales are not only truncate but sparsely tuberculate: in ours they are only a little roughened with some minute projections. The long horns give the heads the appearance of those of *Tragoceras zinnioides*, as figured by Kunth.†

* I have recently seen depauperate and precocious specimens of this plant, gathered in the same district by Dr. J. M. Bigelow, early in the present year. Fully developed specimens with mature achenia are greatly needed.

† To the *Melampodineæ*, which has become an incongruous group, must, from its characters, be referred the plant described under the name of *Heterospermum dicranocarpum*, in Plantæ Wrightianæ, 1. p. 109. Mr. Wright's specimens bore some mature achenia on the receptacle, from which everything else had

Dysodia porophylloides (sp. nov.): glabrum, e basi frutescente ramosissimum; ramulis striatis superne fere nudis monocephalis; foliis parvis plerisque alternis bi–tripartitis, segmentis filiformi-subulatis mucronatis eglandulosis, superioribus in bracteas subulatis minimis transeuntibus; involucro turbinato 12–14-phyllo basi bracteis totidem brevissimis subulatis integerrimis muticis cincto; ligulis paucis involucrum et pappum 10-paleaceum vix superantibus; receptaculo fere nudo. — Sandy hills, near San Felipe, between San Diego and the Colorado, California; May, 1852. — Branches rigid, 1½ to 2 feet high, from a frutescent base. Leaves (those of the flowering branches alone seen) from nearly an inch to a quarter of an inch long, gradually reduced into bracts of one or two lines in length; the larger with their divisions sometimes 1–2-toothed, mucronate, but not setigerous. Involucre about half an inch long; the scales coalescent into a cup, linear, beset with oblong or linear glands; their free tips somewhat scarious, rather obtuse. The few and inconspicuous rays consist of a linear ligule, the lower part of which is convolute around the style, while its expanded apex very little surpasses the stigmas. Pappus 3 lines or more in length; the paleæ much like those of *D. porophylla*, but the undivided portion considerably longer.

Psathyrotes incisa (sp. nov.): arachnoideo-lanata; caulibus humifusis dichotomis; foliis cuneato-oblongis argute inciso-lobatis, lobis dentibusve cuspidato-acuminatis; pe-

fallen. My kind friend Dr. Torrey having furnished me with some sketches and flowering heads, from specimens subsequently gathered by Dr. J. M. Bigelow, while connected with the Mexican Boundary Commission, I have learned that the plant is not a *Heterospermum*, although allied to that genus, but it forms a new generic type, the characters of which are briefly subjoined.

DICRANOCARPUS, Nov. Gen.

Capitulum pauciflorum; floribus exterioribus 3–4 fœmineis subradiatis, ligula minima 2–3-loba stylo breviore; disci totidem sterilibus, tubo corollæ cylindrico, limbo cyathiformi 5-fido. Involucrum 1–2-bracteolatum (bracteolis linearibus parvis), 3–4-phyllum: squamæ oblongæ, obtusæ, membranaceæ, erectæ, subplanæ, demum deciduæ. Receptaculum planum: paleæ lineares parvæ inter flores. Antheræ oblongæ, ecaudatæ. Stylus fl. masc. inclusus, indivisus, apice clavato pubescens; fl. fœm. bifidus, ramis inappendiculatis. Ovaria disci inania, epapposa. Achenia (radii) difformis, nempe 1–2 linearia vel subulata, subteretia, lævia, persistentia, aristis 2 validis lævissimis divergentibus seu recurvis persistentibus cornuta; cætera breviora et crassiora, intus sæpe tuberculato-rugosa, aristis brevioribus vel obsoletis. — Herba annua, gracilis, fere glabra, *Heterospermi* facie, microcephala; foliis oppositis 3–5-sectis, summisve integris, filiformibus; capitulis solitariis pedunculatis; floribus flavis.

Dicranocarpus parviflorus. — *Heterospermum dicranocarpum*, Gray, Pl. Wright. 1. p. 109.

dunculis alaribus gracilibus monocephalis; involucri squamis oblongo-lanceolatis acutatis haud striatis. — On the Californian desert near the Rio Colorado (along with *Eremiastrum*), February, 1852. — The specimen (which is just beginning to flower) evidently indicates a third species of *Psathyrotes*, of nearly the habit of *P. annua.* The plant is clothed with thicker and longer wool (which appears to be deciduous with age); the cuneate leaves are deeply and sharply incised; the naked peduncles acquire the length of $1\frac{1}{2}$ or 2 inches, and bear a larger head than that of *P. annua;* the pappus, as in that species, is not much shorter than the corolla, the lobes of which are similarly, but less strongly, glandular-villous outside. — *P. annua* was also found by Mr. Thurber, at Big-Horn Mountain on the Gila, June, 1852; in this region (and not properly in New Mexico) Mr. Gambell probably gathered the specimen described by Nuttall. Dr. Torrey also informs me that the plant was gathered by Colonel Emory, in his first exploration, and that it is his *Tetradymia (Polydymia) ramosissima*, described in Emory's Report, p. 145, where it is suggested as the probable type of a new genus. Had I been aware of the fact, I should probably have adopted for the genus the name suggested by Dr. Torrey, who had rightly indicated the affinities of the plant, and whose description was published in the same year with that of Mr. Nuttall. Mr. Thurber notes that the flowers of *P. annua* are not ochroleucous, but *bright yellow*, and the leaves are aromatic.

BARTLETTIA, Nov. Gen. Compositarum.

Capitulum multiflorum, heterogamum, radiatum; ligulis uniseriatis fœmineis. Involucrum subtriseriale, campanulatum; squamis oblongo-lanceolatis, exterioribus minoribus. Receptaculum convexo-conicum, tuberculato-alveolatum. Corollæ tubo gracillimo subpiloso; disci fauce infundibuliformi, limbo 5-lobo; ligulæ oblongæ. Styli rami graciles, plani, lævi, fl. disci apice capitellato-truncato tantum puberuli, radii setula apiculati. Achenia (valde juniora) radii et disci conformia, oblonga, compressa, marginibus uninervatis longe ciliata. Pappus uniserialis, e setis capillaribus circiter 20 tenuibus sed rigidulis dentato-barbellulatis corolla disci brevioribus. — Herba annua, parvula, glabella; foliis in caule brevissimo plerisque alternis longe petiolatis rotundatis denticulatis sæpe trilobis; pedunculis scapiformibus (spithamæis) monocephalis; floribus flavis.

Bartlettia scaposa. — On a prairie, near Corralitas, Chihuahua, August, 1852. — Leaves sparsely hirsute, but soon glabrate; the petioles an inch long: the blade only half an inch in diameter. There are sometimes one or two minute leaves near the base of the scape-like peduncles; otherwise these are entirely naked, slender, and 4 to 6 inches long. Head rather large for the size of the plant. Involucre somewhat campanulate, 4 lines long, shorter than the disc; the scales about 20, sparsely and minutely hirsute outside, thin, indistinctly 2–3-nerved, the inner ones with scarious margins, the exterior successively shorter and narrower. Rays about 12; the ligules 3 or 4 lines long, oblong, tridenticulate at the apex, bright yellow. Tube of the disc-corollas longer than the throat and limb. Bristles of the pappus as delicate as in a *Senecio*, but a little rigid, probably from being barbellate with strong denticulations, much as in *Arnica*, but more sparsely so. — This little plant is excluded from the vast genus *Senecio* by its imbricated involucre, and its scanty, uniserial, and barbellulate pappus; from *Aronicum*, by the uniserial pappus and the elongated branches of the style; from *Arnica*, by the alternate leaves and the whole character of the style; and from all these genera by its strongly convex or conical, tubercular-alveolate receptacle, and the flat achenia (judging from the ovaries), fringed with strongly ciliate margins. — The genus is dedicated, at Mr. Thurber's request, to John R. Bartlett, Esq., the United States Commissioner of the Boundary Survey at the time and under whose orders this collection was made, and the author of an elaborate work giving an account of this survey and of the physical character, productions, antiquities, and ethnology of the regions visited.

Perezia Thurberi (sp. nov.): glanduloso-puberula, subviscida; caule herbaceo 1–3-pedali simplici crebe folioso; foliis membranaceo-chartaceis ovato-oblongis oblongisve basi cordata semi-amplexicaulibus scabrellis eximie reticulatis creberrime spinuloso-denticulatis dentatisve, inferioribus obtusis, infimis fere obovatis, superioribus acutatis; corymbis polycephalis bracteatis in thyrsum demum oblongum digestis; involucro 5–6-floro, squamis paucis triseriatis minute glandulosis omnibus acuminatis, extimis subovatis, interioribus oblongis et lato-linearibus discum subæquantibus; pappo albo, setis rigidulis. — Rocky hills, near Santa Cruz, Sonora; September, 1851. — "Viscid and aromatic." Leaves crowded, $2\frac{1}{2}$ to 4 inches long, the larger 2 inches wide, the upper gradually reduced to subsagittate or lanceolate bracts. Heads crowded in a compound corymb, or, in larger and fully developed specimens, forming an oblong and lax thyrsus of six inches or more in length. Involucre 3 or 4 lines long, rather cylindraceous than turbinate, of 9 or 10 cuspidate-acuminate scales. Corolla apparently purplish. Achenia glandular. Pappus rather copious; the bristles somewhat rigid, strongly scabrous, obscurely thickened at the apex. — This most resembles some states of *P.*

Wrightii; but the rather chartaceous leaves are more reticulated and roughish, the corymb is generally thyrsiform, the involucre fewer-flowered and proportionally longer, its scales are abruptly pointed, and the pappus is much stiffer. In the foliage, inflorescence, &c., it resembles *P.* (*Acourtia*, DC.) *microcephala*, which must have more flowers in the head, and narrower involucral scales. *P. Humboldtii* (the *Proustia Mexicana* of Don and the original *Dumerilia* of Lessing), the only five-flowered species hitherto described, is said to be a shrubby plant, with leaves only an inch or two in length. — The present species plainly shows that *Dumerilia* has no claim to the rank of a genus.

Stephanomeria Thurberi (sp. nov.): caule virgato simplici puberulo profunde striato bipedali superne longe aphyllo ad apicem in ramos floriferos paucos paniculatos diviso; foliis runcinatis, radicalibus oblongo-spathulatis lobis creberrimis, caulinis infimis sublinearibus, superioribus minutis subulatis; capitulis (pro genere magnis) sparsis; involucro circiter 20-floro. — On the Sierra de los Animos, Sonora; June, 1851.* — "Flowers pink, fragrant." — This is the largest-flowered species of the genus known; the involucre and disc being almost half an inch in length, and the flowers are much more numerous in the head than in any other. The stem is unbranched in the specimen, except at the summit, and the leaves occur only at or near the base; they are two inches or more in length, and the radical ones three quarters of an inch wide, a little pubescent, or soon glabrate. The root is probably biennial. Pappus white, very plumose. Achenia not seen; the flowers being all young. I have not seen Nuttall's *S. elata;* but that species is stated to be only ten-flowered, and is probably identical with Bentham's *S. virgata*.

Jacquinia pungens (sp. nov.): ramulis junioribus puberulis; foliis confertis subverticillatis lineari-lanceolatis valde rigidis aculeato-acuminatis aveniis margine subrevolutis subtus punctatis; floribus ad apicem ramorum corymbosis aurantiacis pedicello paullo brevioribus; fructu globoso. — Hills between Rayon and Ures, Sonora; October (with unripe fruit and some flowers). — A shrub from 8 to 12 feet high, with the very rigid and pungent, pale leaves (about an inch long and two lines wide) much crowded on the short branchlets, subsessile, either alternate, or imperfectly verticillate, or opposite, veinless, the midrib and margins thickened underneath. Corymb several-flowered,

* The same species occurs in a collection made last year in the neighborhood of the Mimbres, by Dr. Henry, U. S. A., which has just been received.

exceeding the leaves. Pedicels and the orbicular sepals glabrous. Corolla about 4 lines long. Anthers subcordate. Unripe fruit 7 or 8 lines in diameter, yellowish. — This is perhaps the Mexican plant figured in Moçino and Sesse's collection of drawings, and doubtfully referred by De Candolle to *J. ruscifolia;* but it does not belong to that species.

The remaining portions of Mr. Thurber's collection are rich in undescribed plants; but the greater part of these also occur in Wright's, Bigelow's, and Parry's collections. Two plants, however, found by Mr. Thurber alone, deserve particular notice; — one, a remarkable new genus of Eriogoneæ, *Centrostegia*, found on the eastern borders of California, the characters of which have been contributed to the forthcoming volume of De Candolle's Prodromus; — the other, the new parasitic flower mentioned by Mr. Thurber (supra, p. 315), as growing on the branches of a shrubby *Dalea*. An account of it is subjoined.

Pilostyles Thurberi (sp. nov.): bracteis sepalisque rotundis margine nudis; ovario semisupero; stigmate disciformi sessili medio subumbonato. — On a small mountain, near the Gila River; June, 1850; parasitic on the branches of *Dalea Emoryi*.

To the four plants already known of the *Apodantheæ*, a group appended to the *Rafflesiaceæ*, Mr. Thurber has made an interesting addition in the present species. These plants are simply single flowers, surrounded by a few bracts, parasitic and sessile on the stems of various Dicotyledonous plants, mostly of Leguminosæ. While the Rafflesias are extremely large, — the flower of *R. Arnoldi*, as is well known, measuring three feet in diameter, — the largest of the Apodantheæ is only three lines in breadth or length, and most of them, like the present species, of barely half that size. The tribe, so far as known, is confined to America; the original species of *Pilostyles*, Guill. (*Frostia*, Bertero, in Endl.) inhabiting Chili, and the two others being from Brazil, while the single *Apodanthes*, Poit. was found in French Guiana. The present discovery extends the range of the tribe into the temperate region of North America. The late Mr. Gardner, who published (in Hooker's Icones Plantarum, t. 144 and t. 155) the two Brazilian species, confidently referred them all to the older genus *Apodanthes*, and perhaps with sufficient reason. But Mr. Brown, in his conspectus of the Rafflesiaceæ, appended to his second memoir on *Rafflesia*, &c. (in Trans. Linn. Soc. 19, part 3), after having examined original specimens of *Apodanthes Caseariæ*, preserved in spirits, has retained the two genera; *Apodanthes* having a more manifest calyx and corolla, the former gamophyllous and merely four-lobed, and the cavity of the ovary four-sided; while in *Pilostyles* the homogeneous and continuously imbricated (usually more numerous) floral leaves are only to be arbitrarily divided into bracts, sepals, and petals, and are apparently distinct from each other, although more or less adnate to the ovary, except perhaps the outermost and lowest, and the cell of the ovary is not angled. The male flowers of *Apodanthes*, too, are stil unknown; so they are, indeed, in all the species of *Pilostyles*, except *P. Berteri*. Mr. Thurber's specimens furnish only female flowers. These most resemble those of *P. Blanchetii*, R. Br. (*Apodanthes Blanchetii*, Gardn.); but the sepals, &c. are not ciliate, nor are they adnate to more than the lower half of the surface of the ovary; and the stigma is thicker, more dilated and disc-shaped, and slightly umbonate in the middle. The floral envelopes appear to accord very well with those of *P. Calliandræ*, R. Br. (*Apodanthes Calliandræ*, Gardn.); but in that species the ovary is represented as almost wholly free, and its apex contracted into an obtuse point terminated by a small truncate stigma. The broad and depressed stigma of *P. Thurberi* rests directly upon the summit of the globose-ovoid ovary, without the intervention of any style or contracted portion, and is wheel-shaped, or disc-shaped, with a thickened (stigmatic) margin; the upper surface is flat, with a slightly projecting umbo in the centre, which itself is obscurely perforated and cruciate, much as the stigma is represented in *Apodanthes Caseariæ* by Poiteau. All the floral envelopes appear to persist on the fleshy but thin pericarp. The ovules and seeds, as in the tribe, are attached to the whole parietes of the ovary, which they thickly and uninterruptedly cover, filling the cell; they are orthotropous, and borne on slender funiculi of their own length or longer. The seeds are oval, acutish at both ends, not very minute, being about one eighth or one tenth of an English line in length; the testa is thickish, obscurely punctate or reticulated, and conformed to the minutely granular or cellular nucleus, which, according to Mr. Brown, is a homogeneous embryo.*

* A still more remarkable parasitic plant of the same region, recently brought to notice by Mr. Gray, the surveyor of a southern Pacific Railroad route, is about to be published by Dr. Torrey, under the name of *Ammobroma Sonoræ*. It is a large and fleshy root-parasite, growing in the naked sands of the desert at the head of the Gulf of California, where it furnishes the Papigo Indians with an important article of food. The fresh plant is cooked by roasting, when it resembles the Sweet Potato in taste, or it is dried and mixed with other and less palatable kinds of food. Dr. Torrey finds it to constitute a new genus, of the small group or family represented by the little-known and anomalous *Corallophyllum* of Kunth, and the *Pholisma* of Nuttall; in the floral structure and the scales more like the latter, from which it is distinguished by its woolly-plumose calyx and its singular cyathiform inflorescence.

*** Of the Leguminous tree mentioned on p. 313, some fruiting specimens occur in the collection made by Dr. J. M. Bigelow, in Lieut. Whipple's expedition; and Mr. Thurber has fortunately just received others, with a few blossoms, in a small collection made on the Gila by Mr. Gray. The plant appears to be most nearly allied to the South American genus *Coursetia*, DC., to which, however, it cannot well be annexed; and perhaps it may be added to the group of genera enumerated by Mr. Bentham (in Pl. Jungh. p. 249), as making a transition from the Galegeæ to the Dalbergieæ. As it appears to constitute a new generic type, I am happy to further Mr. Thurber's wishes that it may bear the name of our common friend and excellent botanical associate, Stephen T. Olney, Esq., author of the Catalogues of the Plants of Rhode Island, &c.

OLNEYA, Nov. Gen. Leguminosearum.

Calyx campanulatus, quadrilobus; lobis ovatis obtusissimis, supremo latiore emarginato-bifido. Vexillum orbiculatum, profunde emarginatum, reflexum, unguiculatum, auriculis latis inflexis appendiculatum, bicallosum. Alæ oblongæ carinam incurvam obtusam æquantes. Stamina 10, æquilonga, filamento vexillari libero diadelpha: antheræ uniformes. Discus cupularis. Ovarium substipitatum, pluriovulatum: stylus incurvus, supra medium undique villosus: stigma depresso-capitatum. Legumen turgidum, dispermum, vel sæpissime medio seu prope apicem monospermum, obliquum, utrinque constrictum, glandulosum, tarde dehiscens, valvulis crasso-coriaceis. Semen magnum, estrophiolatum, ovale. Cotyledones carnosæ, crasso-planæ, radiculæ gracili incurvæ accumbentes. — Arbor 15–20-pedalis, pube minuta canescens; aculeis infrastipularibus geminis, interdum nullis; foliis abrupte vel impari-pinnatis multijugis; stipulis obsoletis; stipellis nullis; pedunculis folio brevioribus racemoso-plurifloris; corolla alba vel purpurascente.

Olneya Tesota. — On the table-lands of the Gila, Mr. Thurber, Mr. Gray. Near "Bill Williams' Fork," Dr. Bigelow.

XIV.

On the Affinities of the Genus VAVÆA, *Benth.; also of* RHYTIDANDRA, *Gray.*

BY ASA GRAY, M. D.

(*Communicated to the Academy, October* 10, 1854.)

VAVÆA, a well-sounding name, formed from *Vavao*, one of the Friendly Islands, where the plant in question was discovered by the late Mr. Hinds, was employed Mr. Bentham to designate a genus, of obscure affinity, founded on a single incomplete specimen, destitute of fruit.* No opinion as to its relationship was expressed, beyond the remark that it is evidently allied to *Ixionanthes* of Jack, — itself a genus most imperfectly known, and the family to which it belongs having scarcely even been guessed at. *Vavæa Amicorum*, Benth., the only species known, was likewise gathered by the naturalists of the Exploring Expedition in the Pacific under Captain Wilkes, both at the Friendly Islands (on Tongatabu) and at the Feejee Islands. In the first volume, recently published, of the Botany of this Expedition,† I endeavored to illustrate this genus, as far as could be done in the absence of ripe fruit and seeds (the former occurring on one specimen in a state barely far enough advanced to show that the ovary becomes a berry); and I ventured to append it to the order *Meliaceæ*, notwithstanding the stamens of more than double (usually triple) the petals in number, and the incomplete union of their filaments.

I have now had the opportunity of examining one or two blossoms from additional specimens, which clearly belong, I doubt not, to *Vavæa Amicorum*, although they differ

* In Hooker's London Journal of Botany, 2. p. 212.

† Botany of the United States Exploring Expedition under Captain Wilkes; Phanerogamia, 1. p. 244, tab. 16.

from all those previously examined in having only twice as many stamens as petals, — conforming in this respect to the type of the andrœcium in the order *Meliaceæ*, except only that the filaments are not monadelphous to the top. The anthers being rather smaller than usual, and containing little good pollen, while the pistil is well developed, I am led to suspect that the difference may be attributable to sex, and that the flowers may be more or less polygamous, as in *Aglaia*, &c.; which is the more probable, inasmuch as these occur on a specimen which bears, on a lower and earlier inflorescence, some nearly mature fruit. It was apparently these decandrous blossoms that misled Mr. Rich, the Botanist on the Expedition, preventing him from recognizing the plant which he had previously marked as a probable relative of *Canella*,* while these specimens were ticketed and even figured as a *Styrax*. The drawing of the plant was accompanied by some erroneous analyses, in which I had failed to identify the *Vavæa*, and therefore had left the specimens among other *Styracaceæ* without examination until now.

The fruit of *Vavæa* proves to be a berry, as was anticipated from the fertilized and half-grown ovary. It is rather dry, four or five lines in diameter, subtended by the small persistent calyx, and three-celled or four-celled by thin dissepiments, which perhaps are obliterated when only one seed matures. A single seed is sometimes matured in each cell; and in one instance both ovules were fertilized in the same cell. The seeds are oval, about three lines long, smooth, destitute of any arillus, ascending from near the base of the cell, closely sessile; the linear hilum being attached directly to the axis of the fruit without any funiculus: the testa chartaceous, or perhaps somewhat fleshy, its whole base occupied by a large orbicular chalaza, which is connected with the hilum by an extremely short rhaphe. The hilum extends from near the base to about the middle of the seed. There is a rather fleshy inner integument of the seed, but no albumen. The embryo consists of a pair of orbicular-oval, plane, flat or plano-convex, fleshy, peltate cotyledons, which are cordate by a narrow and deep sinus: the radicle is superior, remote from the hilum, slender, but wholly retracted and concealed within the sinus.

The carpological characters, therefore, manifestly confirm the suggested relationship of this genus to the *Meliaceæ*, where the exalbuminous embryo assigns it to the tribe *Trichilieæ*.

Simple and undivided leaves occur, as is well known, in three genuine Meliaceous genera. The cup-shaped disc is partially united with the andrœcium in *Trichilia*, *Eke-*

* Botany of United States Exploring Expedition, l. c. p. 246.

bergia, &c.; and in *Mallea** it is as completely adnate as in *Vavæa*, while the andrœcium is as deeply divided. The only remaining peculiarity, that of the increased number of stamens, is now found not to be a constant one, nor is it wholly irreducible to the type of the Meliaceous andrœcium, whatever particular hypothesis may be adopted in respect to the nature of its interposed lobes or naked teeth.

Although no doubt remains that *Vavæa* is a truly Meliaceous genus,† it is by no means surprising that Mr. Rich, without investigating the ovules and seeds, should have even referred these diplostemonous specimens to *Styrax*. The floral envelopes equally vary from four to seven in both, even in the same species; the general conformation of the pistil is similar; the uniserial stamens, monadelphous below, and even the beard on the inner face of the filaments, are equally points of resemblance; while the freedom of the andrœcium from the corolla, both organs being hypogynous, has its counterpart in *Styrax Benzoin* and some other species.‡

* Adr. Jussieu, Mem. Meliac. t. 15, f. 6, and t. 17, 18, &c.

† The completed character of the genus is subjoined: —

VAVÆA, *Benth.*

Calyx 4–7-fidus, persistens; lobis triangulari-ovatis æstivatione leviter imbricatis. Petala lobis calycis numero æqualia, hypogyna, ligulato-oblonga, utrinque sericeo-puberula, æstivatione convoluto-imbricata, decidua. Stamina numero petalorum dupla vel sæpius tripla aut subtripla, ab iis libera: filamenta plana, linearia, basi glabra in tubum disco hypogyno cupuliformi tenui adnatum monadelpha, superne libera, intus barbato-villosissima, apice acuto antheram bilocularem (loculis longitudinaliter dehiscentibus) introrsam fere basifixam gerentia. Pollen globosum. Ovarium ovoideum, basi lata sessile, 3–4-loculare: stylus columnaris: stigma peltatum, 3–4-radiatum. Ovula in loculis gemina, angulo centrali prope basim inserta, collateralia, adscendentia, subamphitropa; micropyle supera. Bacca globosa, 3–4-locularis. Semina in loculis abortu solitaria rariusve bina, ovalia, adscendentia, exarillata; testa lævi chartacea; hilo lineari chalazæ magnæ basilari proximo; rhaphe brevissima. Albumen nullum. Cotyledones carnosæ, plano-convexæ, suborbiculares, sinu profundo cordatæ, radiculam gracilem superam prorsus includentes. — Arbuscula glabella; foliis simplicibus integerrimis alternis obovato-oblongis obsoletissime punctatis; stipulis nullis; pedunculis axillaribus multifloris; floribus cymosis parvulis (forte polygamis).

Vavæa, Benth. in Lond. Jour. Bot. 2. p. 212; Gray, Bot. Phanerog. U. S. Expl. Exped. 1. p. 244, t. 16.

‡ Endlicher (Gen. p. 743), following Jussieu, assigns to *Styrax* a free calyx and a perigynous corolla; — two characters which I have not found to coexist in this genus. Alph. De Candolle, following Richard (in Michaux, Fl. 2. p. 41), describes the base of the calyx-tube as adherent to the base of the ovary, which is the case in the North American species, and most others. Zuccarini (Fl. Japon. 1. p. 54, t. 23), indeed, describes and figures *S. Japonicum*, a species of the same group as the North American ones, with both the

In this light we may admire the sagacity of Jussieu,* and of De Candolle, † who so long ago indicated a probable affinity between *Styrax* and the *Meliaceæ;* while the younger De Candolle expresses a reasonable doubt whether his own tribe *Pamphilieæ*, annexed to *Styracaceæ*, may not rather belong to the former order. ‡ The seed and embryo of *Styrax* very well accord with those of most *Melieæ;* so do those of *Foveolaria* as far as known; those of *Pamphilia* have not been investigated. The valvular, the convolute-imbricative, and the quincuncial æstivation of the corolla, no less than the union or the want of union between the base of the corolla and of the andrœcium, which occur in different Meliaceous genera, are severally represented in different species of *Styrax*. § The stellular pubescence or scurf of *Styrax* is of no particular

calyx and the corolla hypogynous: but the specimens communicated from the Leyden herbarium plainly exhibit the calyx adnate to the base of the ovary, the corolla, as in other cases, inserted at the line of junction. In *S. Benzoin*, however, both the calyx and the corolla are completely free and hypogynous; but this character does not hold in the few South American species I possess, which have a similar valvate corolla, namely, *S. Camporum*, *S. Gardnerianum*, *S. tomentosum*, and *S. ovatum;* although it must in some others, since a species under the name of *S. leiophylla* is so figured in Lindley's Vegetable Kingdom, ed. 3, p. 593 b, from a sketch by Mr. Miers, who, in the accompanying letter-press, inadvertently assigns an "ovary superior, wholly free from the calyx," as a character of the order *Styraceæ*.

* "An genus potius polypetalum indeque Meliis affine?" — Gen. Pl. p. 156.

† "An *Styrax*, Quivisiæ et Turræa habitu similis, huc revocanda." — Prodr. 1. p. 619.

‡ Prodr. 8. p. 270. — Mr. Bentham, also, in Trans. Linn. Soc. 18. p. 231, indicates the alliance of *Styraceæ* as an order, in the first instance with *Ebenaceæ* and *Humiriaceæ*, and in the next place with *Meliaceæ*.

§ M. Alph. De Candolle describes the æstivation of the corolla of *Styrax*, from *S. officinale*, as "parum constante, initio sinistrorsum convoluta, demum subvalvari." I find it in that species, and all the North American ones except *S. Americanum*, with the petals pretty strongly overlapping in the bud; very rarely, however, in an unbroken convolute series, but for the most part convolute-imbricate, — one petal being wholly exterior while the adjacent one is wholly interior, — just as the æstivation of *S. Japonicum* is correctly figured by Zuccarini (in Fl. Japon. 1. t. 23, f. 1): and in some instances this varies to nearly the regular quincuncial imbrication. But in *Styrax Americanum* the æstivation is valvular, with one or two of the conjoined margins more or less introflexed, often unequally so; while in *S. Benzoin*, as also in all of the few South American species I have examined, it is more strictly valvular. Mr. Miers must have contemplated these species only (overlooking *Pterostyrax* and *Halesia* likewise) in attributing a valvate æstivation to the corolla of the whole order *Styraceæ*, as he limits the group (in Lindley's Vegetable Kingdom, l. c.). Moreover, although the andrœcium is sometimes unconnected with the corolla, as in *Styrax Benzoin*, already mentioned, yet it is far from being "generally free from the petals" throughout the genus.

A few other discrepances in the characters of *Styrax*, of more or less importance, may be noticed in passing. Endlicher (I cannot at this moment ascertain whether the observation originated with him) gives the character, "ovula . . . . . inferiora horizontalia vel adscendentia, superiora sæpius pendula"; and this consequence in a question of affinity, since it occurs in so many plants of widely different families; but it equally exists in many *Meliaceæ*.

Nevertheless, the stronger tendency of *Styrax* and of the *Humiriaceæ* would appear to be in another direction, although the limits between the *Styraceæ* and the *Meliaceæ* cannot be determinately fixed, until the seeds of *Pamphilia* and *Foveolaria* are properly known. But it is singular that so acute a botanist as Mr. Miers, who proposes to separate *Styrax* widely from the *Symplocineæ*,* — allowing only a distant relationship

phrase, with a slight and unimportant transposition, is repeated by Alph. De Candolle in his character of the genus. On the other hand, Mr. Miers, in his character of the family and his analysis of a *Styrax*, already referred to, states of the ovules, that they have the "upper row erect, the middle horizontal, the lower pendulous." In no species have I been able to verify the former statement; that of Mr. Miers is borne out by *S. officinale*, *S. grandifolium*, and some other species. But this is not true of the whole genus. Zuccarini describes the ovules of *S. Japonicum* as *all erect;* the plate represents them as all ascending (which is doubtless what was meant), as inspection shows them to be; and so I believe they are in *S. Americanum* and some other American species.

Mr. Miers also describes and figures the ovary of *Styrax* as "trilocular only at the base, but unilocular at the summit," and naturally refers to this character as confirming the relationship of *Styraceæ* with the *Olacaceæ*. I do not find it so in the species I possess, but rather with the dissepiments extending quite to the summit of the ovary, although early separating from the ovuliferous axis as the ovary enlarges; that is, "parietibus incompletis ab axi centrali demum distantibus," as stated by M. Alph. De Candolle.

A more anomalous character, attributed, by Mr. Miers alone, to the ovary (not only of *Styrax*, but of the order *Styraceæ* as he limits it), namely that of bearing "a remarkable depressed epigynous gland upon its apex," I am wholly unable to confirm. In *Styrax tomentosum*, and to some extent in *S. camporum*, the ovary may be observed of nearly the shape delineated in Mr. Miers's sketch (l. c. fig. 4), that is, constricted below; but what answers to the "epigynous gland" is only the ordinary epidermis of the ovary with its downy covering, unaffected by the pressure of the base of the corolla and the stamineal tube which closely encircles the lower part, and it readily separates from the rest of the parietes, as it also does in *S. Benzoin*.

* Without pronouncing here upon the propriety of such separation, it may be remarked that the *Styraceæ* certainly appear to be closely connected with the *Symplocineæ* through *Pterostyrax* and *Halesia;* and that a diagnosis between the two groups, as limited by Mr. Miers, is not successfully based upon any one of his differential characters, enumerated in Lindley's Vegetable Kingdom, p. 593, b. For, 1. A "tubular and entirely free calyx" belongs merely to a part of the genus *Styrax*, and not at all to *Pterostyrax* and *Halesia*. 2. The same remark is true of "the valvate æstivation of the petals." 3. "Their stamens being always uniserial" does not exclude *Barberina*, in one species of which, moreover, they are only thrice the number of the petals: in *Halesia tetraptera* the stamens are sometimes four times the number of the lobes of the corolla. 4. "Linear anthers dorsally affixed to broad filaments nearly of their length," are not attributable to *Pterostyrax* and *Halesia,* nor to some species of *Styrax*. 5. The same objection applies to a "superior ovary with three incomplete dissepiments" and "a free central placentation," which besides are not true of *Pamphilia;* and the ovules are as numerous in certain *Symploces* as in some *Styraces*.

between them through the *Ebenaceæ*, — should at the same time ignore any affinity between the *Meliaceæ* and his *Styraceæ*, especially while the latter family is made to include *Pamphilia* and *Foveolaria*.

Rhytidandra * is a genus established on a specimen of a shrub or arborescent plant, with unexpanded flowers only, in the collection of the United States Exploring Expedition, from one of the Feejee Islands. It was referred to the *Olacaceæ ;* but with some misgiving, on account of the complete and immediate adhesion of the calyx to the surface of the ovary ; which, moreover, is strictly one-celled, and with a single ovule suspended from the very apex of the cell, without the intervention of any placental column or any trace of sterile cells. I had remarked, that, " if rightly referred to this order, it must be viewed as a genus whose affinity tends towards *Styracaceæ* rather than *Santalaceæ*." † This floral structure should have led me at once to consider the relations of the plant to *Alangium* and *Marlea ;* but, possessing no materials of, and no previous acquaintance with, the *Alangieæ*, I overlooked what I now perceive to be the nearest affinity of *Rhytidandra*.

The leaves of this plant, with their transverse veinlets and oblique base ; the axillary cymose inflorescence ; the adnate and scarcely toothed calyx ; the long and narrow petals, borne, like the stamens, on the margin of an epigynous disc ; the linear and introrsely adnate anthers ; the bearded filaments, such as they are (for they are extremely short) ; the solitary and suspended anatropous ovule ; and the elongated style, are all points of perfect agreement with the *Alangieæ*.

6. " A solitary one-celled putamen having a single erect seed " would commonly exclude *Pterostyrax* and *Halesia*, and does not well apply to *Styrax ;* the albumen is equally " copious and fleshy " in *Symplocos ;* and the embryo of *Halesia* appears to be quite intermediate between that of the *Symplocineæ* and that of *Styrax*, some species of which exhibit little or no stellate pubescence. The petals in both species of *Halesia*, although in some blossoms perhaps merely " agglutinated at the base by the membranaceous ring of the stamens," in others are truly " confluent into a gamophyllous tube " far above the attachment of the andrœcium, the ring of which, moreover, is sometimes but imperfectly adnate to the base of a gamopetalous corolla.

The *Humiriaceæ* are well marked by one or two decisive technical characters ; but nothing appears to forbid their annexation to the *Styracaceæ* while that family includes the *Symplocineæ*.

* Botany of the United States Exploring Expedition under Captain Wilkes : Phanerogamia, p. 302, t. 28.

† It should be stated that Mr. Miers, who has, perhaps, a more profound and extensive acquaintance with the *Olacaceæ* and their immediate allies than any other botanist, and who has most ably illustrated them, on reading the published characters of *Rhytidandra*, immediately expressed to me, in a letter, his opinion that the genus belonged neither to his *Icacineæ* nor *Olacineæ*. He suggested, instead, an affinity with the *Loranthaceæ*.

The only observed discrepancies are the valvular æstivation of the corolla in *Rhytidandra*, and its bifid style; — neither of which characters is likely in the present case to indicate more than a generic distinction. For the flattened divisions of the style, themselves more or less bifid at their summit, would by a further union produce nearly such a four-lobed stigma as that of *Marlea* and of *Alangium*. And if the narrow petals are really convolute in æstivation in the former as well as the latter genus, their margins can but slightly overlap,* while the strictly valvate mode would be no unexpected character in a new genus of a small group, which — following Mr. Brown's suggestion made thirty-six years ago — it is now conceded must be merged in the *Cornaceæ*.†

In its unilocular ovary, *Rhytidandra* accords with *Alangium*, as also with an occasional state of *Marlea;* ‡ while the stamens correspond with those of *Marlea* in number and position, and have even shorter filaments. The anthers are distinct, not connate into a tube, as those of *Marlea* are said to be by Lindley and by Endlicher (but not by De Candolle); nor are the stamens united by pairs, as those of *Marlea* are characterized and represented by Lindley; unless, indeed, what I had taken for a quadrilocellate anther should consist, as it possibly may, of a pair of closely coalescent anthers. Their dehiscence, if known, would determine this point. In respect to it I can only say that, if the anthers of *Rhytidandra* really open longitudinally at all, they must do so by the lateral grooves, one on each side, which correspond with an internal partition, longitudinally dividing each half of the organ into two locelli; and in that case the whole must constitute a single stamen, as I had supposed it to do; and I suspect this is the case in *Marlea* also.

However this prove to be, *Rhytidandra* is sufficiently distinguished from *Marlea* by its moniliform and chambered anther-cells, its one-celled ovary, and its bifid style with elongated and slender but flattened lobes.

This peculiarity of the style is of considerable interest; for the lobes may be justly compared with the style of *Nyssa;* the affinity of which to the *Alangieæ* was happily suggested (though with doubt) by Brongniart,§ while its relationship to the *Corneæ* was practically recognized by Blume, who referred his genus *Mastixia* first (and justly)

* Wight and Arnott's authority (Prodr. Fl. Ind. Or. 1. p. 325) should settle the point, at least for *Alangium*. But the figure of *Marlea begoniæfolia* in Bot. Reg. 24, t. 61, appears as if the petals were valvate.

† Bennett, Plantæ Javanicæ Rariores, p. 194. In collating *Marlea* with the *Corneæ*, no difference in æstivation is here mentioned; from which it may be inferred that the petals of the former genus are valvate.

‡ Lindley, Bot. Reg. l. c. Clarke, in Kew Jour. Bot. 2. p. 129.

§ Enum. Pl. Hort. Mus. Par. p. xxx. note.

to the *Corneæ*, and then to *Nyssaceæ*.* Lindley has adopted Brongniart's suggestion, and referred both *Nyssa* and *Mastixia* to the *Alangiaceæ*.†

I may add, that the fertile flowers of *Nyssa* sometimes exhibit a double perianth, namely, five minute rounded lobes or teeth belonging to the border of the adherent calyx, and alternate and within these as many small, ovate petals.

*** (November 13.) Flower-buds of *Marlea begoniæfolia*, received through the kindness of Sir William Hooker just as this sheet is about to go to press, verify the suggestions given on the preceding page, both in respect to the æstivation of the corolla, which is truly *valvate*, and as to the nature of the anthers, which are *simple and quadrilocellate*, not united in pairs as described by Lindley. Nor, in the flower-buds examined, are the anthers in the least coalescent into a tube. The generic character assigned by De Candolle is therefore correct as far as it goes. That of Endlicher is incongruous as regards the stamens, he having adopted the view of Lindley without consistently carrying it out, and erroneous as to the æstivation of the corolla, probably from having transferred this point of Wight and Arnott's character of the *Alangieæ* to the genus *Marlea*. The relationship between *Rhytidandra* and *Marlea* is therefore immediate. The essential differences between them are correctly enumerated in a preceding paragraph.

* Museum Bot. Lugd.-Bat. p. 256.

† Vegetable Kingdom, pp. 719, 720.

XV.

On Two New Crystalline Compounds of Zinc and Antimony, and on the Cause of the Variation of Composition observed in their Crystals.

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(*Communicated June* 27, 1854.)

The metallic alloys have not received that share of investigation which their importance would seem to demand; nevertheless, the researches which have been made during the last twenty years are sufficient to refute the formerly received opinion, that they are all merely mechanical mixtures. In 1830, F. Rudberg,* while determining the latent heat of the alloys of tin and lead, observed that, when the proportions of the two metals corresponded to $PbSn_3$, the temperature of the melted alloy fell uniformly to the point of fusion, 187° C., where it remained constant for some minutes, owing to the escape of latent heat. If, however, the metals were mixed in other proportions while the same fixed point was observed, he found that the thermometer also stood still at a second and higher point, which approached nearer and nearer the point of solidification of lead or tin, according as the alloy contained a greater excess of one or the other of these two metals. From these facts he concluded that the alloy $PbSn_3$ was a definite chemical compound, having but one point of solidification, and that the other alloys were mixtures of this compound with one or the other metal, and that the two stationary points of temperature corresponded, the lower to the point of solidification of $PbSn_3$, the higher to that of tin or lead, according as one or the other was present in excess. Similar phenomena were afterwards observed in several other alloys,

* Poggendorf, *Annalen*, Vol. XVIII. p. 240.

especially in the ternary alloys of zinc, tin, and lead, which were shown by the Messrs. Svanberg,* on the same grounds, to contain a definite compound, $ZnSn_3, 2\,PbSn_3$. The fact that, in a melted mixture of bismuth and zinc, which do not alloy together, there are two stationary points of temperature coinciding very closely with the melting points of the two metals, seems to support Rudberg's opinion.† It is well known that Newton's (or Arcet's) alloy $Bi_3Pb_2Sn_2$, after it has been rapidly cooled from a melted condition to 57° C., or even a few degrees lower, becomes suddenly heated by a spontaneous evolution of heat, accompanied with a very considerable expansion of the mass. Since, after the expansion, the specific heat of the alloy is the mean of that of the metals which compose it, and since the change is accompanied with a manifest alteration of texture, Person ‡ argues that the phenomenon indicates an actual chemical decomposition in the whole mass of the alloy, and that the combination between the metals is only momentary, and confined within certain temperatures. Similar facts he shows to be true of Rose's alloy Bi_2PbSn_2, and also of Bi_3Pb_2 and Bi_3Sn_4.

Croockewit,§ by melting together copper, tin, lead, and zinc in different atomic proportions, stirring the melted metals while cooling, and after partial solidification turning out the still fluid portion, obtained crystalline masses which, as he found by analysis, approached, and sometimes very closely coincided with, the calculated composition of Cu_2Sn_5, $CuSn$, Cu_2Sn, Cu_3Zn_5, Cu_3Zn_2, Cu_2Zn, Cu_2Pb_3, $CuPb$, $SnZn_2$, $SnZn$, Sn_2Zn, $SnPb_2$, $SnPb$, Sn_3Pb_2. He obtained, moreover, similar results in regard to the amalgams, though not quite so satisfactory, and draws the conclusion, that the binary alloys of these metals are mixtures of the above compounds either with each other or with one or the other of the metals. Rieffel || makes seven different compounds of tin and copper, $CuSn$, $CuSn_{24}$, $CuSn_{48}$, $SnCu_{24}$, $SnCu_{48}$, $SnCu_{72}$, $SnCu_{96}$, of which $CuSn$ "crystallizes in large and exceedingly characteristic plates," and $CuSn_{24}$ and $CuSn_{48}$ "both in needles radiating in all directions from numerous centres." These compounds do not correspond to those of Croockewit, and the discrepancy is probably owing to a variation in composition similar to that, hereafter to be explained, in the compounds of zinc and antimony, which will be found to resemble those of copper and tin, as described by Rieffel, at least in their crystalline characters.

* Poggendorf, *Annalen*, Vol. XXVI. p. 280.

† M. Fournet, *Ann. de Chim. et de Phys.*, Vol. LIV. p. 247.

‡ Ibid., Vol. XXIV. pp. 143, 148.

§ *Journal für prakt. Chemie*, Vol. XLV. p. 87.

|| *Compt. Rend.*, Sept., 1853, p. 450.

Quite recently Levol * has examined the alloys of copper and silver, of copper and gold, and of lead and silver, in regard to their chemical constitution, starting on the supposition that these metals are capable of forming definite chemical compounds with each other, and that the ordinary alloys employed in coinage and in the arts are mixtures of such compounds and an excess of metal, and moreover considering as proved, that, when such melted alloys cool slowly, these compounds tend to separate from the metal, producing inequality of composition in the cast lingot, so that homogeneity in such cases is an indication of definite composition. In the alloys of copper and silver, Ag_3Cu_4 was the only one of which the lingots carefully cast in spherical or cubical moulds were found, by analysis of portions taken from the interior and exterior of the mass, to have a uniform composition throughout. The alloys either of copper or silver with gold were all found to give homogeneous lingots, and the reverse was the case with the alloys of lead and silver, except $PbAg_{100}$. If the hypotheses from which this investigation starts are assumed to be correct, the conclusions to be drawn from the results are, — 1st, that the only definite compound of copper and silver is Ag_3Cu_4; 2d, that either gold is not capable of forming a definite compound with silver or with copper, or else that their compounds, being isomorphous with each other and with the metals, are capable of mixing uniformly in any proportions; 3d, that lead and silver do not form with each other any definite compounds.

Karsten † found that dilute sulphuric acid or a solution of sulphate of copper is not decomposed by alloys of zinc and copper when the zinc equals or exceeds the proportion corresponding to ZnCu; also that nitric acid or a solution of nitrate of silver is not decomposed by alloys of copper and silver when the amount of silver exceeds or equals that of CuAg. If, however, the zinc in the first, and the copper in the last, were in excess, he observed that decomposition took place, and continued until these metals were completely removed from their respective alloys, and pure copper or silver left. He opposes the opinion that these alloys are mixtures of a definite compound with an excess of one or the other metal, arguing that, if this were the case, the acids would dissolve only the excess of metal, and leave the compounds ZuCu and CuAg.

The above are the most important investigations, bearing directly on the chemical nature of metallic alloys, which have fallen under the notice of the author, and they concur to support the opinion that, in many cases at least, the metals tend to unite in definite proportions. The alloys of zinc and antimony, which form the subject of this

* *Annales de Chimie et de Physique*, Vol. XXXVI. p. 193, and Vol. XXXIX. p. 163.

† Poggendorf, *Annalen*, Vol. XLVI. p. 160.

memoir, do not appear to have been included in any of these investigations. The previous knowledge in regard to them is given by Gmelin in his text-book in the following words: "These two metals fuse together with facility, and, according to Gehlen and A. Vogel, without emission of light, and form a hard, brittle, steel-colored alloy, whose density is less than the medium density of its elements (Gellert)." *

It will be the object of the present memoir to show, first, that zinc and antimony form with each other two, and probably only two, definite compounds; secondly, that these compounds are capable of a very large variation in composition without any change in the crystalline form; and lastly, that this variation can only be explained by admitting an actual perturbation in the law of definite proportions produced by the influence of mass. The two compounds are

I. *Terantimonide of Zinc, or Stibiotrizincyle*, $SbZn_3$.

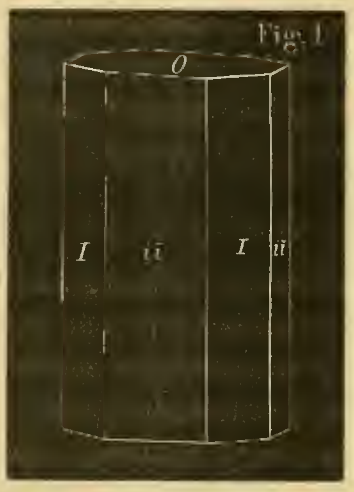
This may be best prepared by melting together 57 per cent of antimony and 43 per cent of zinc,† and allowing the liquid mass when thoroughly mixed to cool until a crust forms on the surface. On piercing through this crust, and turning out the still liquid alloy, the crucible, if broken open when cold, will be found filled with the most beautiful prismatic crystals. These crystals are obtained in their greatest perfection by employing eight or ten pounds of the alloy, and cooling the crucible very slowly in sand. In order to insure a constant composition of the alloy, it is best to melt the antimony first, and afterwards add the zinc in small portions, removing the crucible from the fire as soon as the whole is melted, and stirring with a heated earthenware rod. Moreover, in order to prevent oxidation of the crystals, it is important that the hole pierced through the crust should be quite small, and it requires a little practice to catch the exact moment when the crust is thick enough to support the mass of melted metal in the crucible.

The crystals thus obtained present the following properties. They have a very brilliant metallic lustre and a silver-white color; (the surfaces are often, however, iridescent, owing to a slight oxidation, and the true color is then only seen on the fracture.) They are very brittle, and can readily be reduced to a grayish-white powder. Their hardness = 3.5. The Sp. Gr. varies with the composition, as will be shown hereafter; that of crystals containing 43 per cent of zinc = 6.327 nearly. The form is a rhombic prism belonging to the Trimetric System, with sometimes only one, but

* Gmelin's *Hand-Book*, Cavendish ed., Vol. V. p. 50.

† When the metals are not pure, it is best to make allowance for the impurity.

generally with both sets of lateral edges truncated. The crystals almost invariably, so far as I have observed, run out to fine points, and although I have examined many hundreds, I have only met with a very few having the basal plane *O*, and with none on which planes modifying the basal edges could be distinguished. It was, therefore, only possible to ascertain the relative size of the lateral axes. This is given below under Fig. 2. Fig. 1 exhibits the general form of the isolated crystals supplying the terminal plane *O*.



I on i ī = 148° 30′.
I on i ĭ = 121° 30′.
I on I = 117° or 63°.

I in 1 on I in 2 = 117°.
i ĭ in 2 on I in 1 = 121° 30′.
i ĭ in 1 on I in 1 = 121° 30′.

The faces of the crystals are generally striated, but from a quantity of them several can almost always be obtained whose faces reflect a very well defined image, so that the angles can be measured with the greatest accuracy. The angles as above given measured the same on a large number of crystals from several different crystallizations, and in cases where a variation from them was observed it was evidently the result of striation or of some imperfection. The measurements were made in a darkened room, using as a signal a narrow horizontal slit in the screen which covered the window illuminated by the sun. This simple arrangement, for which I am indebted to Professor Miller of Cambridge, England, enabled me to determine the angles even of the smallest crystals with great precision. The isolated crystals of $SbZn_3$ obtained as described above are small, a few tenths of a line only in diameter, and not generally over an inch in length. They tend, however, to form compound crystals with parallel axes, which are often several inches in length, and a quarter of an inch or more in diameter. Fig. 2 is a section of a very well formed double crystal, on which all the angles were accurately measured. A few of these angles given beneath the figure show that the character of the combination is as described. The crystals do not have any distinct cleavage, but it is possible that the basal plane *O*, which, as before stated, is seldom seen, may be a cleavage plane.

The composition of the crystals of $SbZn_3$ varies, as will hereafter be shown, with the composition of the alloy in which they form. The crystals whose analyses are given below were prepared by melting together 58 per cent of commercial antimony and 42 per cent of zinc. The zinc was melted first, and when in fusion the antimony was added. This involved a greater loss of antimony than if the opposite course had been followed, as recommended above, which, with the impurity of the metal,* had the effect of increasing the percentage of the zinc in the alloy about eight tenths of one per cent. The crystals may therefore be regarded as having formed in an alloy whose composition approximated closely to Sb. 57.2 per cent, Zn 42.8 per cent. The analyses 1, 2, and 3 were made by myself, of crystals from as many different crystallizations. The fourth column gives the calculated composition of $SbZn_3$ on the supposition that the equivalent of antimony = 129.032, and that of zinc = 32.527, as is generally received.

	1.	2.	3.	4.
Antimony, . .	57.24	56.50	56.93	56.93
Zinc, . . .	42.83	43.06	43.15	43.07
	100.07	99.56	100.08	100.00

From these analyses it appears that an alloy which contains 42.8 per cent of zinc yields crystals of the same composition with itself, and corresponding to the calculated composition of $SbZn_3$.

The most characteristic property of the new compound is its strong affinity for oxygen, which gives it the power of decomposing water with rapidity at the boiling point. This property led in fact to its discovery. The author, while washing with hot water some granulated alloy, having the composition of $SbZn_3$, which had been used for preparing antimoniuretted hydrogen, observed that the metal continued to evolve gas after the last trace of acid had been removed. The singular phenomenon was at first referred to an increased activity of the zinc in the alloy, produced by the galvanic action of the particles of antimony set free by the action of the acid. This theory was

* The zinc used in these experiments was nearly pure. The antimony was a good article of commercial antimony, containing about one per cent of impurity, which, with the exception of a slight trace of arsenic, was not taken up by the crystals.

soon, however, disproved, by the fact that an alloy of the same composition, which had not been acted on by acids, when placed in boiling water, produced the same action, though in a less degree, and by the no less important fact, that the rapid evolution of gas could only be produced with alloys containing about 43 per cent of zinc.* Two hundred grammes of this alloy granulated to about the size of fine shot evolved one hundred and thirty centimetres of cubes of gas in ten minutes. When previously treated with a few drops of a solution of bichloride of platinum, and afterwards washed, the amount of gas was nearly doubled. The same quantity of alloy which had been previously treated with hydrochloric acid, and then thoroughly washed, gave, when boiled with water, nearly a litre of gas in the same time. The gas evolved was pure hydrogen, as is shown by the following experiments.

1st. The gas evolved from an alloy containing 50 per cent of zinc, which had been previously treated with hydrochloric acid, and then washed, was burnt in Regnault's eudiometer, with the following results: —

Tension of gas,	0.379	metres.
" " gas + oxygen,	1.219	"
" " oxygen after combustion,	0.653	"
" " gas consumed,	0.565	"

$0.566 \times \frac{2}{3} = 0.378$, tension of hydrogen consumed.

2d. Gas evolved from water and alloy at 100° C., but not in ebullition, was passed through hot concentrated nitric acid for six hours, about two bubbles passing a second. The acid, afterwards evaporated to dryness, and the residue dissolved in hydrochloric acid, diluted and treated with sulphuretted hydrogen, gave no indication of antimony.

3d. The gas evolved during violent ebullition gave, under the same treatment, a trace of antimony, which was evidently carried over by the stream in mechanical suspension. Both experiments were repeated twice, with the same results.

4th. The gas from an alloy of commercial metals, passed for several hours through a small tube of Bohemian glass heated to redness, gave a slight mirror of arsenic.

5th. The gas from an alloy of pure metals gave no metallic mirror under precisely the same circumstances as in the last experiment.

From all these results, indicating, as they do, an analogy between $SbZn_3$ and the

* See Table on subsequent page of this memoir.

well-known metallic radicals of Organic Chemistry, it was naturally inferred that it would be easy to prepare from it a large number of compounds; but although the first qualitative experiments seemed to verify this assumption, it afterwards proved to be unfounded. The first action of chemical agents on $SbZn_3$ is similar to their action on the simple metals, but before the reaction is terminated and a definite compound formed, the radical is decomposed, and compounds of the separate elements alone result. Thus, when the powdered $SbZn_3$ is boiled with water, the first effect, as is sufficiently evident from the above experiments, is a direct oxidation of the alloy; before, however, the whole is oxidized, a grayish-white powder is formed, from which hydrochloric acid dissolves a large amount of oxide of zinc, and a very small amount of oxide of antimony.* The instability of this singular substance will also appear from the following experiments.

1st. Exposed to the action of chlorine gas, powdered $SbZn_3$ inflamed, and a mixture of the chlorides of zinc and antimony was formed.

2d. A solution of iodine in strong but not absolute alcohol converted the same powder into a yellow substance, which proved to be an oxyiodide of antimony, and into iodide of zinc, which was found in solution.

3d. Bromine dissolved in alcohol formed, with the powder, bromide of zinc, which dissolved, and oxide of zinc, which is insoluble. The small amount of water which the strong alcohol contained was, as is evident, essential to these reactions, and on using solutions of iodine and bromine in absolute alcohol, little or no change could be observed.

4th. Dry oxygen was passed over a weighed portion of finely powdered $SbZn_3$ contained in a glass bulb, which was gently heated with a spirit lamp. When the temperature was yet much below ignition, the mass suddenly glowed throughout like tinder, and changed into a white powder, which the increased weight proved to be a mixture of ZnO, SbO_5, and SbO_4.

Weight of powdered $SbZn_3$, ...	0.4647
" " oxygen absorbed, ...	0.1235
" " oxygen required to form $3\,ZnO + \frac{1}{2}\,SbO_4 + \frac{1}{2}\,SbO_5$,	0.1231

* Dr. A. A. Hayes, of Boston, has had the kindness to submit some crystals of $SbZn_3$ to his new process of analysis by electrolysis, thinking that under the influence of a feeble galvanic current they might act as a radical. He found that at first they seemed to act in this way, both the zinc and antimony entering into solution; but that, before the process was finished, decomposition ensued, after which the zinc only dissolved.

On attempting to moderate the action by using a lower temperature regulated by a bath of fusible metal, little or no change resulted.

5th. A few grammes of very finely pulverized crystals of $SbZn_3$ were covered in a thick glass flask, with about twice their bulk of iodide of ethyle, and the hermetically sealed vessel exposed to a temperature of about 150° C. in a Papins digester, for several hours. On opening the flask when cold, it was found to contain a white crystalline solid, which was readily purified by dissolving in alcohol and recrystallizing. There separated from the alcoholic solution needle-shaped crystals, which were also soluble in water. They were found to melt at about 140° C. to a yellowish fluid, and when heated in the air to about 190° C., boiled, forming a dense white smoke, which condensed on the sides of the tube to a white amorphous powder. The smoke had a strong and disagreeable alliaceous odor, probably due to stibethyle. The crystals have also a slight alliaceous odor, and a bitter metallic taste. Their solution in water gives with test-paper the reaction of the feeble acids. An analysis conducted in the usual way gave the following results : —

	Found.	Calculated.
Hydrogen, . .	3.53	3.47 = H_{25}
Carbon, . .	16.91	16.67 = C_{20}
Zinc, . . .	9.03	9.03 = Zn_2
Antimony, . .	18.06	17.92 = Sb
Iodine, . . .	52.47	52.91 = I_3
	100.00	100.00 = $2\,Zn\,(C_4H_5)\,I + Sb\,(C_4H_5)_3\,I$

which, as will be seen, show that the substance analyzed was a compound of iodide of zincethyle and iodide of stibithyle, and therefore prove that $SbZn_3$ is decomposed even by iodide of ethyle. A similar compound, $Zn\,(C_4H_5)\,I + As\,(C_4H_5)_3\,I$, is described by Cahours and Riche as formed by the action of iodide of ethyle on arsenide of zinc.*

6th. Weak hydrochloric or sulphuric acids decomposed $SbZn_3$ with great violence. Hydrogen gas escaped mixed with only a very small amount of antimoniuretted hydrogen,† the zinc dissolved, and the greater part of the antimony was left behind as a black amorphous powder.

7th. Nitric acid also violently decomposed $SbZn_3$, forming soluble nitrate of zinc,

* *Compt. Rend.*, June, 1853, p. 1001.

† Lassaigne found that the gas evolved from an alloy of three parts of zinc and two of antimony, when treated with dilute sulphuric acid, contained at most only two per cent of its volume of antimoniuretted hydrogen. *Journal de Chimie Medicale*, Vol. XVII. p. 444, or Berzelius, *Rapport Annuel*, 1842.

and an insoluble white powder, which was a mixture of basic nitrate of antimony and of antimonious or antimonic acid.

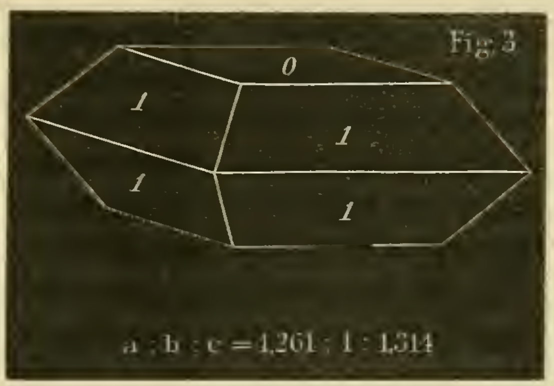
8th. Hydrochloric acid mixed with a few drops of nitric acid completely dissolved the compound, and a solution was obtained of chloride of zinc and chloride of antimony, from which the two metals could be precipitated and determined in the usual way.

The most obvious explanation of all these phenomena seems to be, that $SbZn_3$ is a radical in which the affinity between the elements is very feeble. The rapid decomposition of water; the facts that pure hydrogen, and not antimoniuretted hydrogen, is evolved during the process; that rapid decomposition is produced by the alloys of zinc and antimony only when they have the composition of $SbZn_3$; and, finally, that the composition of $SbZn_3$ is similar to that of $SbMe_3$ and $SbAe_3$, zinc, an electro-positive metal, supplying the place of an electro-positive radical,—all point to the conclusion that $SbZn_3$ belongs to the ammonia family. On the other hand, the action of strong chemical agents on the compound proves that the affinity between its elements is very feeble, and that these agents, under ordinary conditions at least, have a stronger affinity for the zinc of the radical than for the radical itself.

Should the opinion here advanced in regard to the nature of $SbZn_3$ be correct, it undoubtedly will be soon substantiated by the examination of other similar compounds of antimony or arsenic. Moreover, it is not impossible that by some indirect process compounds of $SbZn_3$ may yet be prepared, since only the most obvious methods of combining it have been hitherto tried, my attention having been diverted to what I regarded as a more important subject, the variation in the composition of its crystals. This it is the especial object of the present memoir to elucidate, and here the very feebleness of the affinity, which prevented the formation of compounds, has been of the greatest advantage, by increasing the extent of the variation, which otherwise would probably have been confined within such narrow limits that the discovery of the law which it followed would have been impossible. I propose soon to investigate more fully the chemical relations of this peculiar compound, and, should any important results be obtained, they will be communicated in a future paper.

II. *Binantimonide of Zinc, or Stibiobizincyle,* $SbZn_2$.

Crystals of this compound, having almost exactly the same composition as the theoretical $SbZn_2$, can be obtained by melting together 31.5 per cent of zinc and 68.5 per cent of antimony, and crystallizing, with the precautions already described. From 32 per cent of zinc and 68 of antimony smaller isolated crystals are formed, and therefore better adapted for measurement, but they contain an excess of antimony. In their natural state the crystals of $SbZn_2$, like those of $SbZn_3$, have a silver-white color, and a very bright metallic lustre. Their hardness = 3.5. Their specific gravity varies with their composition; that of crystals containing 33.6 per cent of zinc = 6.384. They are frequently perfect, and their faces so plane and bright that the angles can be measured to a minute. Fig. 3 represents an isolated crystal, which was formed in an alloy containing 32.5 per cent of zinc. The angles given at the side of the figure were all obtained by measurement, except that over Y, which measured six minutes more than that required by the other two.



O on 1 = 122° 15′ measured the same on each side.
1 on 1 over Z = 115° 30′.
1 on 1 over Y = 95° 24′ measured 95° 30′.
1 on 1 over X = 118° 24′.

The isolated crystals of $SbZn_2$, like those of $SbZn_3$, are usually small; but, like the latter, they tend to combine together, with parallel axes, forming large, flat plates. They also frequently unite by a plane parallel to the octohedral face 1, producing a cellular structure which is especially characteristic of the thin plates which form in the alloys between 33 and 43 per cent of zinc. From this it appears that the crystals of $SbZn_2$ differ from those of $SbZn_3$, not simply in their dimensions, but also in their whole character and conformation. Indeed, the difference in this respect could hardly be greater, and will be found to have been of great assistance in the subsequent part of the investigation.

The composition of the crystals of $SbZn_2$ varies with the composition of the alloy in which they form. The three analyses given below, made by Mr. F. H. Storer, are of crystals from three different alloys. No. 1 is the analysis of crystals from the alloy of 31.5 per cent of zinc; No. 2, from the alloy of 29.5 per cent of zinc; No. 3, from the alloy of 27.5 per cent of zinc.

	No. 1.	No. 2.	No. 3.	Calculated.
Zinc, . . .	33.95	33.62	33.85	33.55
Antimony, .	66.09	66.38	65.81	66.45
	100.04	100.00	99.66	100.00

These analyses tend to prove that crystals formed in alloys between 27.5 and 31.5 per cent of zinc correspond very closely in composition to the calculated composition of $SbZn_2$.

In its chemical relations $SbZn_2$, unlike $SbZn_3$, is an entirely inactive substance. It does not decompose boiling water except very feebly, and is not attacked by dilute mineral acids. Boiled with strong hydrochloric acid, it is decomposed; but unless reduced to a very fine powder, the decomposition is not complete. Strong nitric acid acts upon it as upon $SbZn_3$, though the first action is less violent.

The Variation in Composition of $SbZn_3$ and $SbZn_2$.

An abstract of the description of the two compounds of zinc and antimony just given was published about a year since in the *American Journal of Science.** It was there stated that crystals of $SbZn_3$ could be obtained, retaining exactly their crystalline form, and yet containing a very much larger amount of zinc than that which corresponds to three equivalents. The important bearing of this fact on many obscure points, both of chemistry and mineralogy, and the circumstance that the large extent of the variation, connected with the fact that the conditions of formation of the crystals were entirely under command, seemed to afford a reasonable prospect of discovering the cause of this remarkable phenomenon, have induced the author to devote the leisure he could spare from his profession during the last year to investigating this subject, and it is the especial object of the present memoir to communicate the results of this investigation. The descriptions of $SbZn_3$ and $SbZn_2$ have been added, in order to make it more complete and more intelligible.

In the course of this investigation crystallizations have been made or attempted of alloys differing in composition by one half to five per cent., according to circumstances, from the alloy containing 95 per cent of zinc to that containing 95 per cent of antimony; but only two crystalline forms were observed, that of $SbZn_3$ and that of $SbZn_2$. Well-defined crystals, like those described under $SbZn_3$, were obtained from the alloys between 43 and 60 per cent of zinc, and even in alloys of a higher zinc percentage crystals of the same form were still seen, although they were no longer well defined.

* Vol. XVIII. p. 229.

In the alloys between 20 and 33 per cent of zinc, well-defined crystals, like those described under $SbZn_2$, were formed, and finally there separated from the alloys between 33 and 42 per cent of zinc thin metallic plates, which evidently belonged to the same crystalline form. In making the alloys from 43 to 95 per cent of zinc, the zinc was melted first, and when in fusion the antimony added. As the melting point of antimony is much above that of zinc, the fluid zinc acted on the solid antimony as a solvent, dissolving the pure metal, but not the impurity, which rose to the surface, forming a scum. The scum seemed to take with it some of the antimony, and thus caused a loss, which, together with the impurity, was found by experiment to be about three per cent of the antimony used. This resulted in raising the percentage of zinc in the alloy at most about eight tenths of one per cent. The alloys below 43 per cent of zinc were made by melting the antimony first, and then adding the zinc. By this method the loss of antimony was very greatly diminished, and, counting the impurity, was found to be only about one per cent and a half of the antimony used. In preparing the alloys, this loss was always allowed for, and the crystallizations were all made as nearly as possible under the same circumstances, so that any unsuspected cause of error should affect all equally. The crystals formed in the alloys were all analyzed. Several methods for separating zinc and antimony were tried, but the process which finally recommended itself as the most accurate was the following.

Method and Results of Analysis.

From five decigrammes to one gramme of the crystals were dissolved in strong hydrochloric acid, to which had been added about one tenth of nitric acid, and the solution heated until the excess of the latter was expelled. It was then diluted largely with water, which precipitated oxide of antimony; sulphuretted hydrogen was passed through the liquid for at least an hour, and the beaker left standing on the sand-bath until the odor of the gas had disappeared. The precipitate, which was now a mixture of sulphur and of sulphide and a little oxide of antimony, was next collected on a tared filter, and, having been dried at 100° C. and weighed, the amount of antimony which it contained was determined by reducing a portion with hydrogen in the usual way. The loss of antimony in the last step can be almost entirely avoided by making the exit-tube of the bulb, used for reducing the mixed sulphide, very small, and keeping an inch of it red hot during the process, and also by a little practice in regulating the temperature of the bulb and the current of hydrogen so as to drive off all the free sulphur before the sulphide begins to decompose. In order to show how great accuracy may be attained by this method, I will subjoin the results of two reductions of different portions from the same mass of mixed sulphides.

Whole amount of mixed sulphides, 0.8423.

	No. 1.	No. 2.
Weight of reduction tube, ...	4.2793	6.2020
" " " " + ($SbS_3 + SbO_3 + S$),	4.4715	6.4044
" " " " + Sb (after reduction),	4.3920	6.3207
" " ($SbS_3 + SbO_3 + S$), ...	0.1922	0.2024
" " Sb, ...	0.1127	0.1187

$$0.1922 : 0.1127 = 0.8423 : 0.4939 \therefore 0.2024 : 0.1187 = 0.8423 : 0.49397.$$

Several similar examples might be given. The filtrate from the mixed sulphide, containing nothing but zinc in solution, was collected with the washings in a large beaker glass, which was covered with a shallow glass tunnel having the orifice so fine as to allow fluid only to drop. The beaker was heated on a sand-bath, and when the liquid was in ebullition a concentrated solution of carbonate of soda was poured into the tunnel, from which it dropped gradually into the boiling liquid. The zinc was in this way invariably perfectly precipitated, and the carbonate obtained in a granular condition, which rendered the subsequent filtering and washing exceedingly easy. This very simple mode of precipitating zinc must have occurred to others, but as I have never seen it described, I will add, that it is very much to be preferred to the ordinary mode of precipitating in a flask. It renders the determination of zinc one of the most accurate of Analytical Chemistry; in proof of which I would refer to the analyses of crystals from the alloys of 33, 32.5, and 29.5 per cent of zinc, given in the table of analyses on the next page. The only source of error in this process arises from neglecting to wash thoroughly the precipitated carbonate of zinc.

In all the analyses published in this memoir, the zinc was determined by the method just described; but, unfortunately, the accuracy of the method indicated above for determining antimony was not ascertained until the investigation was half finished. In the earlier analyses the antimony was determined from a separate portion of crystals by the method commonly used, namely, dissolving in aqua regia, adding tartaric acid before diluting, in order to keep the oxide of antimony in solution, and determining the sulphur in the precipitated sulphide as sulphate of baryta. This process in the hands of the author proved much less generally accurate than the one which has been recommended; for the slight loss of antimony to which the analyst is liable while reducing with hydrogen was found to be more than counterbalanced by the greater length of the last process, and the danger of obtaining a small amount of oxide mixed with the sulphide. The analyses were all made in my laboratory, under my direction and immediate supervision, and the greater part of them by myself. The rest, with one exception, were made by my assistants, Mr. F. H. Storer and Mr. C. W. Eliot, to whose great care and accuracy I take pleasure in bearing witness. Their work is, in all respects, as reliable as my own. The results are collected in the following table, which will explain itself.

Analyses of the Crystals formed in the Alloys of Zinc and Antimony.

Composition of the Alloys by Synthesis.		Composition of the Crystals by Analysis.			Name of the Analyst.
Per Cent of Zn.	Per Cent of Sb.	Per Cent of Zn.	Per Cent of Sb.	Sum.	
70.40	29.60	64.15	35.77	99.92	Cooke.
66.50	33.50	61.00	39.00	*100.00	"
64.50	35.50	58.50	41.44	99.94	"
60.60	39.40	55.00	45.09	100.09	Homer.
58.60	41.40	50.39	49.29	99.68	Eliot.
56.60	43.40	49.92	50.05	99.97	"
54.70	45.30	48.26	51.42	99.68	Storer.
52.70	47.30	47.47	52.53	†100.00	Cooke.
50.70	49.30	46.89	53.11	†100.00	"
do.	do.	46.45	53.55	†100.00	"
48.70	51.30	48.66	51.34	†100.00	Eliot.
46.70	53.30	46.77	53.23	†100.00	"
44.80	55.20	44.26	55.73	†100.00	"
43.80	56.20	44.04	55.96	†100.00	Cooke.
42.80	58.20	43.15	56.93	100.08	"
do.	do.	43.06	56.50	99.56	"
do.	do.	42.83	57.24	100.07	"
33.00	67.00	35.37	64.57	99.94	"
do.	do.	35.40	64.60	†100.00	"
32.50	67.50	34.62	64.92	99.54	Storer.
do.	do.	34.61	65.39	†100.00	Eliot.
31.50	68.50	33.95	66.09	100.04	Storer.
29.50	70.50	33.62	66.38	†100.00	"
do.	do.	33.62	66.38	†100.00	"
27.50	72.50	33.85	65.81	99.66	"
26.50	73.50	32.08	67.60	99.68	"
26.00	74.00	30.74	69.06	99.80	Cooke.
25.50	74.50	30.43	69.51	99.94	Storer.
25.00	75.00	29.88	70.20	100.08	Cooke.
24.50	75.50	28.76	71.24	100.00	"
23.50	76.50	27.93	71.85	99.78	"
22.50	77.50	26.62	73.27	99.89	Storer.
21.50	78.50	24.83	74.74	99.57	Cooke.
20.12	79.88	20.58	79.42	100.00	"

* In this analysis the antimony only was determined.

† In these analyses the zinc only was determined.

Curve of Variation in Composition.

In order to compare together the composition of the crystals and that of the alloy in which they form, I have resorted to the usual method of Analytical Geometry, and in the plate at the end of this memoir the lower horizontal line is the axis of abcissas, and the vertical line at the extreme left the axis of ordinates. The first has been divided into equal parts, which denote the per cents of zinc in the crystals, and the last into parts of the same size, which stand for the per cents of zinc in the alloys. The zinc rather than the antimony determinations have been selected for comparison, as being generally more accurate, and as having been all made in exactly the same way. The points determined by analysis are indicated with dots, and the double line drawn through these dots is a curve, which represents the relation of the composition of the crystals to that of the alloy in which they form. In order to make clear the connection between the two, it will be well to discuss this curve, commencing with what may be termed the two centres of crystallization, the alloys of 42.8 and 31.5 per cent of zinc, and examining the effect produced on the crystals by diminishing or increasing the amount of zinc in the alloy.

It has already been stated, that the crystals of $SbZn_3$ are obtained in their greatest perfection from the alloy of 42.8 per cent of zinc. They are then comparatively large, generally aggregated, and, as the three analyses already cited prove, have the same composition as the alloy. On increasing gradually the amount of zinc in the alloy up to 48.7, the crystals continued to have the composition of the alloy, and the only difference which could be observed in their character was, that they were smaller, and more frequently isolated. Between these limits the whole mass of the alloy exhibited a strong tendency to crystallize, and by pouring it as it cooled from one vessel to another, it could be crystallized to the last drop. The portion *a b* of the curve is therefore a straight line equally inclined to the two axes. On increasing the amount of zinc in the alloy to 50.7 per cent, the amount of zinc found in the crystals was only 46.89 per cent, and above this it was uniformly less than it was in the alloy; but no closer relation between the two could be detected, owing undoubtedly to the unavoidable irregularity in the crystallizations of the alloys which contained more than 50 per cent of zinc. This arose from a peculiar pasty condition which the fluid mass assumed at the point of crystallization, apparently caused by the separation of the excess of zinc. Definite crystals, however, were obtained even from the alloy of 60 per cent of zinc, which contained 55 per cent; above this, the crystals became less and less abundant, and gradually faded out, although the alloy even of 86 per cent of zinc exhibited a radiated crystalline texture, and a trace of this structure could be still discovered even in the alloy containing only 4 per cent of antimony. It might be supposed that, on returning to the alloy of 42.8 per cent of zinc, and increasing the amount of antimony, we should obtain crystals containing an excess of antimony; but so far is this from being true, that the slightest excess of antimony entirely changes the character of the crystallization. On crystallizing an alloy containing 41.8 per cent of zinc, not a trace of any prismatic crystals could be seen, but in their place there was found a confused mass of thin metallic scales, which, as will soon be shown, are imperfect crystals of $SbZn_2$. Thus it appears that, although perfectly formed crystals of $SbZn_3$ can be obtained containing 55 per cent of zinc, they cannot be made to take up the slightest excess of antimony. A more remarkable example of break in continuity than the lower limit of $SbZn_3$ I have never seen. It was brought to notice very forcibly on attempting to recrystallize a quantity of alloy of 42.8 per cent of zinc, which had already afforded large and definite crystals of $SbZn_3$, after adding a very small piece of antimony, when no trace of crystallization could be obtained except the scales described above.

In order to obtain crystals having the composition of $SbZn_2$, that is, containing 33.5 per cent of zinc, it is necessary to crystallize an alloy at least as low as 31.5 per cent of zinc. At this point large compound crystals are obtained corresponding to the large crystals of $SbZn_3$. On increasing the amount of zinc in the alloy up to 33 per cent, the proportion of zinc in the crystals appeared to increase in the same ratio, so that the curve of $SbZn_2$ is, at this part, a straight line parallel to the curve of $SbZn_3$. It should, however, be noticed, that the extent of this line, *k i*, is so limited, that a very small error in the analyses might change very considerably its direction. The crystals of $SbZn_2$, containing an excess of zinc, are smaller and more frequently isolated than those containing exactly two equivalents. A similar fact, it will be remembered, is true of the crystals of $SbZn_3$. At the alloy of 33 per cent of zinc the definite crystals of $SbZn_2$ begin to disappear, and are succeeded by thin metallic scales, which, as the two following facts will prove, are imperfect crystals of the same crystalline form. First, the scales from the alloy of 33 per cent are frequently found having a definite crystal as a nucleus, when it is evident that their surfaces are extensions of the basal plane *O* of Fig. 3. Secondly, the scales twin together like the large tabular crystals of $SbZn_2$, forming a cellular structure; and the angle between two scales thus united measured, with an application goniometer, approximatively 115° 30′, and was therefore equal to the basal angle of the definite crystals. These scales continue up to the alloy of 41.8 per cent of zinc, becoming, however, constantly less abundant and less distinct.

Several specimens of them were analyzed, but no regularity in their composition could be detected, except that they all contained a very much larger amount of zinc than the alloys in which they formed. This irregularity and the imperfection in the crystallization seem to be caused by the interference of $SbZn_3$, that is, by a tendency to form $SbZn_3$, which exhibits itself in a proneness of the crystals of $SbZn_2$ to an excess of zinc. The line *k i* has been continued with dots, in order to show that the influence of $SbZn_2$ extends as far as the alloy of 42.8 per cent of zinc. On returning to the alloy of 31.5 per cent of zinc, and adding an excess of antimony, it was found that the crystals formed continued to have the theoretical composition of $SbZn_2$ until the amount of zinc in the alloy had fallen to 27 per cent, so that the tendency towards the theoretical composition was so great, that in the alloys between 31.5 and 27 per cent of zinc, crystals were formed having very nearly this composition. On still further increasing the amount of antimony in the alloy, the composition of the crystals gradually approached that of the alloy, and from the alloy of 20.2 per cent of zinc very imperfect crystals were obtained, having almost the same composition as the menstruum. At the same time the crystals became less and less perfect, and finally disappeared altogether in the alloys below 20 per cent of zinc.

The portion of the curve *k m n h* is the most important result of this investigation, and therefore deserves especial notice. It has been shown that crystals of the form of $SbZn_2$, or at least crystalline scales of the same character, are formed in the alloys between 20 and 43 per cent of zinc, the first per cent corresponding to SbZn, and the second to $SbZn_3$. Half-way between these two points, that is, the alloy of 31.5 per cent, is the point where crystals having the calculated composition of $SbZn_2$ are first obtained. Were the variation in the composition of the crystals of $SbZn_2$ exactly proportional to the excess of zinc or of antimony in the alloy, as is the case with $SbZn_3$, then the curve of variation would be the straight line formed by the continuation of the line *a b*. From this line (*b h*) the course of the curve is deflected by the force which determines the union of the elements in definite proportions, and which, for the want of a special term, I will call the Chemical Force. This is so strong, that the curve runs parallel to the axis of ordinates through the distance *k m*. Beyond this point the influence of the excess of antimony in the alloy becomes stronger than the chemical force, and the curve gradually bends towards the line *h b*, which it finally meets at *h*. In the portion *h n* of the curve the analyses are best represented by the arc of a circle, of which the radius equals *h e*, one half of *h b*, and to which the line *k m* is tangent. In the portion *n m* the points determined by analysis may also be connected by the arc of a circle, of which the radius *o′ n* equals the difference between the radius *o n* and twice *g n*, so that the two centres are at the same distance from the line *a h*. The whole curve is evidently the result of two forces; one acting along the chord in the direction *b h*, a force tending to increase the amount of antimony in the crystals proportional to the amount in the alloy, the same force in fact which acts undisturbed in forming the portion of the curve *b a*; the other, the chemical force acting in the direction of the tangent *k m*. It has already been stated, that crystals having the calculated composition of $SbZn_2$ are not first formed in the alloy of the same composition, 33.5 per cent of zinc, but in an alloy containing two per cent less; so that the line *m k*, instead of extending to *e*, diverges from this direction at *k*, and afterwards runs parallel to the line *b h*. Unless this fact can be explained by a tendency in $SbZn_2$ to an excess of zinc caused by the influence of $SbZn_3$, as suggested above, the reason of the difference between $SbZn_2$ and $SbZn_3$ in this respect is not clear; but as some evidence that it is not accidental, it may be stated that the distance *k c* equals *c i*, the last point being the one at which the tangent line *m k* extended meets the curve. Another remarkable fact, whose bearing cannot at present be seen, but which, like the last, serves to corroborate the general accuracy of the result, was pointed out by my friend and colleague, Professor Peirce, after the plate had been engraved. The distances of the three most important points of the curve of $SbZn_2$ from the line *a h*, namely, *k d*, *m f*, and *n g*, are simple multiples of the first; *n g* is twice and *m f* three times *k d*. The curve has been fixed, as will be noticed from the dots, by a large number of points determined throughout the greater part of its length at every per cent, and in the portion *m n* at every half per cent. They certainly coincide with the curve as closely as could possibly be expected, and the very agreement of so many different determinations by three separate analysts is a strong proof of the general correctness of the work.

By making hypotheses in regard to the nature of the two forces which have generated the curve just described, it would not be difficult to obtain for it a mathematical expression; but as such hypotheses in our ignorance of the nature of these forces would be premature, I must content myself with giving its geometrical construction on a chart, ruled like the plate at the end of the memoir. Let the co-ordinates of any point of the curve be $x =$ per cent of zinc in the crystals, and $y =$ per cent of zinc in the alloy. In order to construct the curve of $SbZn_3$, find a point (*a*) of which $x = y = 43$ per cent (the calculated per cent of $SbZn_3$), and draw a straight line *a b* equally inclined to the two axes in the direction from the origin. To construct the curve of $SbZn_2$, produce the line *a b* in the opposite direction to the point $x = y = 20$, which will be the lowest point of the curve. Find next a point (*k*) of which $x = 33.7$ per cent (the calculated per cent of $SbZn_2$ is 33.5), and $y = 31.5$ per cent, which is one half of $43 + 20$. Through this point draw a line $m\ k$, parallel to the axis of ordinates, and intersecting the line $a\ b\ h$ at c. The line $m\ i$ is the tangent, and the line $b\ h$ the chord, of the required arc. On the line $m\ i$ take $c\ i = c\ k$, and i is the point at which the arc should touch the tangent. Erect a perpendicular on the tangent at the point i; take $o\ i =$ half $b\ h$, and from o as a centre with a radius $= o\ i$ describe the arc $h\ n\ i$. Also, from the centre o let fall a perpendicular $o\ g$ on the chord $b\ h$, and produce it to a point o', making $o'\ g = o\ g$. It will intersect the arc at n. From o', as a centre with a radius $o'\ n$, describe a second arc, $m\ n$ intersecting the tangent at m. Finally, draw from k a straight line $k\ l$ parallel to $b\ h$, then the broken line $l\ k\ m\ n\ h$ will be the required curve.

It will be noticed that the tangent, which has been laid down on the plate through the points determined by analysis, is two tenths of one per cent in advance of the line which would correspond to $SbZn_2$. This position is essential to the equality of $k\ c$ and $c\ i$, if we retain as the value of the radius of the larger arc $R = \frac{1}{2}\ b\ h$. If the analyses should have given erroneously too much zinc, so that the true position of the line should be at $x = 33.5$ per cent, then this equality would be destroyed, and the conditions for finding the centre o would be reduced to the co-ordinates of the point h, the length of the radius, and the position of the tangent, from which, by a very simple construction, the curve might be drawn. It should, however, be remarked, that the position of the tangent in advance of the line $x = 33.5$ is in accordance with the fact, already noticed, that the crystals of $SbZn_2$ have, throughout, a proneness to an excess of zinc, caused apparently by the influence of $SbZn_3$; but it is also true that the tendency of the error in the zinc determinations is in the same direction.

Before discussing the conclusions to which the facts already stated seem directly to point, it will be well to see how far the variation in composition corresponds to a variation in the properties of the two compounds. Three classes of properties have been examined in this connection; namely, Specific Gravity, Crystalline Form, and Affinity for Oxygen, which will be treated of in order.

Specific Gravity.

The specific gravity of all the crystals analyzed, as well as that of the antimony and zinc used in the investigation, has been taken with the greatest care. The determinations were made with a nicely constructed specific gravity bottle, as this method was found susceptible of greater accuracy than any other when the temperature of the water was observed with precision. The small double cone of silver recommended by

Scheerer * was tried, but so great accuracy could not be obtained with it as with a bottle.† On an average, about ten grammes of crystals ‡ were taken for each determination, and the bottle used was capable of containing about the same weight of water. The crystals, coarsely powdered, were introduced into the bottle, covered with water, and, on account of the action of $SbZn_3$ on hot water, the entangled air was removed by an air-pump. The bottle was then filled with water, and, after the stopper had been introduced, suspended in a large beaker of water, the temperature of which was very slightly higher than that of the room. In contact with it was placed the bulb of a centigrade thermometer, graduated to tenths of a degree. When an equilibrium had been established in the temperature, the bottle was removed from the beaker, wiped dry, and weighed. In calculating the specific gravity the weight of the water was corrected for the temperature so that the unit is in all cases distilled water at 4° C. A similar correction could not be made for the temperature of the substance, as the coefficients of expansion of the crystals are not known; but as the maximum difference between the temperatures in the different determinations was not over 10° C., this correction would only very slightly affect the relative results. The mean temperature was about 15° C. In order to show that very accurate results can be obtained by delicate manipulation with a specific-gravity bottle, I will subjoin the numbers obtained in the determination of the specific gravity of antimony and zinc.

* Poggendorf, *Annalen*, Vol. LXVII. p. 120.

† A specific-gravity bottle for delicate experiments should be made with a thick rim, ground square at the top, and the glass stopper should be so fitted to the neck as not to leave a channel between the two in which water can collect.

‡ The very great liability to error which the use of a small amount of substance, in a specific gravity determination, necessarily involves, does not seem to be appreciated by many experimenters, and it may therefore be of use to add a very simple mathematical statement of the process. Let $M =$ weight of substance at 4° C. and $m =$ weight of bottle filled with water at same temperature. Place $x =$ the weight of bottle, substance, and water, as this is the weight on which the accuracy of each determination depends, since the weight m is the same for all, and is the mean of a large number of observations; then Sp. Gr. $= \frac{M}{(M+m)-x} = u$; $\delta u = \frac{u^2}{M}\delta x$. Here δu represents the amount of error produced in the specific gravity by making an error of δx in the weight. Suppose $u = 6.32$, then $\delta u = \frac{40}{M}\delta x$, so that, if forty grammes of the substances are used, an error of one millegramme in the weight x will produce an error of one one-thousandth in the specific gravity. Suppose, however, only one gramme is taken, then the same error in the weight x will cause an error of four one-hundredths in the specific gravity. From this it appears, that, where only a limited amount of a substance is at command, it is best to unite it all in one careful experiment, rather than to distribute it through several; for it must be remembered, that, of two experiments in which the liability to error is as one to four, the relative value is not as these numbers, but as their squares.

	1.	2.
Weight of antimony, ...	18.8642	12.5433
" " water displaced at 4° C., ...	2.8250	1.8785
Specific gravity of antimony at 15° compared with water at 4°, .	6.677	6.677

	1.	2.
Weight of zinc, ...	12.4145	11.0383
" " water displaced at 4° C., ...	1.7356	1.5431
Specific gravity of zinc at 12°.4 C. compared with water at 4°, .	7.153	7.153

In the table on the opposite page, the results of the specific gravity determinations are given in the column headed "Sp. Gr. of Crystals by Experiment." Each number is the mean of at least two, and generally of three experiments, agreeing within a few thousandths. The column headed "Mean Sp. Gr. of Zinc and Antimony," is the calculated specific gravity of the same crystals, on the supposition that the two metals had undergone no expansion on uniting. The last column gives the differences of these two numbers, and therefore shows the amount of expansion. On examining the table it will be found, — 1st. That the union of antimony and zinc is accompanied with expansion; 2d. That the specific gravity of the crystals varies slightly with the composition; 3d. That the two minimum specific gravities correspond precisely to the composition of $SbZn_2$ and $SbZn_3$, so that the specific gravity increases, and the expansion diminishes, as you depart on either side from these two centres; 4th. That the specific gravity of $SbZn_3$ is smaller than that of $SbZn_2$. We find, then, that the specific gravity determinations confirm, in general, the results of the analyses, pointing out the same two centres of crystallization.

Crystalline Form.

It has already been stated, that only two crystalline forms can be obtained from the alloys of zinc and antimony, — that of $SbZn_3$ and that of $SbZn_2$. A large number of crystals of $SbZn_3$ from different alloys, and therefore containing different proportions of zinc, were carefully measured for the purpose of ascertaining whether the angle was at all affected by the variation of composition. Fortunately, four different crystallizations afforded excellent crystals, the angles of which could be measured to a minute. The crystals contained, respectively, 43.15, 44.14, 46.90, and 55.00 per cent of zinc, and on all these, by repeated measurements, the angles were found to be *identical* with those given under Figs. 1 and 2. Crystals from many of the other alloys were also measured, but on account of the imperfections of their surfaces the angles could not be

Specific Gravities of Crystals formed in the Alloys of Zinc and Antimony.

Composition of the Alloys.		Composition of the Crystals.		Sp. Gr. of Crystals by Experiment.	Mean Sp. Gr. of Zinc and Antimony.	Expansion in Crystallizing.
Per Cent of Zn.	Per Cent of Sb.	Per Cent of Zn.	Per Cent of Sb.			
100.00				7.153	7.153	0.000
*96.00	4.00			7.069	7.134	0.065
*86.20	13.80			6.898	7.086	0.188
*76.30	23.70			6.769	7.039	0.270
70.40	29.60	64.20	35.80	6.699	6.982	0.283
66.50	33.50	61.00	39.00	6.628	6.967	0.339
64.50	35.50	58.56	41.44	6.596	6.956	0.360
62.50	37.50	55.53	44.47	6.506	6.941	0.435
60.60	39.40	55.00	45.00	6.440	6.939	0.499
58.60	41.40	50.39	49.61	6.396	6.917	0.521
56.60	43.40	49.95	50.05	6.388	6.915	0.527
48.70	51.30	48.66	51.34	6.404	6.909	0.505
46.70	53.30	46.77	53.23	6.376	6.900	0.524
44.80	55.20	44.26	55.74	6.341	6.888	0.547
42.80	57.20	43.09	56.91	6.327	6.882	0.555
*40.00	60.00			6.386	6.867	0.481
*35.00	65.00			6.404	6.844	0.440
33.00	67.00	35.37	64.63	6.401	6.845	0.444
29.50	70.50	33.62	66.38	6.384	6.837	0.453
27.50	72.50	33.85	66.15	6.383	6.838	0.455
26.50	73.50	32.08	67.92	6.400	6.829	0.429
26.00	74.00	31.07	68.93	6.418	6.824	0.406
25.50	74.50	30.43	69.57	6.428	6.822	0.394
24.50	75.50	28.76	71.24	6.449	6.813	0.364
22.50	77.50	26.62	73.38	6.453	6.803	0.350
21.50	78.50	24.83	75.17	6.467	6.795	0.328
*15.00	85.00			6.564	6.748	0.184
*10.00	90.00			6.603	6.725	0.122
*5.00	95.00			6.655	6.701	0.046
	100.00			6.677	6.677	0.000

* Alloys not crystallized.

determined within five or ten minutes. In all these cases, however, the values of the angles given above were included within the limits of uncertainty.

The faces of the crystals of $SbZn_2$ are not generally so perfect as those of $SbZn_3$, nor is their tabular form so well adapted for measurement. Moreover, variations in some of the angles have been noticed in crystals from the same crystallization, amounting even to ten minutes. The angle O on 1, however, appeared to be very constant, for in all cases where it could be accurately measured the same value was obtained. As none of the crystals of $SbZn_2$, containing an excess of antimony, could be measured with precision, no constant variation of angle could be detected, and, on the other hand, it could not be proved to be invariable.

Affinity for Oxygen.

The affinity of the crystals of $SbZn_3$ of different compositions for oxygen was estimated by boiling alloys of the same composition as the crystals with water, and measuring the amount of hydrogen evolved in a given time. The following table contains the results of these experiments. Column 1 gives the number of cubic centimetres of hydrogen obtained by boiling 200 grammes of different alloys (granulated) with water. The per cent of zinc contained in the alloys is given at the left-hand side of the table, opposite to the number of cubic centimetres. The composition is known only synthetically. The alloys were made by melting together the zinc and antimony of commerce in the required proportions, making no allowance for impurities, and when melted, they were granulated as nearly as possible under the same conditions. Two hundred grammes of each alloy were boiled with water, the gas collected over water, and the number of cubic centimetres evolved in an observed time read off after the gas had been cooled to 20° C. These amounts were afterwards reduced for ten minutes, and, thus reduced, are given in the table. As it was impossible to obtain granules of a uniform size in all the alloys, another set of experiments was made in a precisely similar way, except that the alloys were cast into small cylinders of a uniform size. As these cylinders had absolutely the same diameter, and very nearly the same specific gravity, throughout, the same amount of surface was obtained by weighing out 200 grammes of each alloy, and taking care to have the same number of little cylinders in each lot. Column 3 gives the results of these experiments. It will be seen that the two sets of numbers compare as closely as could be expected, it being remembered that the amount of surface in the first set of experiments was variable, while that in the second was constant, and smaller than the first. These results, however, are only approximate. The limits of variation in different experiments on the same alloy would quite cover the differences between the first ten numbers of column 1, excepting the first, so difficult is it to granulate the alloys to a uniform size, and submit them during the experiments to precisely similar conditions. The numbers of column 3, from which the variations due to difference of surface have been eliminated, are probably, relatively to each other, very nearly correct.

Table of the Amounts of Hydrogen Gas evolved by 200 *Grammes of Different Alloys of Antimony and Zinc, in Ten Minutes, at* 100° *C. measured at about* 20° *C.*

Per Cent of Sb.	1.	2.	3.
0	2	63	
5	6	34	
10	4	28	3
15	4		
20	6	18	5
25	4	19	
30	4	31	5
35	5	49	
40	6	72	7
45	5	45	
50	8	44	9
55	17	46	
58	130	244	84
60	50	139	47
65	14	35	
70	10	45	7
75	6	36	
80	5	23	6
85	4	20	

A mere glance at the table will discover two facts: —

1st. That up to 40 per cent no great increase in the amount of hydrogen evolved is obtained by increasing the amount of zinc in the alloy.

2d. That at the alloy containing 42 per cent of zinc there is an immense maximum, which is confined at most between two per cent on either side.

It is a well-known fact, that the rapidity of the evolution of hydrogen from dilute sulphuric acid and zinc can be very greatly increased by adding to the materials a few drops of a solution of bichloride of platinum. The platinum, being immediately deposited over the zinc, forms with it a galvanic pair, and thus increases the affinity of the zinc for oxygen. The same increased action can be produced by the same means in the decomposition of pure water by the antimony and zinc alloys. Column 2 of the table gives the results which were obtained by boiling with pure water in a small flask 200 grammes of the granulated alloys previously treated, with the same amount in each case of a solution of chloride of platinum. After the platinum had been deposited on the granules, and the surfaces had been thus blackened, the alloys were thoroughly washed with water, and the experiments conducted as in the other two cases. These experiments were made with the same alloys as those from which the numbers of column 1 were obtained. As, however, in the experiments with bichloride of platinum, new and obvious causes of irregularity were introduced, that did not exist in the other two sets of experiments, no great uniformity can be expected on comparing the results. The two main facts, however, noticed in the columns 1 and 3 of the table, are quite as prominent in column 2, and also the additional fact that the presence of platinum very greatly increases the rapidity of the evolution of hydrogen from the alloys.

One set of results given in the table requires particular notice, — those obtained from *pure* zinc, to be found on the first line opposite 0 per cent of antimony. It is stated with great confidence, by all chemical authors* who have written on the subject, that zinc does not decompose water at the boiling temperature. On this account the experiments with pure zinc were made with peculiar care, and repeated several times, great pains being taken to insure that both the zinc and water employed were perfectly pure. There is no doubt in regard to the fact of the decomposition, which becomes, as is shown in the table, quite rapid when the affinity of the zinc is strengthened by the galvanic action of the platinum.

It has already been shown, that, when the alloys of zinc and antimony are treated with hydrochloric or sulphuric acid, they are, as a general rule, and under favorable circumstances, completely decomposed, the zinc uniting with the acid, and the greater part of the antimony separating as a black powder, only a very small amount ever, even under the most favorable circumstances, escaping as antimoniuretted hydrogen. When the alloys are in granules, it is almost invariably the case with those containing more than 50 per cent of antimony, that after a short time the acid ceases to act, owing to the formation of a coating of antimony on the surface. The action is, of course, renewed on reducing the alloy to powder, but here, as in other alloys, the less oxidizable metal appears to be able to protect entirely a certain amount of the other from the action of acids.

These facts, in connection with those previously stated in regard to the increased action of the alloys on water in presence of platinum, sufficiently explain the remark-

* Since this was written, and first published in the *American Journal of Science* for September, 1854, I find that Deville has noticed the fact of the decomposition of boiling water by zinc. *Comptes Rendus*, 14 Aout, 1854, p. 322, note.

ably rapid decomposition of water obtained by means of alloys which have been previously acted upon by dilute hydrochloric or sulphuric acids, even after the excess of acid and the salts formed have been completely removed by repeated washings. This decomposition is so rapid, that I have obtained from 200 grammes of an alloy containing 43 per cent of zinc, prepared as just described and boiled with water, nearly a litre of gas in ten minutes. It is plain that the antimony acts here exactly as the platinum in the previous experiments, by forming a galvanic circuit with the alloy. A set of experiments was made with alloys, which had been acted upon by acids, similar to those the results of which are given in the table. The irregularities, however, which resulted from the unequal action of the acids on the different alloys, from the differences of surface, and from other causes, rendered the final results so discordant, that they were of no value for comparison. They were always much greater than those obtained by using platinum, with the exception of pure zinc, whose decomposing power was not increased by the action of acids.

This new mode of decomposing water is of value as a process for preparing pure hydrogen, and also for illustrating the composition of water to a class. My mode of preparing the alloy for making pure hydrogen is simply thus. I melt together equal parts of zinc and antimony free from arsenic (this alloy being nearly as active after having been treated with acid as the alloy of 43 per cent of zinc), and granulate as finely as possible. I place the granules in a deep porcelain basin, and pour over them enough hydrochloric acid of ordinary strength to cover them. An energetic action ensues, which I allow to continue until it becomes weak, and the acid nearly exhausted. The excess of acid, and also the chloride of zinc formed, I now wash away by allowing a stream of water to pour into the basin until it runs off clear and tasteless. The alloy thus prepared is ready for use. It will evolve hydrogen from boiling water with almost as much rapidity as zinc and dilute sulphuric acid, and even after the temperature of the water has fallen to that of the air, the evolution continues, though only very slowly. A flask containing about 500 grammes of the prepared alloy covered with water continued to evolve hydrogen during the winter for over two months, when the temperature was seldom above 4° C.

The rapidity of the evolution of hydrogen from the alloy and boiling water diminishes quite rapidly, and finally, after several hours, ceases altogether, from the formation of a coating of oxide on the surfaces. The activity can be restored by dissolving off this coating with dilute acids. Where, however, the alloys contain a large per cent of antimony (above 50), the activity cannot be renewed indefinitely in this way, since the particles of antimony set free by the acid adhere to the surface of the alloy, and soon form a coating impregnable to the strongest acid. As has been shown in the previous part of this memoir, when the antimony and zinc used are free from arsenic, the hydrogen obtained by this process is chemically pure. It is, consequently, completely destitute of odor.

General Conclusions.

I stated at the commencement of this memoir, that I expected to be able to prove, first, that zinc and antimony form with each other two, and probably only two, definite compounds; second, that these compounds are capable of a very large variation in composition without any change in the crystalline form; and, lastly, that this variation can only be explained by admitting an actual perturbation in the law of definite proportions produced by the influence of mass. That zinc and antimony form with each other two compounds, and that these compounds are capable of a very large variation in composition without any change in the crystalline form, have been shown to be facts. The cause of this variation can only be inferred. Before stating the conclusions to which, as I think, the facts now established directly point, it will be well to consider the only two admitted principles of chemical science which could possibly be brought forward to explain similar variations. They are, first, that of impurities in crystals; second, that of isomorphous mixtures. It will not be difficult to show that the variations in composition of $SbZn_2$ and $SbZn_3$ cannot be explained by either of these principles.

It is a well-known fact, that crystals frequently take up impurities, which are either dissolved or mechanically suspended in the menstruum in which they form, and it might be supposed, at first sight, that the excess of zinc or antimony in $SbZn_3$ or $SbZn_2$ bore the same relation to their crystals that the sand does to the rhombohedrons of Calcite from Fontainebleau, or oxide of iron and Chlorite to crystals of Quartz; but, in the first place, in all cases where a considerable amount of impurity is present, the crystals are either imperfect, or else the angle is considerably changed, at times even as much as two or three degrees; and, secondly, as such impurities are merely mechanical, the amount in the crystals would in all probability be proportional to the amount present in the menstruum at the time of their formation. Now, in the crystals of $SbZn_3$ from the alloy of 60 per cent of zinc, there is present an excess of zinc amounting to 15 per cent, and nevertheless the crystals are perfect, and their angles identical with those of the crystals obtained from the alloy of 43 per cent. In the crystals of $SbZn_3$ the excess of zinc is, to a certain limit, directly proportional to the excess in the alloy; but in those of $SbZn_2$ the excess of antimony is far from obeying this rule, and were the excess in both cases a mechanical mixture, the variation in both cases would undoubtedly follow the same law. Again, the crystals of $SbZn_3$ take up an excess of zinc, but do not take up an excess of antimony, while those of $SbZn_2$ crystallize with an excess of either, facts which are as inconsistent with the idea of mechanical impurity as the last. Finally, the form of the curve of $SbZn_2$ of itself alone proves that the excess of antimony in the crystals is not in the condition of mechanical impurity, for in that case the variation of composition would not be influenced, as the curve shows that it is, by the chemical force.

A theory that the variation in composition resulted from the mixture of two or more isomorphous compounds, would be even less tenable than the one just discussed, for, in the first place, it would be necessary to assume the existence of two other compounds of zinc and antimony isomorphous with $SbZn_2$, and of one other, if not of more, isomorphous with $SbZn_3$. Not only would such an assumption be contrary to all the analogies of chemistry, and therefore require strong evidence to sustain it; but, in the second place, it can almost be demonstrated that no such compounds exist. The crystals having the calculated composition of either $SbZn_3$ or $SbZn_2$ are marked, as has been shown, by striking peculiarities, and, with one possible exception, similar peculiarities were not observed throughout the whole series of crystals which have been examined. The crystals containing 50 per cent of zinc and of the composition of $SbZn_4$, were found to have a slightly smaller Sp. Gr. than those just above or just below them; but the difference is so small that it may be accidental, and as the crystals exhibited none of the other peculiarities which characterize crystals having the calculated composition of $SbZn_3$ or $SbZn_2$, I could not attach sufficient weight to the one circumstance to feel authorized in admitting a third compound of zinc and antimony. Admitting, however, the existence of $SbZn_4$, yet, as exactly the same angle has been observed on crystals containing 55 per cent as on those containing 43 per cent of zinc, it would be necessary, in order to explain the variation in composition by the principle of isomorphous mixtures, to assume the existence of still a third compound isomorphous with $SbZn_3$, and containing more zinc than $SbZn_4$, which would increase greatly the improbability of the theory in question. Again, the only probable compound of zinc and antimony containing less zinc than $SbZn_2$ would be SbZn; and it will be remembered that the crystals of $SbZn_2$ which contained the largest excess of antimony corresponded very nearly to this compound. In like manner the crystals of $SbZn_2$ which contained the largest excess of zinc corresponded very nearly to $SbZn_3$. If, then, the excess of antimony or zinc in the crystals of $SbZn_2$ arises from a mixture of isomorphous compounds, it must be that $SbZn_3$, $SbZn_2$, and SbZn are isomorphous. That the first two are not isomorphous may be seen by turning back to the description of their crystalline form, and that there is no crystalline compound SbZn is sufficiently proved by the fact that the crystals of $SbZn_2$, which correspond most closely to it, are so very imperfect, that they would hardly be recognized as crystals did they not form the lower limit of a series. Several other facts pointing in the same direction might be added, but sufficient, it is thought, has been said to show that the variations of composition described in this paper cannot be explained either by mechanical impurities in the crystals or by the mixture of isomorphous compounds.

In the absence of any known principle of chemical science by which the remarkable variations of composition that have been demonstrated in this memoir can be explained, the conclusion is almost forced upon us, that zinc and antimony are capable of uniting and producing definite crystalline forms in other proportions than those of their chemical equivalents; in other words, that the law of definite proportions is not so absolute as has been hitherto supposed. The explanation, then, of the variation of composition which I would offer is, that it is due to an actual perturbation of the law of definite proportions produced by the influence of mass. I suppose, for example, that in the crystals of $SbZn_3$ containing 55 per cent of zinc, the zinc and antimony are united in exactly the same way as in those containing 43 per cent, or, in other words, just as if the equivalent of zinc were increased to 52.57, that of antimony remaining the same. In support of this position I would offer two considerations. The first is, that, if the variation is not caused by mechanical impurities or by the mixture of isomorphous compounds, we can conceive of no other explanation for the phenomenon than the one offered. This, of course, is merely negative evidence, for although science as yet presents us with no principle for explaining variations of composition other than those which have been discussed, and although we can conceive of none others, it does not follow that others may not exist, or may not hereafter be discovered; but, nevertheless, this consideration is important, inasmuch as it meets an obvious objection, which would be urged against any new doctrine which conflicts with a generally received canon of chemical philosophy. The second consideration has the character of demonstration. It is that the curve of variation is evidently generated by a second force counteracting directly the chemical force. This second force, as has been shown, is exerted by the excess of one or the other elements present in the menstruum, and it may therefore be appropriately termed the force of mass. While the chemical force tends to make the curve a straight line parallel to the axis of ordinates, the force of mass would reduce it to a straight line, making an angle of 45° with the axis. Under the influence of both these forces, it follows the arc of a circle between the two. Now, I urge that the character of this curve proves that the chemical force has been directly influenced by what we have called the force of mass, in the same way that the irregularities of the orbits of the planets prove that the force of gravitation exerted by the sun has been disturbed in its action by the influence of the other members of the system. As the details in the form of the curve have been fully discussed in the previous part of the memoir, it does not seem to be necessary to dwell upon this argument, and I would therefore, without further comment, offer the curve as it has been laid down on the plate, as the proof of the validity of the explanation of the variation in composition here advanced.

It is worthy of remark, that, while the curve of variation may be said almost to demonstrate that the law of definite proportions may be disturbed in its action, it also most clearly sustains the integrity of the law itself; for, as may be seen on inspection, the chemical force is sufficiently strong to retain the curve of $SbZn_2$ parallel to the axis of ordinates through a variation in the menstruum of nearly five per cent, and it is only when the excess of antimony present in the alloy exceeds six per cent that the force which it exerts becomes strong enough to disturb the action of the law. What the nature of the disturbing force is must be for the present a matter of theory. I am inclined to believe that it is a phase of the chemical force itself, in the same way that the perturbations in the motions of the planets are a secondary result of the force of gravitation.

Accepting the view of the subject which has been offered, it will be obvious that the very large extent of the variation in the compounds of zinc and antimony is due to the very weak affinity between these elements. Were the chemical force stronger in proportion to the disturbing force, the variation would be lessened; were it weaker, the variation would be increased. This is illustrated in the difference between the curve of $SbZn_2$ and that of $SbZn_3$. It is evident from the action of chemical agents on the two compounds, that one equivalent of antimony and two of zinc are united by a stronger force than one equivalent of antimony and three of zinc, and we find that the crystals of $SbZn_2$ retain the calculated composition under a considerable variation in the composition of the menstruum, while the composition of those of $SbZn_3$ vary with the slightest increase of the amount of zinc in the alloy.

To what extent this perturbation of the law of definite proportions prevails among chemical compounds, it must remain for future investigation to determine. There are, however, a number of facts which tend to prove that it is very general wherever chemical affinity is weak. Four of these I will cite, as being remarkably analogous to the facts under discussion.

1. Rieffel, to whose investigation of the compounds of tin and copper we have already referred, says, after the paragraph quoted in the introduction to this memoir: — "Les aiguilles de $CuSn_{24}$ sont plus grosses que celles de $CuSn_{18}$. On croit, sans oser

l'affirmer, qu'elles sont, par compensation, en nombre moindre, et que des différences analogues ont lieu dans les autres $CuSn_\varphi$ à mesure que ϕ augmente jusqu'à $\phi = \infty$, ou jusqu'à l'étain pur." It will be noticed that the difference between these needles is precisely the same as the difference between the crystals of $SbZn_3$ containing a small and a large amount of zinc, and I think that no one, after reading Rieffel's paper, can doubt that the compounds of copper or tin vary in composition like those of zinc and antimony.

2. The mineral Discrasite, a compound of silver and antimony, crystallizes in trimetric prisms, of which I on I = 119° 59'.* The analyses given below are copied from Dana's *System of Mineralogy*, changing slightly the order.

$SbAg_3$ = Antimony 28.5, Silver 71.5 = 100. $SbAg_4$ = Antimony 23, Silver 77 = 100.

1. Andreasberg (foliated granular)	Antimony	24.25	Silver	75.25	= 99.5.	Abich.
2. Wolfach (coarse granular)	"	24.00	"	76.00	= 100.	Klaproth.
3. Andreasberg (foliated granular)	"	23.00	"	77.00	= 100.	"
4. " " "	"	22.00	"	78.00	= 100.	Vauquelin.
5. Wolfach (fine granular)	"	16.00	"	84.00	= 100.	Klaproth.

It needs no comment on these results to show that discrasite is homeomorphous with $SbZn_3$, and varies like it in composition.

3. In a paper recently published,† W. Satorius von Walterhausen, gives descriptions and three analyses of a new mineral occurring with Dufrenoysite in the Binnen-Valley, Switzerland, in Dolomite. As the analyses do not agree with each other and do not correspond to a simple formula, von Walterhausen regards the compound as consisting of two hypothetical isomorphous compounds, $PbS + AsS_3$ and $2\ PbS + AsS_3$, and calculates the proportions in which these compounds are mixed in the specimens analyzed. He infers that they are isomorphous, from their analogy in composition to Zinkenite and Heteromorphite, $PbS + SbS_3$ and $2\ PbS + SbS_3$, which he regards as isomorphous. Dr. J. D. Dana questions the isomorphism of the last, and thinks that the hypothesis that the new compounds are isomorphous requires further evidence.‡

4. It is stated by Staedeler,§ that crystals of the compound of grape-sugar and common salt can be obtained containing for every equivalent of grape-sugar one or two

* Dana's *System of Mineralogy*, 4th ed., Vol. II. p. 35.

† Poggendorf, *Annalen*, Vol. XCIV. p. 123.

‡ *American Journal of Science*, Vol. XIX. p. 355.

§ *Chemical Gazette*, Vol. XIII. p. 44.

equivalents of chloride of sodium, and also of intermediate composition. He states, moreover, that "Calloud, who first observed that the grape-sugar of honey combined with chloride of sodium, found that the amount of the latter varied between 8.3 and 25 per cent." Staedeler refers the variation in composition to a mixture of the compound of one with the compound of two equivalents of chloride of sodium, which he assumes to be isomorphous. He adds, that it may be caused by "inclosed crystals of chloride of sodium, although the eye could not distinguish any heterogeneous constituents."

All the above compounds are examples of weak chemical affinity, accompanied by large variations in composition without any change in the general crystalline form. It is not meant to assert that the variations are identical in character with those of $SbZn_3$ and $SbZn_2$, but only that there is a strong probability that this is the case, which, in the first two instances, amounts almost to a certainty.

If variations in composition of such magnitude are possible when the force of chemical affinity is weak, it is highly probable that some variation may occur when the force is strong; and, whatever view may be taken of the cause of the variation, it will now become a matter of importance to ascertain whether many discrepancies in analyses hitherto referred to imperfections in the process may not be owing to the same cause which influences the composition of the crystals of the two compounds of zinc and antimony. For this purpose it will be best to make several analyses of the same compound, prepared under circumstances differing as widely as possible, and then to apply to the results Peirce's "Criterion for the Rejection of Doubtful Observations." Such investigations will be greatly simplified by the tables prepared by Dr. B. A. Gould, Jr., for facilitating the application of this criterion, to which I would refer all chemists who are inclined to take up this line of investigation.

I am well aware that, in announcing the existence of perturbations of the law of definite proportions, I am calling in question one of the most fundamental dogmas of chemical philosophy, and that the new doctrine will have to encounter prejudice on this very ground. This law is so intimately associated in many minds with the atomic theory, that to such absolute definiteness seems to be its essential characteristic. Nevertheless, I cannot but believe that, laying aside the prejudices which the theory begets, it will be seen by all that the analogies of nature support the doctrine of variation as maintained in this memoir. The phenomena of none of the phenomenal laws * of nature

* I have used the term *phenomenal laws* to designate a class of laws of nature which are empirical in their character, inasmuch as they are obviously not ultimate, although their derivation has not been discovered, but which are more universal than those to which the term *empirical* is commonly applied.

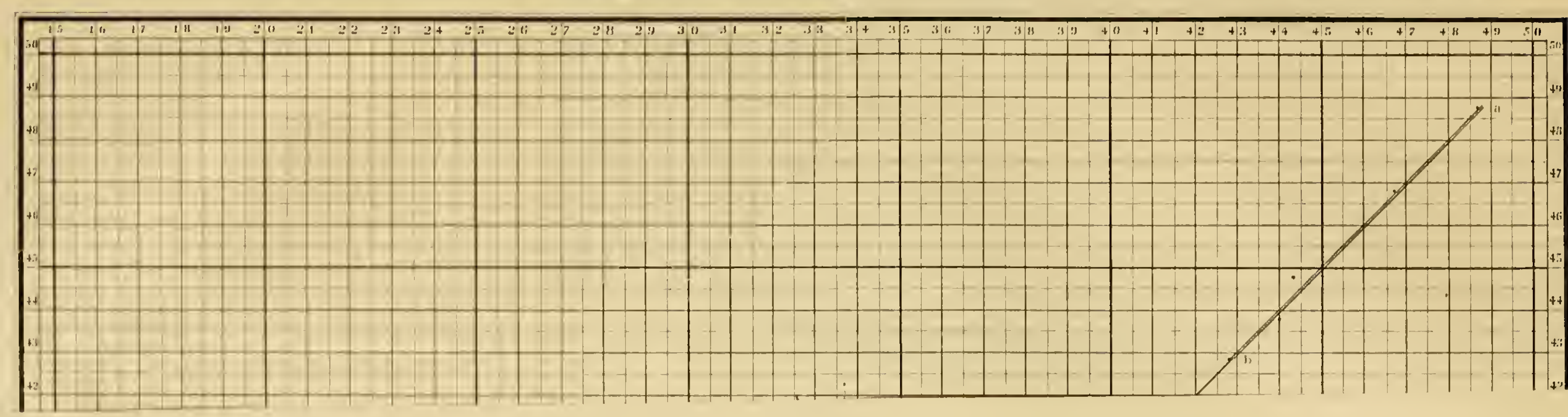
have that definiteness of character which is claimed for those of the chemical law. The planetary orbits are not perfect ellipses. The ratios of the harmonic scale are but approximatively realized. The arrangement of leaves on the stem is not perfectly regular. Isomorphism is seldom absolute. In all we observe only a tendency towards a maximum effect, which is the perfect expression of the law, but which is rarely fully reached. The limits of variation are broader in some instances than in others, but we find no case in which there is absolutely none. This same character, which pervades the other phenomenal laws of nature, I claim for the great law of Chemistry. The definite proportion I regard as a maximum towards which the chemical force strives, a maximum from which the deviations in most cases are small, although in others they may be very large; and I maintain that this view of the subject, which the memoir has aimed to establish, is supported by the analogies of nature.

When the dynamical law has been discovered, of which the phenomenal law was merely the outward manifestation, as Kepler's laws were merely the phenomena of the law of universal gravitation, the very variations have been seen to be necessary consequences of the law itself; and if ever the dynamical law which governs chemical phenomena shall be discovered, it is most probable that the variations from the law of definite proportions will become as much a matter of calculation as the perturbations of astronomy. In both cases the perturbation is apparently due to the influence of an extraneous mass of matter.

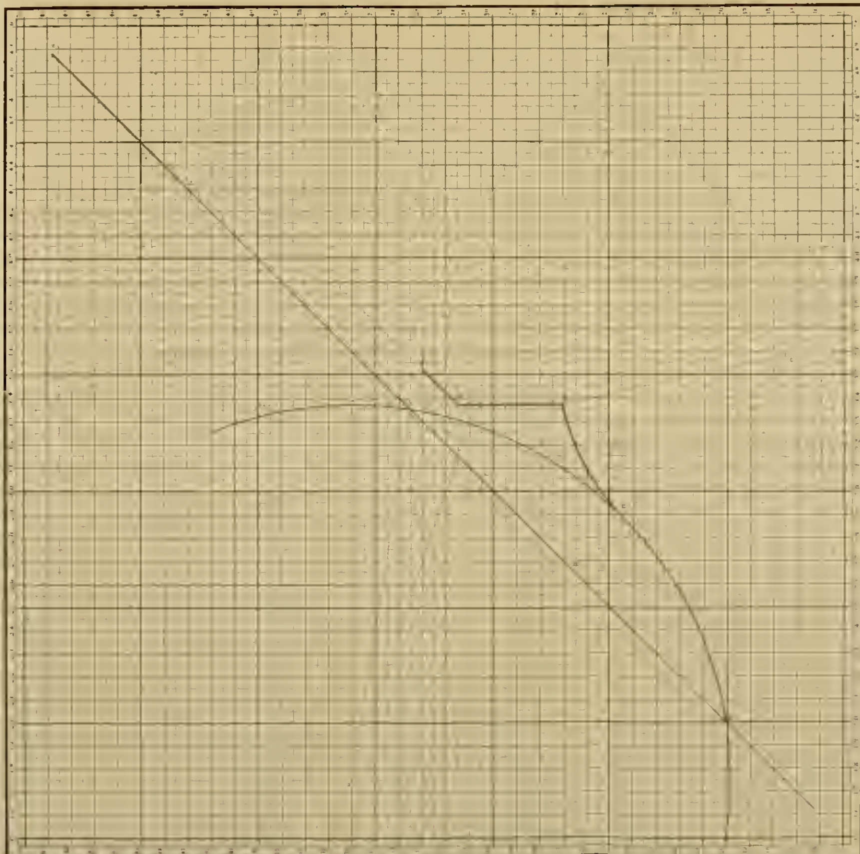
The argument from analogy becomes stronger when we consider the equivalent numbers. I have shown in a former memoir,* that these numbers may be connected by a very simple numerical law; but here, as in other cases, we find merely a tendency towards the law, not an absolute agreement with it, the differences between the theoretical and the experimental equivalents being in many cases too great to be covered by errors of observation. The present memoir may throw light upon these discrepancies; for, to say the least, it is possible that the differences may originate in variations of the equivalent itself, and that the theoretical equivalent may be the maximum towards which the chemical force tends. On comparing carefully the different determinations of the chemical equivalents, many facts will be noticed supporting this view; those equivalents, for example, which coincide with, or very nearly approach, whole numbers, such as those of oxygen, carbon, and sulphur, will be found as a general rule to have been determined by the analysis or synthesis of compounds whose elements are united by a strong chemical force; also, when the equivalents have been determined by essentially

* This volume, page 235.

CURVE EXHIBITING THE VARIATION IN COMPOSITION OF THE CRYSTALS FORMED IN THE ALLOYS OF ZINC AND ANTIMONY.



CURVE EXHIBITING THE VARIATION IN COMPOSITION OF THE CRYSTALS FORMED IN THE ALLOYS OF ZINC AND ANTIMONY



Per Cents of Zinc found by Analysis in the Crystals

Per Cents of Zinc in the melted Alloys in which the Crystals were formed different processes, it will be noticed that they seldom perfectly agree; so that, whatever view may be taken of the subject, it will now become a matter of the highest importance to ascertain how far, if at all, the determinations of the chemical equivalents have been influenced by similar causes to those which have produced the variations described in this memoir. This influence can only be detected by multiplying the determinations by as many different processes as possible, and submitting the results to a rigorous mathematical scrutiny.

If the doctrine of this memoir is correct, and the chemical equivalents are really liable to variation, it will have an important influence on chemical philosophy. The atomic theory, as at present interpreted by chemists, is irreconcilable with it, and our present ideas in regard to isomorphism must be materially changed. But it must be remembered, that the conclusions of the memoir are drawn from the examination of only two compounds, and therefore that it would be premature to dwell on these obvious consequences of the principle until it has been substantiated by further investigations. In conclusion, I would express my obligation to the gentlemen who have assisted me in the labor of the investigation, which, on account of the large number of analyses, has been very great, and could not have been concluded so soon had it not been for their very great industry and zeal.

Cambridge, July 20th, 1855.

XVI.

Discussion of Observations for the Isodynamic, Isogonic, and Isoclinal Curves of Terrestrial Magnetism on and near the Line of the Boundary Survey between the United States and Mexico, made in 1849, 1850, 1851, *and* 1852, *under the Orders of*

W. H. EMORY,

ASTRONOMER OF THE BOUNDARY COMMISSION,

And combined with Observations at San Francisco (California), and Dollar Point (East Base), and Jupiter (Texas), furnished by

A. D. BACHE,

SUPERINTENDENT OF THE UNITED STATES COAST SURVEY.

With a Map.

(*Communicated to the Academy, February* 13*th*, 1855, *by W. C. Bond, Director of the Observatory of Harvard College.*)

The magnetic elements contained in this paper have been obtained with a Fox Dip-Circle, — the same which was used by Major Emory for the observations published in Volume V. of the Memoirs of the Academy.

The values of total intensity are expressed in units of the intensity at Falmouth, England. To reduce them to the arbitrary standard commonly adopted, they should be multiplied by the coefficient 1.374. As observations of this element with Mr. Fox's apparatus are liable to be affected by changes in the magnetic condition of the needles, it would be desirable to know to what extent such changes may have taken place. The successive comparisons, between 1844 and 1854, which have been made at Cambridge, with the instrument used by Major Emory, furnish the data for estimating their amount. If it be allowable to assume that there has been no sensible secular change of total intensity at Cambridge since 1842, at which time its value by direct determination was 1.777 in units of the common scale, there would be a correction of $+ 0.002 \times 1.374$ to be applied yearly, for the interval elapsed since 1844, to the intensity derived from this instrument by using the weights, and of $- 0.005 \times 1.374$, when the deflectors are employed.

In the manuscript copy of the observations received from Major Emory, the particulars respecting the mannner of making the observations have not been given. It can only be assumed that the mean of the above corrections, $= - 0.0015 \times 1.374 \times (1851 - 1844) = - 0.014$, is to be applied to all the total intensities, (reduced to the common scale,) contained in the present paper.

In projecting the lines of equal variation, dip, and total intensity, as represented upon the accompanying map, no attempt has been made to consider the *curvature* of the lines. A complete determination of this element will best be made by combining the results here presented with others from points lying at some distance from the line of the survey.

The accompanying tables contain the principal steps of the reductions furnished by Major Emory, agreeably to the following formula. In constructing the lines upon the map, however, a different combination has been employed.

FORMULÆ

for computing, theoretically, the Variations in the Magnetic Declination, Intensity, or Dip, due to Changes in the Latitude and Longitude.

[From the Fifth Report of the British Association for the Advancement of Science, 1835.]

$$x \Sigma\, d\, L^2 + y \Sigma\, d\, L \,.\, d\, M = \Sigma\, d\, L \,.\, d\, [V, I \text{ or } D]$$
$$x \Sigma\, d\, L \,.\, d\, M + y \Sigma\, d\, M^2 = \Sigma\, d\, M \,.\, d\, [V, I \text{ or } D],$$

in which

$x =$ variation of the magnetic element in Latitude.
$y =$ " " " " in Longitude.
$d\, L =$ difference of Latitude, from the origin.
$d\, M =$ " Longitude, "
$d\, V =$ " Declination, "
$d\, I =$ " Intensity, "
$d\, D =$ " Dip, "

$\frac{x}{y} =$ tang. Z; Z being the angle made with the meridian by the line passing through all the points of equal declination, intensity, or dip.

Isodynamic Observations.

Station.	Date.	Inst.	Weight.	Intensity.	Latitude.	Longitude.
Panama, . . .	April 2, 1849,	Fox Dip,	2 grains,	0.87766	N. 8° 57′ 12″.15	W. 79° 29′ 24″.5
"	" " "	"	3 "	0.87573		
San Francisco, .	Mar. 12, 1852,	"	2 "	1.1712	37 46 53	122 27 30
"	" " "	"	3 "	1.1563		
Sta. Maria, . .	Sept. 15, 1849,	"	2 "	1.1490		
"	" " "	"	3 "	1.1635		
Colorado Desert,	Dec. 22, 1851,	"	2 "	1.1284	32 43 43	114 36 45
" "	" " "	"	3 "	1.1244		
Rio Gila, near Junction of Colorado,	Dec. 16, 1851,	"	2 "	1.1367	32 43 32.3	114 32 51.6
Station 38, . .	Dec. 9, 1851,	"	2 "	1.1457	32 59 49.1	112 36 58.2
" "	" " "	"	3 "	1.1384		
Station 31, . .	Nov. 22, 1851,	"	2 "	1.1528	33 10 14.7	111 54 13.6
" "	" " "	"	3 "	1.1486		
Pimo Villages, .	Nov. 20, 1851,	"	2 "	1.1409	33 9 4.4	110 44 25.6
" "	" " "	"	3 "	1.1452		
San Pedro, . .	Sept. 9, 1851,	"	2 "	1.1467	32 59 6.8	110 39 34.8
" "	" " "	"	3 "	1.1411		
Copper Mines, .	Aug. 18, 1851,	"	2 "	1.1686	32 47 53.1	108 4 26.2
" "	" " "	"	3 "	1.1592		
Doña Ana, . . .	Aug. 23, 1851,	"	2 "	1.1747	32 22 0	106 47 34.8

(No. 1.)

Station.	L.	M.	I.	d L.	d M.	d I.	d L².	d M².	d L. d M.	d L. d I.	d M. d I.
San Francisco,	37° 46′	122° 27′	1.163	+3° 56′	−6° 15′	+0.019	+55696	+140625	− 88500	+4.484	−7.125
Sta. Maria,	33 2	116 51	1.156	−0 48	−0 39	+0.012	+ 2304	+ 1521	+ 1872	−0.576	−0.468
Colorado Des't,	32 43	114 36	1.126	−1 7	+1 36	−0.018	+ 4489	+ 9216	− 6432	+1.206	−1.728
Near Mouth of Gila,	32 43	114 33	1.136	−1 7	+1 39	−0.008	+ 4489	+ 9801	− 6633	+0.536	−0.792
Station 38,	32 59	112 36	1.141	−0 51	+3 36	−0.003	+ 2601	+ 46656	− 11016	+0.153	−0.648
	33 51	116 12	1.144				+69579	+207819	−110709	+5.803	−10.761

(No. 2.)

Station.	L.	M.	I.	d L.	d M.	d I.	d L².	d M².	d L. d M.	d L. d I.	d M. d I.
Station 31,	33° 10′	111° 54′	1.150	+17′	−2° 5′	−0.005	+ 289	+12625	− 2125	−0.085	+0.625
Pimo Villages,	33 7	111 44	1.143	+14	−1 55	−0.012	+ 196	+30625	− 2450	−0.168	+1.380
Rio San Pedro,	32 59	110 39	1.143	+ 6	−0 50	−0.012	+ 36	+ 2500	− 300	−0.072	+0.600
Copper Mines,	32 47	108 4	1.164	− 6	+1 45	+0.009	+ 36	+11025	− 630	−0.054	+0.945
Doña Ana,	32 22	106 47	1.174	−31	+3 2	+0.019	+ 961	+33124	− 5642	−0.589	+3.458
	32 53	109 49	1.155		3	1	+1518	+92899	−11147	−0.968	+7.008

Isoclinal Observations.

(No. 1.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
S. Francisco,	37° 46′	122° 27′	62° 32′	+3° 0′	−4° 2′	+2° 15′	+ 32400	+ 58564	− 43560	+ 24200	− 32670
Sacramento,	38 34	121 17	64 3	+3 48	−2 52	+3 46	+ 51984	+ 29584	− 39216	+ 51528	− 38672
San Diego,	32 42	117 8	57 33	−2 4	+1 17	−2 44	+ 15376	+ 5929	− 9548	+ 20336	− 12628
S. Isabella,	33 8	116 41	58 48	−1 38	+1 44	−1 29	+ 9604	+ 10816	− 10192	+ 8722	− 9256
Mouth of Rio Gila,	32 43	114 33	58 30	−2 3	+3 52	−1 47	+ 15129	+ 53824	− 28546	+ 13161	− 24824
	34 46	118 25	60 17	3	1	1	+124493	+158717	−131062	+117947	−118050

$x = 1.257$ log. $= 0.099335$

$y = 0.295$ " $= \bar{1}.469822$

tang $Z = 0.629513$ $Z = 76° \ 47'$

(No. 2.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
XLV.	32° 41′	114° 5′	58° 24′	−10′	−33′	−30′	+100′	+1089′	+330′	+ 300′	+ 990′
XLIV.	32 44	113 50	58 30	− 7	−18	−24	+ 49	+ 324	+126	+ 168	+ 432
XLIII.	32 49	113 33	58 43	− 2	− 1	−11	+ 4	+ 1	+ 2	+ 22	+ 11
XLII.	32 59	113 11	59 16	+ 8	+21	+22	+ 64	+ 441	+168	+ 176	+ 462
XLI.	33 1	113 2	59 36	+10	+30	+42	+100	+ 900	+300	+ 420	+1260
	32 51	113 32	58 54	1		1	+317	+2755	+926	+1086	+3155

$x = 2.426$ log. $= 0.384353$

$y = -0.343$ " $= \bar{1}.535294$

tang $Z = 0.749059$ $Z = 79° \ 53'$

(No. 3.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
XL.	33° 2′	112° 51′	59° 15′	− 2′	−27′	+ 6′	+ 4′	+729′	+ 54′	− 12′	−162′
XXXIX.	32 59	112 42	58 49	− 5	−18	−20	+25	+324	+ 90	+100	+360
XXXVIII.	33 0	112 37	58 53	− 4	−13	−16	+16	+169	+ 52	+ 64	+208
XXXII.	33 9	111 57	59 22	+ 5	+27	+13	+25	+729	+135	+ 65	+351
XXXI.	33 10	111 54	59 28	+ 6	+30	+19	+36	+900	+180	+114	+570
	33 4	112 24	59 9								

$x = 1.265$ log. $= 0.102091$

$y = 0.418$ " $= \bar{1}.621176$

tang $Z = 0.480915$ $Z = 74° \ 42'$

(No. 4.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
XXX.	33 7	111 44	59 6	+4	−21	− 8	+16	+ 441	−84	−32	+168
XXIX.	33 3	111 33	59 6	0	−10	− 8		+ 100			+ 80
XXVIII.	33 0	111 23	59 16	−3	0	+ 2	+ 9			− 6	
XXVII.	33 2	111 16	59 19	−1	+ 7	+ 5	+ 1	+ 49	− 7	− 5	+ 35
XXVI.	33 4	111 2	59 24	+1	+21	+10	+ 1	+ 441	+21	+10	+210
	33 3	111 23	59 14	1	3	1	27	+1031	−70	−33	+493

$x = 2.424$ log. $= 0.384533$

$y = 0.478$ " $= \bar{1}.679428$

tang $Z = \overline{0.705105}$ $Z = 78° \ 50'$

(No. 5.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
XXIV.	33 6	111 2	59 19	+3	−12	+ 6	+ 9	+144	−36	+18	− 72
XXIII.	33 6	110 55	59 23	+3	− 5	+10	+ 9	+ 25	−15	+30	− 50
XXII.	33 5	110 49	59 13	+2	+ 1	0	+ 4	+ 1	+ 2		
XXI.	33 2	110 46	58 59	−1	+ 4	−14	+ 1	+ 16	− 4	+14	− 56
XX.	32 59	110 39	59 10	−4	+11	− 3	+16	+121	−44	+12	− 33
	23 3	110 50	59 13	3	1	1	+39	+307	−97	+74	−211

(No. 6.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L d M.	d L. d D.	d M. d D.
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
XIX.	33 4	110 35	59 4	−4	+1	−20	+16	+ 1	− 4	+80	− 20
XVIII.	33 8	110 44	60 8	0	−8	+44		+ 64			−352
XVII.	33 12	110 42	59 23	+4	−6	− 1	+16	+ 36	−24	− 4	+ 6
XV.	33 9	110 31	59 27	+1	+5	+ 3	+ 1	+ 25	+ 5	+ 3	+ 15
XIII.	33 9	110 28	58 57	+1	+8	−27	+ 1	+ 64	+ 8	−27	−216
	33 8	110 36	59 24				+34	+190	−15	+52	−567

(No. 7.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
	° ′	° ′	° ′	′	° ′	′	′	′	′	′	′
Santa Vita del Cobre,	32 47	108 4	59 17	+36	−1 3	+10	+1296	+3969	−2621	+360	− 730
IX. on Line,	32 22	107 24	59 9	+11	− 23	+ 2	+ 121	+ 529	− 253	+ 22	− 46
Doña Ana,	32 22	106 47	59 6	+11	+ 14	− 1	+ 121	+ 196	+ 154	− 11	− 14
Frontera,	31 48	106 33	59 5	−23	+ 28	− 2	+ 529	+ 784	− 664	+ 46	− 56
S. Elciario,	31 35	106 16	58 57	−36	+ 45	−10	+1296	+2025	−1620	+360	− 450
	32 11	107 1	59 7	1	1	1	+3363	+7503	−5004	+777	−1296

(No. 8.)

Station.	L.	M.	Inc.	d L.	d M.	d D.	d L².	d M².	d L. d M.	d L. d D.	d M. d D.
	° ′	° ′	° ′	° ′	° ′	° ′	′	′	′	′	′
Mouth of Cañon,	31 2	105 37	57 38	+2 51	—4 33	+3 0	+29241	+ 74529	— 46681	+30780	— 49140
Presidio del Norte,	29 34	104 25	55 41	+1 23	—3 21	+1 3	+ 6889	+ 40401	— 16683	+ 5229	— 13230
Ft. Duncan,	28 42	100 30	55 31	+0 31	+0 34	+0 53	+ 961	+ 1156	+ 1054	+ 1643	+ 1802
Ft. McIntosh,	27 30	100 5	54 7	—0 41	+0 59	—0 31	+ 1681	+ 3481	— 2419	+ 1271	— 1829
Ringgold Barracks,	26 23	98 43	52 27	—1 48	+2 21	—2 11	+11664	+ 19881	— 15228	+14148	— 18471
Mouth of Rio Grande,	25 57	97 7	52 23	—2 14	+3 57	—2 15	+17956	+ 56169	— 31858	+18090	— 31995
	28 11	101 4	54 38	2	3	1	+68392	+195617	—111815	+71161	—112863

$x = 1.485$ log. $= 0.171726$

$y = 0.271$ " $= \bar{1}.432969$

tang $Z = \overline{0.738757}$ $Z = 79° \ 39'$

Isogonic Observations.

(No. 1.)

Station.	L.	M.	Var. E.	d L.	d M.	d V.	d L².	d M².	d L. d M.	d L. d V.	d M. d V.
	° ′	° ′	° ′	° ′	° ′	° ′	′	′	′	′	′
San Francisco,	37 46	122 27	15 37	+4 6	—5 50	+2 16	+60516	+122500	+86100	+33456	—47600
San Diego,	32 42	117 12	13 15	—0 58	—0 35	—0 6	+ 3364	+ 1225	+ 2030	+ 348	+ 210
Camp Riley,	32 35	117 5	12 57	—1 5	—0 28	—0 24	+ 4225	+ 784	+ 1820	+ 1560	+ 672
San Isabel,	33 7	116 41	12 34	—0 33	—0 4	—0 47	+ 1089	+ 16	+ 132	+ 1551	+ 188
Mouth of Rio Gila,	32 43	114 33	12 50	—0 57	+2 4	—0 31	+ 3249	+ 15376	— 7068	+ 1767	— 3844
Pimo Villages,	33 7	111 44	12 52	—0 33	+4 53	—0 29	+ 1089	+ 85849	— 9669	+ 957	— 9669
Mean,	33 40	116 37	13 21				+73532	+225750	—98855	+39693	—60043

$x = +0.442$

$y = -0.072$

(No. 2.)

Station.	L.	M.	Var. E.	d L.	d M.	d V.	d L².	d M².	d L. d M.	d L. d V.	d M. d V.
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
Pimo Villages,	33 7	111 44	12 52	+ 70	—217	+57	+ 4900	+ 47089	—15190	+ 3990	—12369
San Pedro,	32 59	110 40	12 25	+ 62	—183	+30	+ 3844	+ 33489	—11346	+ 1860	— 5490
Cobre Mines,	32 47	108 4	11 22	+ 50	— 27	—33	+ 2500	+ 729	— 1350	— 1650	+ 891
Doña Ana,	32 22	106 47	12 7	+ 25	+ 50	+15	+ 625	+ 2500	+ 1250	+ 375	+ 750
Frontera,	31 48	106 33	12 24	— 9	+ 64	+29	+ 81	+ 4096	— 576	— 261	+ 1856
Mouth of Cañon,	31 2	105 37	12 1	— 55	+120	+ 6	+ 3025	+ 14400	— 6600	— 330	+ 720
Pres. del Norte,	29 34	104 24	10 16	—143	+193	—99	+20449	+ 37249	—27599	+14157	—19107
Mean,	31 57	107 37	11 55				+35424	+139552	—61411	+18141	—32749

$x = +0.444$

$y = -0.039$

(No. 3.)

Station.	*L.*	*M.*	Var. *E.*	*d L.*	*d M.*	*d V.*	*d L*².	*d M*².	*d L. d M.*	*d L. d V.*	*d M. d V.*
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
Pres. del Norte,	29 34	104 24	10 16	+117	—254	+34	+13689	+ 64516	—29718	+ 3978	— 8636
Eagle Pass,	28 42	100 30	10 1	+ 65	— 20	+19	+ 4225	+ 400	— 1300	+ 1235	— 380
Ft. McIntosh,	27 30	100 5	10 0	— 7	+ 5	+18	+ 49	+ 25	— 35	— 126	+ 90
Ringgold Barracks,	26 23	98 43	9 15	— 74	+ 87	—27	+ 5476	+ 7569	— 6438	+ 1998	— 2349
Mouth of Rio Grande,	25 57	97 7	9 0	—100	+183	—42	+10000	+ 33489	—18300	+ 4200	— 7686
Mean,	27 37	100 10	9 42				+33439	+105999	—55791	+11285	—18961

$$x = +0.317$$

$$y = -0.012$$

(No. 4.)

Station.	*L.*	*M.*	Var. *E.*	*d L.*	*d M.*	*d V.*	*d L*².	*d M*².	*d L. d M.*	*d L. d V.*	*d M. d V.*
	° ′	° ′	° ′	′	′	′	′	′	′	′	′
Ft. McIntosh,	27 30	100 5	10 0	— 24	—194.5	+46	+ 576	+37830	+ 4668	—1104	— 8947
Ringgold Barracks,	26 23	98 43	9 15	— 91	—112.5	+ 1	+ 8281	+12656	+10237	— 91	— 112
Mouth of Rio Grande,	25 57	97 7	9 0	—117	— 16.5	—14	—13689	+ 272	+ 1930	+1638	+ 231
Dollar Point,	29 26	94 53	8 57	+ 92	+117.5	—17	+ 8464	+13806	+10810	—1564	— 1997
East Base,	29 13	94 55	9 5	+ 79	+115.5	— 9	+ 6241	+13340	+ 9124	— 711	— 1039
Jupiter,	28 55	95 20	9 9	+ 61	+ 90.5	— 5	+ 3721	+ 8190	+ 5520	— 305	— 452
Mean,	27 54	96 50	59 14				+40972	+86094	+42289	—2137	—12316

$$x = +0.193$$

$$y = -0.283$$


CALIFORNIA
NEW MEXICO
TEXAS
MEXICO
PACIFIC OCEAN
GULF OF CALIFORNIA
GULF OF MEXICO
SCALE OF MILES.
Rio Colorado
Rio Gila
Rio Pecos
Rio Bravo del Norte
R. Conchos
Los Angeles
San Diego
Monterey
Paso del Norte
Presidio del Norte
Ft. Duncan
Laredo
Palatos
S. Ygnacio
Ringold
Rio Grande Barracks
Dip 60°.00'
Dip 59°.00'
Dip 58°.00'
Dip 57°.00'
Dip 56°.00'
Dip 55°.00'
Dip 54°.00'
Dip 53°.00'
Var. 13°.00' E
Var. 12°.00' E
Var. 12°.00'
Var. 10°.00'
Var. 9°.00'

XVII.

Descriptions of New Species of Fossils, from the Cretaceous Formations of Nebraska, with Observations upon Baculites ovatus *and* B. compressus, *and the Progressive Development of the Septa in Baculites, Ammonites, and Scaphites.*

By JAMES HALL and F. B. MEEK.

(*Communicated June* 27, 1854.)

The collections which have furnished the following new species from the cretaceous formation of the Upper Missouri, were made in the summer of 1853, by Mr. F. B. Meek and F. V. Hayden. The collection of Mammalian remains from the Tertiary period has been placed at the disposal of Professor Leidy, for his forthcoming new memoir upon the fossil remains of that region.

Callianassa Danai, *n. sp.* (Fragment.)

Plate I. Fig. 1, *a*, *b*.

Exterior surface convex, inner surface flat, upper and lower edges obtusely angular; fingers nearly as long as the hand; upper one nearly triangular in section and depressed above near its articulation, and marked along its upper edge at regular intervals by four small foramina, outer side depressed above the middle and towards the lower margin, and marked by two large foramina, dividing the whole into three nearly equal spaces; upper angle obtuse, lower edge sharp and smooth, arcuate from the apex back a little more than half the distance to the base, from which point it curves again towards the articulating extremity, leaving the widest part near the middle. Lower finger narrower than the upper, equal in length, bending slightly downwards from the hand, and thence gradually curving upwards to the extremity, marked on the upper slope of the outer angle by two foramina, one near the base and one near the centre. Section sub-triangular, centre of the outer side forming an obtuse angle, the lower edge more acute, the inner side flat, and the upper edge acute, and finely denticulated near the hand, gradually becoming less prominent and finally obsolete on the outer half of the edge. Surface smooth and polished, showing no external marks, but, through the translucent shell, a kind of reticulation, owing to inequalities beneath.

Locality and Position. — Great Bend of the Missouri. Lower part of division No. 4 of Section.

LINGULA SUBSPATULATA, *n. sp.*

PLATE I. FIG. 2, *a*, *b*.

Shell sub-elliptical, margins regularly curved above, straight or little contracted below the centre; base sub-truncate; surface marked by faint concentric striæ, and a few strong wrinkles parellel with the lateral margins. Viseral impression trifoliate.

The only specimen we have is imperfect, and the shell is preserved only on the margins. It has nearly the proportions of *Lingula Rouliniana*, (D'Orbigny, *Pal. Française*, *Terrains Crétacés*, Brach. p. 10, pl. 490, fig. 1,) but differs in having its greatest width above the middle, while in the European species the greatest width is below the middle. Our species is also more abruptly rounded or sub-truncate at the base. The surface markings are similar.

Locality and Position. — Near Red Cedar Island, thirty-five miles below Fort Pierre. Division No. 4 of Section.

CAPRINELLA CORALOIDEA,. *n. sp.*

PLATE II. FIG. 3, *a–f*.

Our specimen is a portion of the larger valve extending about two and a half inches from the apex, and partially invested with the thick, fibrous shell. From this is drawn the following description.

Inferior valve spiral, rapidly increasing from the apex towards the aperture; when divested of the outer fibrous shell, the internal septate part is seen to be spirally curved, and rapidly increasing in size; a longitudinal groove or depression extends from the apex along the back of the curve to the larger extremity, crossed by numerous irregular septa, which pass from the inner side outwards and upwards.

This interior septate portion is enveloped in a thick, fibrous shell, which, in the imperfect specimen, is much thicker on the inner than on the outer side of the volution; fibres longitudinal, consisting of four or six angled, more or less flattened prisms, which are crossed at regular intervals of less than their diameter by septa or diaphragms, and externally marked by fine transverse striæ, the whole presenting an appearance like a small columnar Favosite or Chætetes.

This specimen differs from the species figured by D'Orbigny, in being curved not exactly in the same plane, in increasing much more rapidly in size from the apex, and in having the fibrous portion of the shell so thick upon the inner side of the volution as to bring the sides in contact if continued a single turn. The septa are also much more irregular than in the European species, those which are distinct upon the back of the shell often converging so that two unite in a single one on the inner side of the volution.

The differences noticed suggest an inquiry whether the generic description of Caprinella should be modified; since it seems impossible that a shell of this character, from its extreme thickness on the inner side, and from its rapidly increasing size, could have formed several volutions. An examination of more perfect specimens will probably show the necessity of such modification, or the establishment of a new genus.

Locality and Position. — Sage Creek, Nebraska. Upper part of division No. 4 of Section.

PECTEN RIGIDA, *n. sp.*

PLATE II. FIG. 4, *a*, *b*, *c*.

Shell obovate, height greater than length, very gradually narrowing towards the hinge; valves equally convex; hinge line short; wings minute, nearly equal, anterior one truncate, posterior one pointed, striated upon the surface; left or inferior valve marked by strong, concentric undulations; superior valve smooth, or marked in the exfoliated shell by faint radiating striæ. Length, .19 inch; height, .23 inch.

The strong concentric undulations of the inferior valve are likewise conspicuous on the cast, and are there crossed by radiating striæ. The superior valve, which has the shell partially exfoliated, shows only faint radiating striæ without concentric undulations as in the other valve. Perfect specimens may perhaps show other markings on the superior valve not visible in these.

Locality and Position. — Sage Creek, Nebraska. Upper part of division No. 4 of Cretaceous Strata.

Avicula Haydeni, *n. sp.*

Plate I. Fig. 5, *a*, *b*.

Shell small, sub-rhomboidal, oblique; beak small, pointed, slightly elevated above the hinge line; hinge line straight, less than the length of the shell, and pointed at the posterior extremity, anterior extremity short, rounded; posterior margin obliquely truncate; no line of demarcation between the wing and body of the shell; basal margin forming a regular elliptic curve; surface marked by sharp strong ribs, with sometimes an intermediate smaller one, crossed by faint concentric undulations and parallel fine lines of growth. Length, .3 inch; height, .22 inch; hinge line making an angle with the posterior slope of about 129°.

All the specimens we have seen are of the left valve only. The shell is extremely thin and fragile, and preserved only upon portions of one of our specimens. Some individuals show a depressed line along the hinge margin.

Locality and Position. — On the Missouri, near Red Cedar Island, twenty-five miles below Fort Pierre. From division No. 4 of Section.

Lucina subundata.

Plate I. Fig. 6, *a*, *b*.

Shell sub-orbicular; length a little greater than height; beak little elevated, sub-central or nearer the posterior side; anterior margin broadly rounded, posterior one sloping from the beak and rounded below; surface with concentric undulations and finer parallel lines, crossed by very minute radiating striæ. Length, .4 inch; height, .36 inch; width, .2 inch.

This shell bears some general resemblance to *L. cornuelana* of D'Orbigny, (*Terrains Crétacés*, p. 116, pl. 281, fig. 3,) but the beaks are much less elevated, the anterior end much broader, and the concentric undulations larger and less uniform. This species strikingly possesses the characters of the genus Lucina, and may readily be distinguished among the smaller bivalves from this region.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

Cytherea orbiculata, *n. sp.*

Plate I. Fig. 7.

Shell thick, sub-orbicular; beak moderately elevated and near the anterior side;

posterior margin regularly rounded; surface marked by fine equal concentric lines. Length, .18 inch; height, 1 inch; width, .66 inch.

The form is neatly rounded throughout, the umbones curving gently towards the antero-cardinal margin. Our specimens of this shell are all imperfect.

Locality and Position. — On the Missouri, five miles below James River. Calcareous beds of the base of division No. 2 of Section.

Cytherea tenuis, *n. sp.*

Plate I. Fig. 8, *a*, *b*, *c*.

Shell thin, ovate-orbicular, length and height nearly equal; beak elevated, nearly central; anterior and posterior extremities rounded, the latter somewhat broader; surface marked by concentric undulations and fine parallel striæ. Length, .4 inch; height, .36 inch.

This is a fragile shell with beaks more nearly central than the preceding species. It is much more delicate than any shell of this family which has been found in the cretaceous formation of this region.

Both this and the preceding species are referred to the genus Cytherea from external form, no opportunity having offered of examining the hinge.

Locality and Position. — Same as preceding.

Crassatella Evansii, *n. sp.*

Plate I. Fig. 9, *a*–*e*.

Shell obliquely ovoid (varying somewhat in form), ventricose; beaks much elevated; anterior margin short, rounded below; postero-cardinal margin sloping abruptly downwards, the extremity sub-truncate; basal margin distinctly and neatly crenulated on the interior; escutcheon broad lanceolate, well defined; lunule distinct, but margins not strongly defined; surface somewhat undulated, marked by fine irregular striæ or lines of growth; muscular impressions strongly marked.

This shell is probably identical with the imperfect cast figured by Dr. D. D. Owen in his Report, Pl. 7, fig. 9, as a *Pectunculus.* Our specimens showing the interior of the hinge, muscular impressions, etc., are from the same position in the series, and from the same district of country. The shell is a well-marked *Crassatella*, presenting all the ordinary characteristics of the genus, in the cardinal and muscular characters. It is abundant, occurring entire and in the condition of casts. The species may be readily distinguished by its oblique form and extended beaks, its ventricose character, and the fibrous or striated structure of the interior, produced by exfoliation. It occurs more commonly in the septaria, which furnish only casts, the shell adhering to the rock on breaking, while the entire specimens are only obtained from the clay. Length, 1.4 inches; height, .97 inch; width, .70 inch.

Locality and Position. — Sage Creek, in the upper part of division No. 2 of Section.

Pectunculus Siouxensis, *n. sp.*

Plate I. Fig. 12.

Shell sub-orbicular (in the cast); beaks elevated, nearly central; longer than high, nearly convex; anterior margin regularly rounded; posterior margin somewhat obliquely sub-truncated; basal margin without crenulations; cardinal margin curved and marked by fine dividing crenulations; posterior muscular impression strong.

The specimen described is a cast preserving the form of the shell, and showing very distinctly the crenulations of the cardinal margin. The external markings of the shell are unknown.

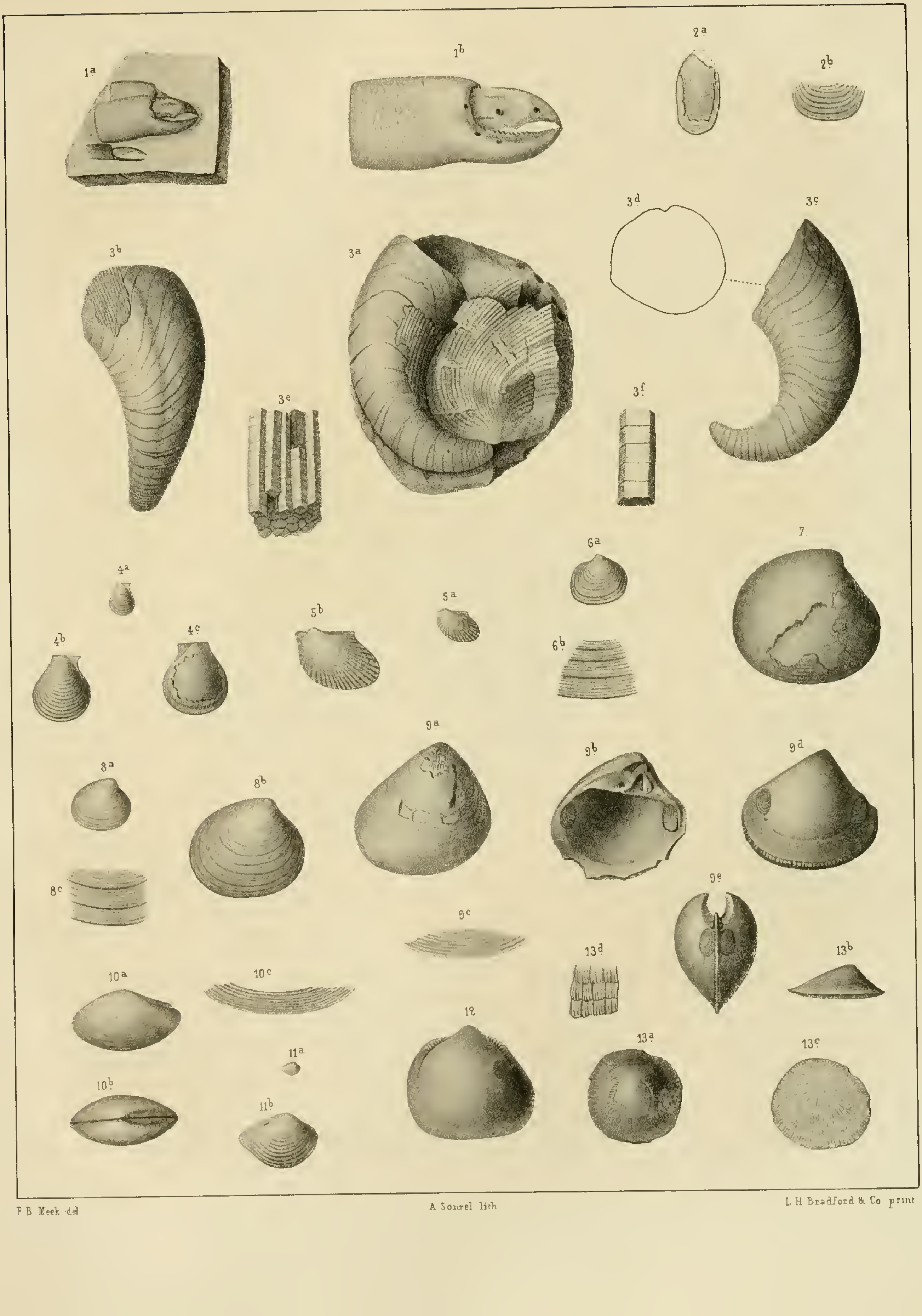
Locality and Position. — Mouth of Big Sioux, on the Missouri River, in a ferruginous sandstone. Division No. 1 of Section.

Nucula subnasuta, *n. sp.*

Plate I. Fig. 10, *a*, *b*, *c*.

Shell sub-elliptical, contracted towards the posterior extremity, somewhat ventricose in the middle; a shallow groove or depression extending obliquely from the beak to the base of the shell, where it produces a slight indentation in the regular elliptic curve of the basal margin; escutcheon margined by a broad shallow groove, extending from near the beak, and causing a faint emargination near the posterior extremity above; beaks nearly central, small and incurved; shell marked by faint striæ or lines of growth, and a few broader concentric undulations which give a scarcely perceptible inequality to the surface; crenulations of the hinge line very fine. Length, .78 inch; height, .45 inch; width, .36 inch.

This neat little shell is sufficiently well marked to be readily distinguished, particularly by the slight impression on the edges of the shell above and below near the posterior extremity. The crenulations are fine and slender; and in one specimen the erosion of the shell exhibits the crenulated edge of a former hinge line, at some dis-



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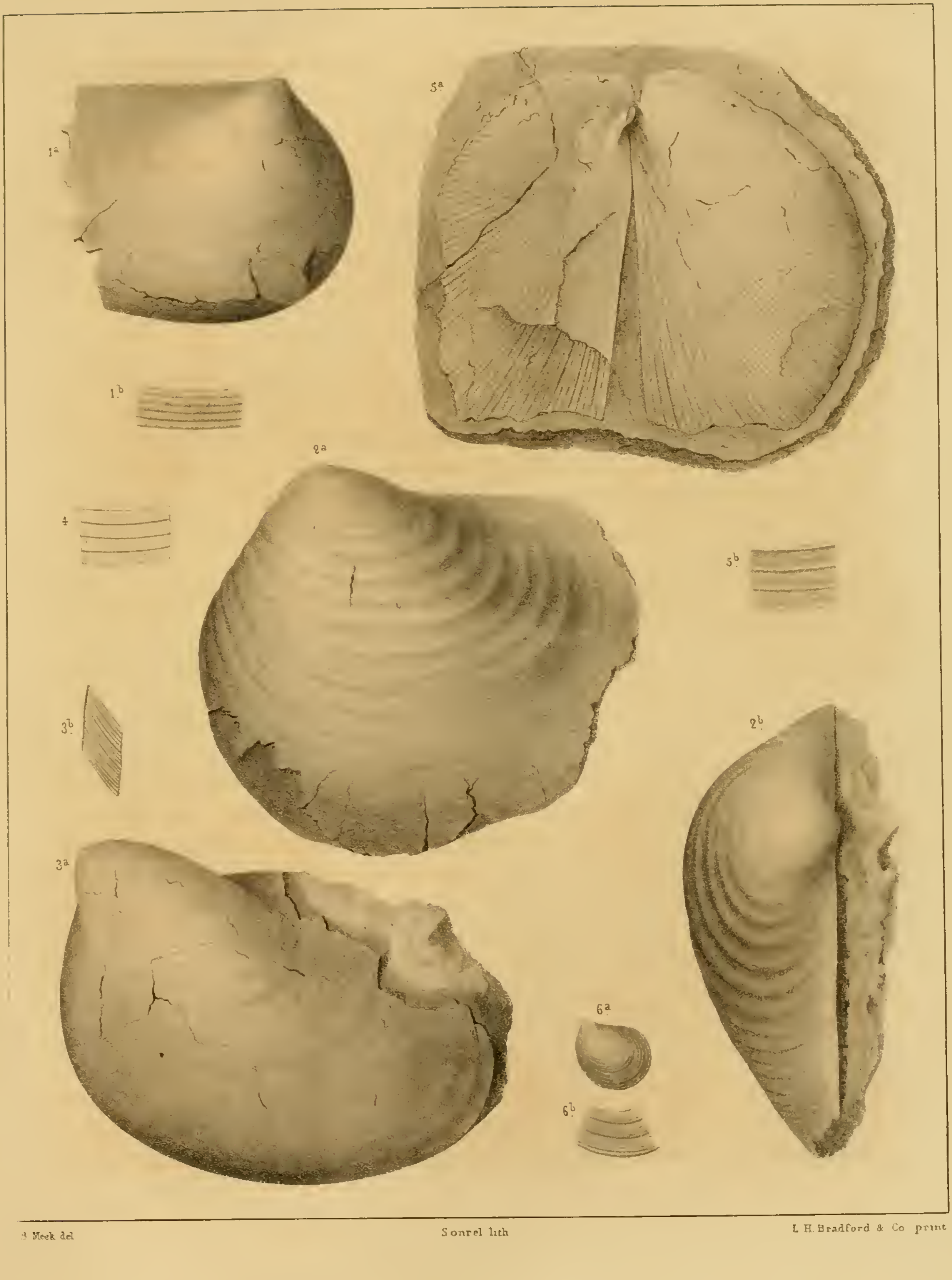

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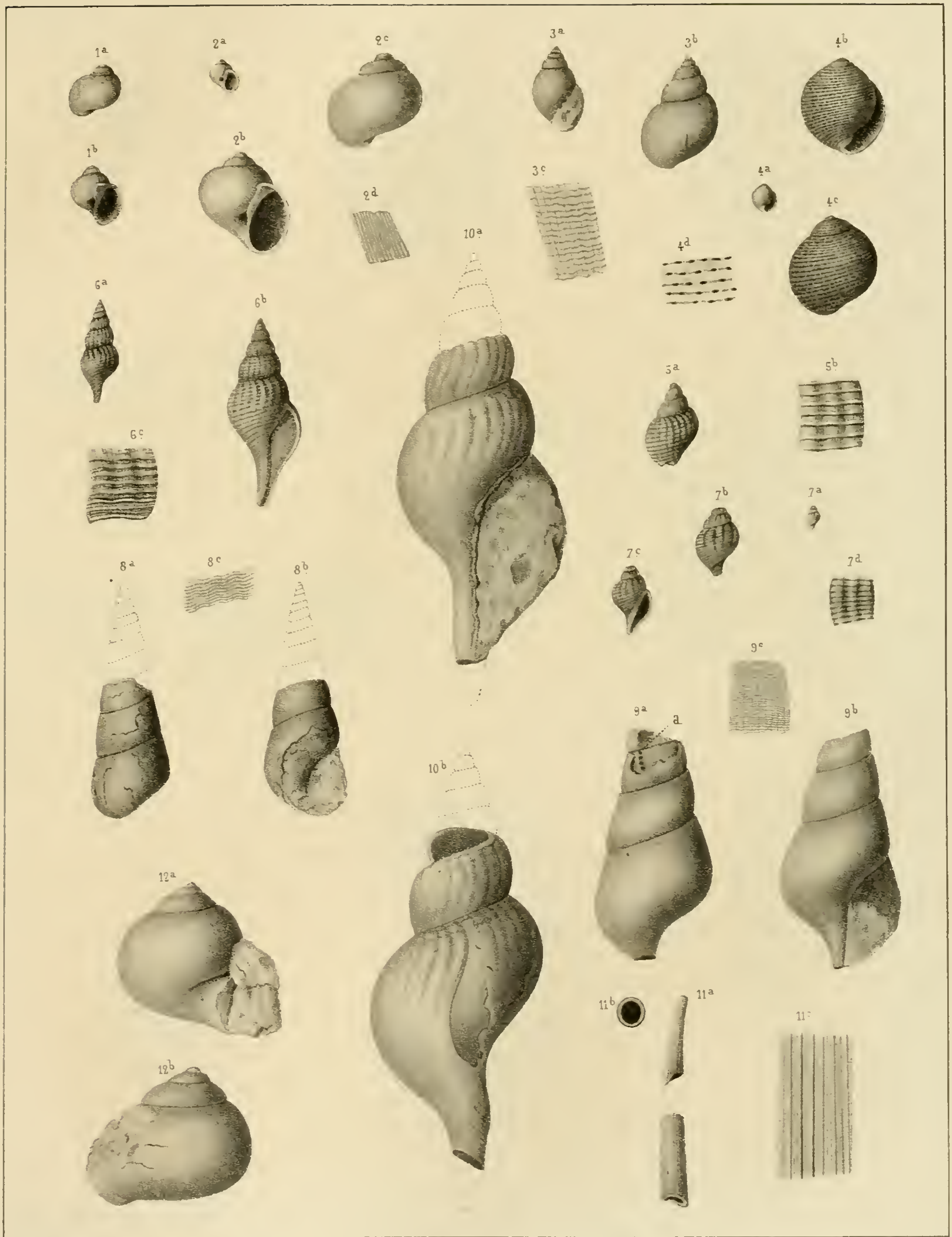

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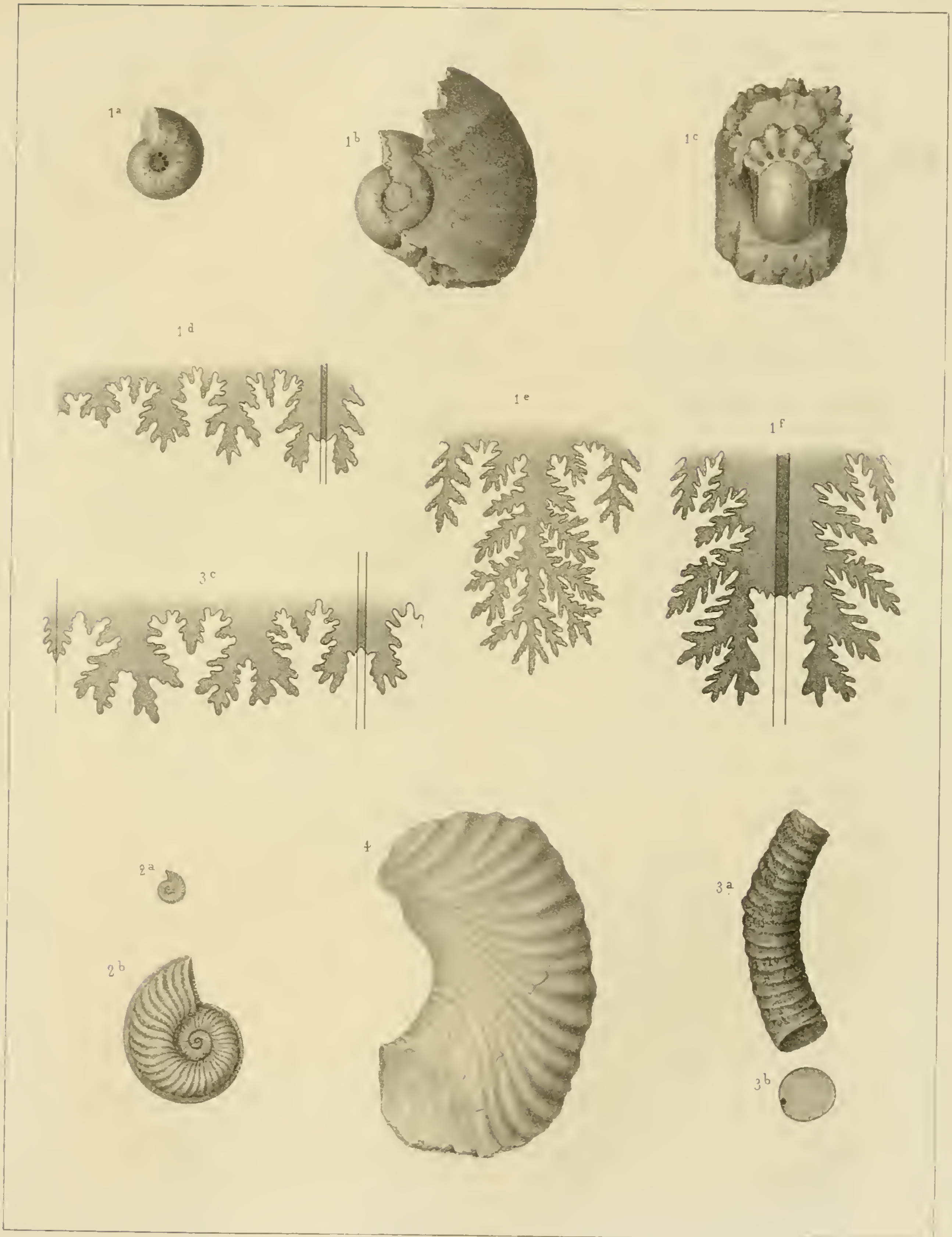

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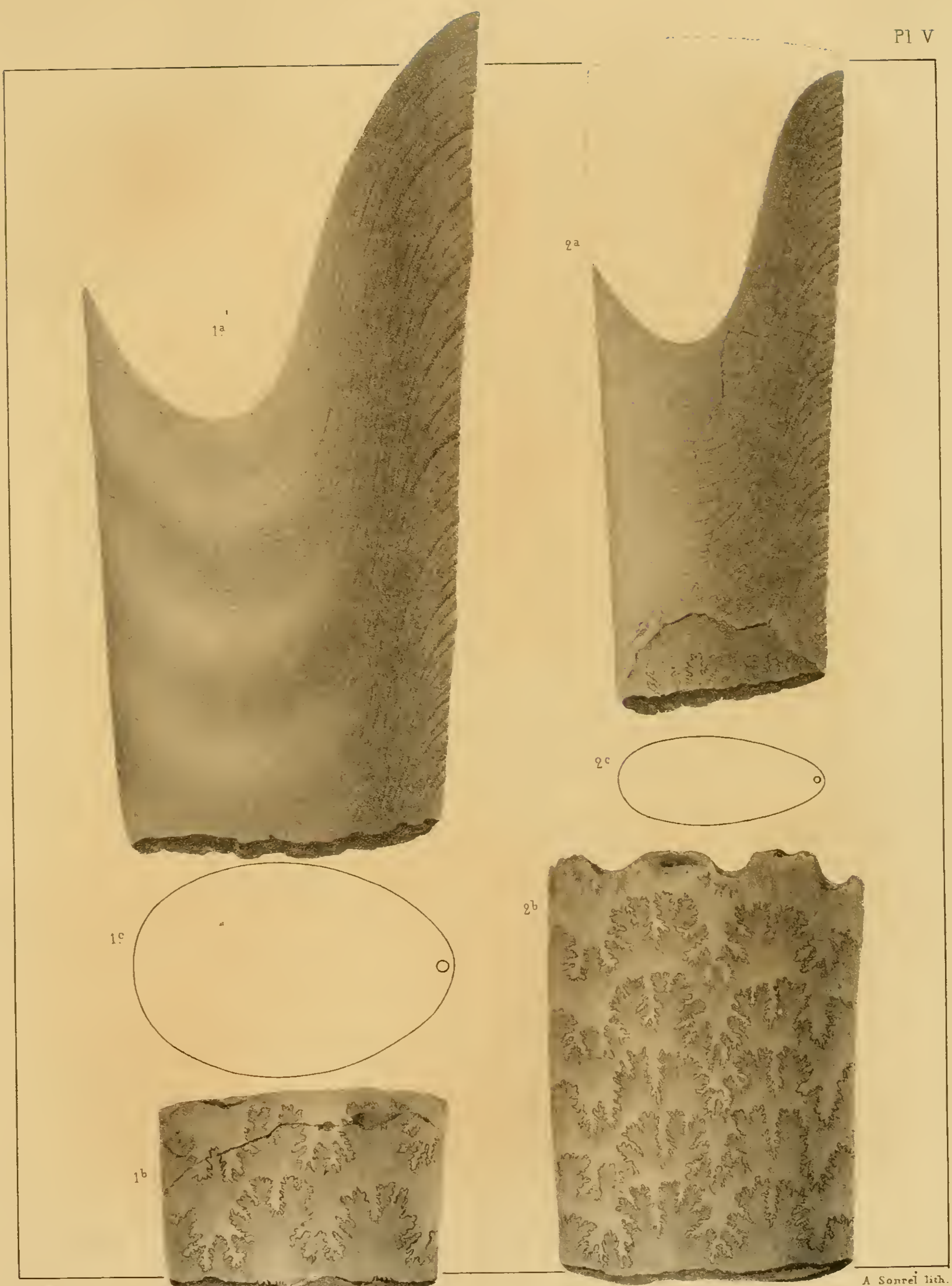

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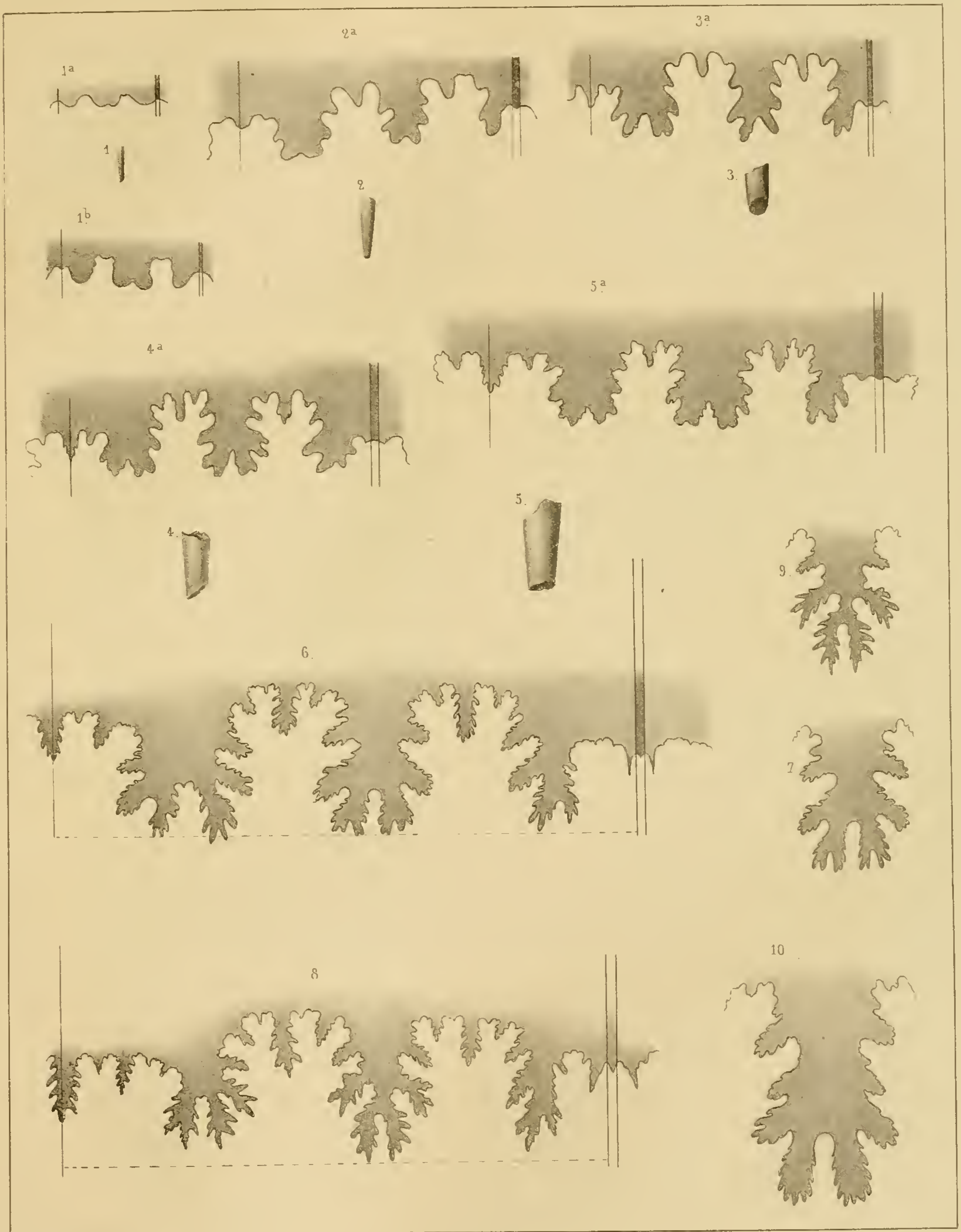

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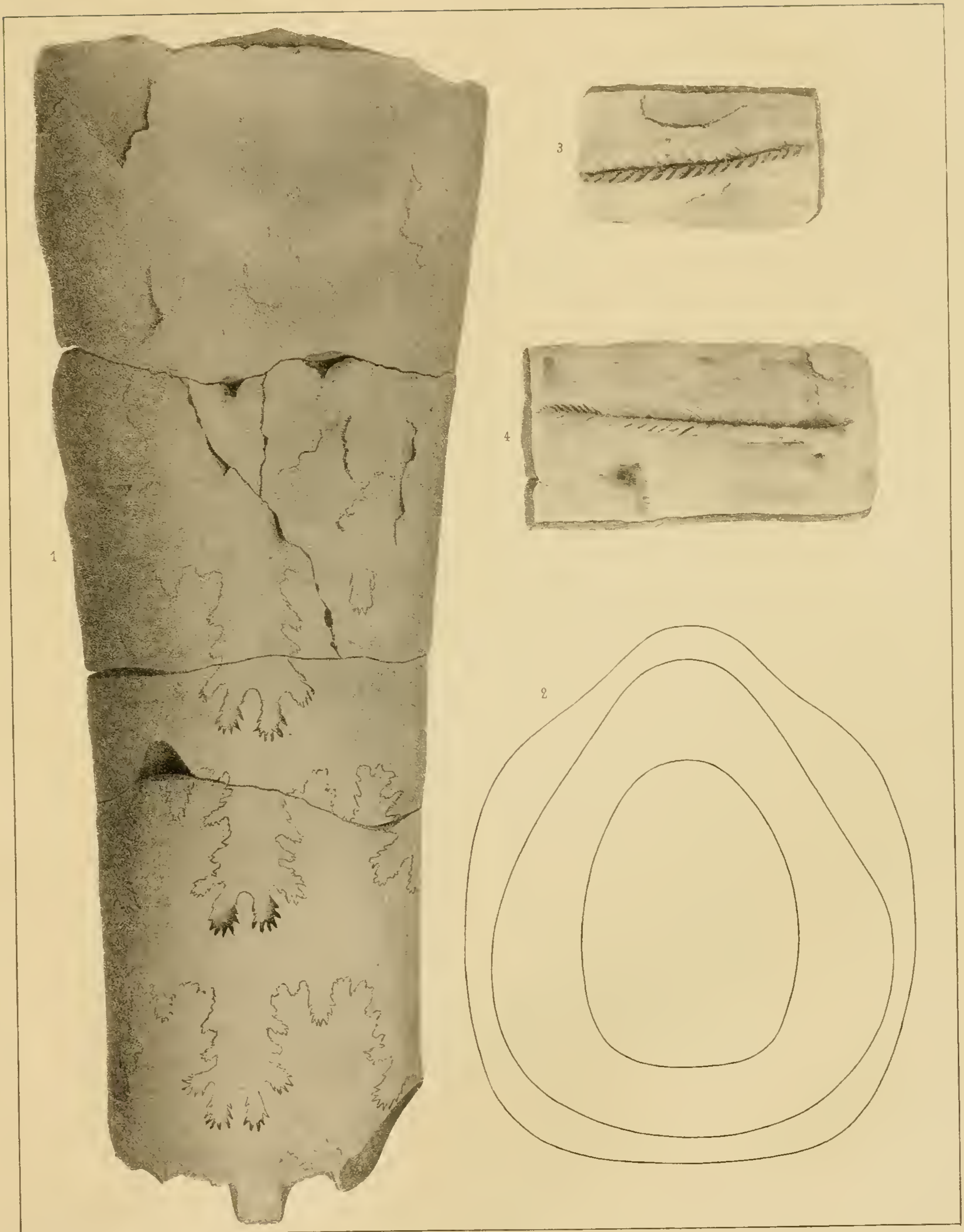

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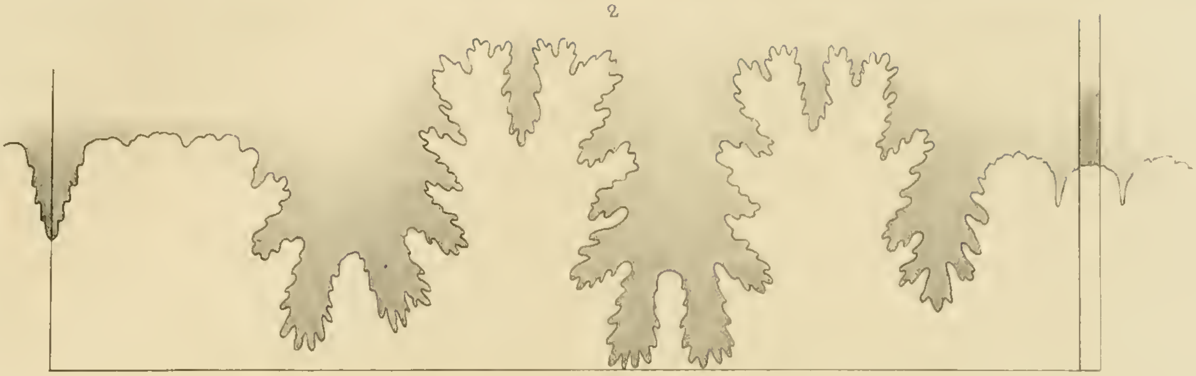

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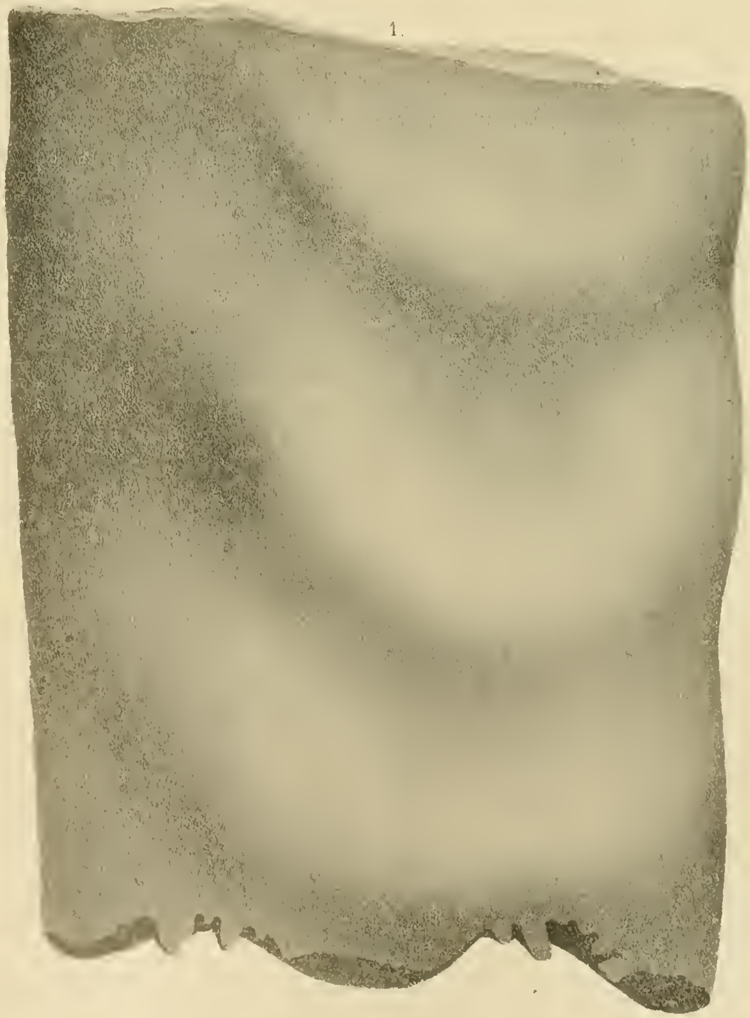

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tance from the present one; showing that the shell increased by additions to its cardinal, as well as ventral margin.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

Nucula ventricosa, *n. sp.*

Plate I. Fig. 11, *a*, *b*.

Shell ventricose in the middle and depressed at each end, ovate, prolonged posteriorly, somewhat regularly rounded in front, contracted behind; a broad shallow impression extending from below the beak to the postero-ventral margin of the shell; beaks elevated, nearer to the anterior extremity; basal margin regularly rounded to near the posterior end; surface marked by regular, distinct concentric ridges, which are strong upon the middle of the shell, and become somewhat abruptly obsolete as they pass to the depressed parts at either extremity; hinge line slightly curved; crenulations strong. Length, .14 inch; height, .09 inch; width about the same as height.

This minute shell is distinguished by its ventricose middle and depressed extremities, and by the strong concentric ridges becoming almost abruptly obsolete in passing from the ventricose portion of the shell to the flatter extremities; the teeth of the hinge line are comparatively strong. The mature character of the shell is indicated by its thickness, as well as by the strong concentric ridges; while several casts of the same dimensions were found associated with it.

Locality and Position. — Sage Creek. In division No. 4 of Section.

Capulus occidentalis, *n. sp.*

Plate I. Fig. 13, *a – d*.

Orbicula (*undet*), Owen, Report. Pl. vii. Fig. 11.

Sub-orbicular, patelliform; base nearly flat; very depressed, conical above; the apex intermediate between the centre and margin; lower surface marked by fine lamellose imbricating radiations, which diverge from a point nearly opposite the apex of the convex side, and are crossed by concentric undulations. The convex side is distinctly marked by a horseshoe-form muscular impression, which is connected at its two extremities by a fainter parallel impression; muscular impression marked transversely by radiating striæ, which are continued obscurely beyond it to the margin, and which, in the muscular impression, are crossed by finer concentric lines.

Small fragments of pearly nacreous shell adhere to a few points on the flatter side, but they present no markings of any kind.

We have identified this fossil as the *Hipponix* (Defranc), *Pileopsis capulus*, described under the genus Cabochon by Des Hayes. Our specimen is the smaller valve, very distinctly marked on its upper surface by the muscular impression which may be the cast of the interior of the other valve, and on the lower surface by imbricating striæ, very much like those of the *Hipponix* (*Pileopsis*) *patelloidea* (Des Hayes, *Coc. Foss.*, Tom. II. Pl. III. figs. 23, 24, and 25). It may also be compared with other species of this genus as figured by Des Hayes.

Locality and Position.— Sage Creek, Nebraska, from division No. 4 of the Section of the cretaceous formation.

INOCERAMUS SUBLÆVIS, *n. sp.*

PLATE II. FIG. 1, *a*, *b*.

Shell comparatively thin, moderately convex, length about one fifth more than height; hinge line long and straight, forming an angle of about 130° with the front; anterior extremity rounded; posterior side long and rounded at the extremity; beaks small, scarcely elevated above the hinge line; surface with nearly obsolete concentric undulations, and fine regular concentric striæ, which continue almost as distinct where the shell is partly exfoliated.

The most striking feature of this shell is the almost entire absence of concentric undulations, by which it will at once be distinguished from any species heretofore described from that region, or even in this country. It differs from the *I. sagensis* of Owen in the lesser obliquity of the shell, in the more extended and rounded anterior extremity, and in the smaller and less elevated beaks, while the entire shell is less convex. The fine equal concentric striæ, and faint radiating lines with obsolete undulations, are usually sufficient to distinguish this shell, even where the surface is much exfoliated. Our specimens do not show the whole outline, but it can be inferred by the direction of the concentric striæ.

Locality and Position.— Great Bend of the Missouri, in division No. 4 of Section.

INOCERAMUS CONVEXUS, *n. sp.*

PLATE II. FIG. 2, *a*, *b*.

Shell ovate, very convex, height a little more than three fourths of length; beaks prominent; hinge line long and straight, forming an angle with the anterior margin of about 145°; anterior side somewhat extended and regularly rounded; posterior side extended (and probably subtruncated). Shell marked by strong undulations, which are simple at their extremities, while some of them become divided towards the centre of the shell, where they are prominent, being less conspicuous towards the beak, and almost obsolete towards the base of the shell. Concentric lines mark the surfaces of exfoliated specimens somewhat irregularly.

This species differs from the *I. sagensis* in the less obliquity of the form, and the greater extension of the anterior side of the shell, giving an angle with the hinge line of 50° greater than in that species. The concentric undulations in *I. sagensis* are more simple than in this species, and more persistent towards the base of the shell, while this is more ventricose in the middle. This shell appears to differ sufficiently from all described species known to us, to render it easily recognizable.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

Inoceramus tenuilineatus, *n. sp.*

Plate II. Fig. 3, *a*, *b*.

Shell obliquely rhomboid-ovate, height a little more than two thirds the length; beaks towards the anterior extremity, elevated, ventricose, and incurved; hinge line straight, making an angle with the anterior margin of about 100°; posterior side extremely elongated and rounded at the extremity; surface marked by irregular undulations, which are nearly obsolete on exfoliated specimens. A small portion of the external surface remaining near the anterior extremity, shows minute crowded concentric striæ.

This shell has the form and obliquity of *I. sagensis*, but the beaks are more elevated and incurved, and the umbonial region more ventricose, while the undulations are much less conspicuous, irregular, and more obtuse. The portion of the external surface observed has the striæ much finer and more closely crowded than in *I. sagensis*. This species resembles in form the *I. impressus* of D'Orbigny, (*Terrains Crétacés*, p. 515, pl. 409,) except in the extension of the hinge line, which we have not been able to see in its perfect condition.

Locality and Position. — Sage Creek and Great Bend of the Missouri. Division No. 4 of Section.

Inoceramus Conradi, *n. sp.*

Plate II. Fig. 5, *a*, *b*.

Shell very thin, ventricose; surface marked by numerous fine concentric striæ or lines of growth, apparently destitute of undulations, structure fibrous, fibres coarse and angular.

The only specimen we have of this fossil has an appearance as if the two valves had been crushed in the direction of the length of the shell, presenting a view of the anterior end. We refer this specimen to the genus Inoceramus, for the reason that the shell is fibrous in its texture, being thicker towards the margin and thinner towards the beaks, precisely similar in these respects to the external fibrous portions of the shells of this genus.

In its surface markings this shell differs from any cretaceous species hitherto described, so far as known to us, either in this country or in Europe; and more resembles the Liasic and Oolitic species as figured by Goldfuss; and in its surface marking it may be compared with *I. lævigatus*, (Munster) Goldfuss, *Petrefacta*, II., p. 111, ta. 109, fig. 6. This species is associated with *I. fragilis* and *Ammonites percarinatus.*

Locality and Position.— On the Missouri River, five miles below the mouth of Vermilion River. Lower part of division No. 2 of Section.

INOCERAMUS FRAGILIS, *n. sp.*

PLATE II. FIG. 6, *a*, *b*.

Shell small, thin, obliquely rhomboid-obovate, height a little less than length; beaks acute, pointed forward; hinge line straight, or slightly concave, extended somewhat less than the length of the shell; forming a nearly right angle with the anterior side; marked by comparatively strong undulations, which expand upon the body of the shell, and become less prominent towards the base; surface of the shell marked by finer concentric lines.

The shell of this species is extremely fragile, and appears to be fibrous throughout its entire thickness. In general appearance it resembles the *Inoceramus mytiloides* of Mantell, as figured by Roemer, but the hinge line is more extended, and forms a more obtuse angle with the anterior side, and the height is proportionally greater. It differs extremely from the *I. mytiloides* as given by Goldfuss; and it also differs widely from D'Orbigny's figures of *I. problematicus*, which Roemer regards as identical with *I. mytiloides* of Mantell.

Locality and Position.— On the Missouri River, five miles below the mouth of Vermilion River. In the lower clay beds of division No. 2 of Section; associated with a small species of Ammonites, etc

NATICA OBLIQUATA, *n. sp.*

PLATE III. FIG. 1, *a*, *b*.

Shell longer than wide, very obliquely sub-ovate, spire little elevated. Volutions three to three and a half, convex; last one ventricose, prolonged in front. Suture deeply impressed. Surface marked by faint, very fine, closely arranged lines of growth, which are crossed by fine, nearly obsolete, revolving lines. Aperture ovate, somewhat oblique. Umbilicus small, and partly closed by the deflected pillar lip. Columella marked with a distinct opercular impression, which continues down to the base of the aperture. Spiral angle 92°. Length, .36 inch; breadth, .32 inch. Body volution, .7 of whole length.

Locality and Position. — Great Bend of the Missouri. From the clay beds of division No. 4 of Section.

NATICA CONCINNA, *n. sp.*

PLATE III. FIG. 2, *a – d*.

Shell obliquely sub-ovate; length and breadth nearly equal. Spire little elevated. Volutions three and a half, convex; last one ventricose. Suture sharply impressed. Surface nearly smooth, or marked only with exceedingly fine, closely arranged lines of growth, which are invisible to the naked eye. Aperture ovate, obtuse at both extremities. Umbilicus of medium size, round. Columellar lip not thickened, slightly deflected upon the body volution, but not so as to cover any part of the umbilicus. Spiral angle 92°. Length, .22 inch; breadth, .23 inch. Body volution .75 of the whole length.

In form this shell bears much resemblance to the *N. obliquata*. The difference in size, however, can hardly be due to age, as this appears to be a mature shell.

Locality and Position. — Sage Creek. Higher part of the upper clay formation, No. 4 of Section.

NATICA PALUDINÆFORMIS, *n. sp.*

PLATE III. FIG. 3, *a*, *b*, *c*.

Shell sub-rhomboidal, obliquely conical above, prolonged below; spire extremely elevated; volutions five to five and a half, convex; suture deeply impressed or sub-canaliculate; surface ornamented with numerous fine, closely arranged lines of growth, which are crossed by fine, slightly undulating, sub-equal, revolving lines, presenting under the magnifier a beautiful cancellated appearance. Aperture oval, approaching sub-ovate, narrower above, oblique; outer lip thin; pillar lip not thickened; umbilicus obsolete or none. Spiral angle 57°. Length (of largest specimen), .9 inch; breadth, .6 inch. Last volution, .6 of whole length.

This shell resembles very closely the *N. cassisiana* of D'Orbigny, (*Terrains Crétacés*, p. 166, pl. 175, figs. 1–4,) but differs in its more acutely elevated spire. The surface markings are also quite different, the lines of growth being regular and distinct, while the revolving lines are not punctate, as in D'Orbigny's species; and the aperture of the latter is proportionally wider below. In general form this species approaches the *N. clementina* and *N. lævigata* among the Cretaceous species, and several Oolitic species figured by D'Orbigny, *Pal. Française*, *Terrains Jurassiques.*

Locality and Position. — Great Bend of the Missouri River and Sage Creek, division No. 4 of the Section.

Acteon concinnus, *n. sp.*

Plate III. Fig. 4, *a – d.*

Shell globose or sub-oval; spire very short; volutions three and a half to four; suture narrow, but distinct; surface brilliant, with a porcelain-like polish, and ornamented with about thirty equidistant punctate revolving grooves or striæ. Aperture narrow, semilunar, contracted at the posterior extremity, rounded in front. Columella with one strong fold at the base, and a broad, deep spiral depression above it. Spiral angle about 100°. Length, .17 inch; breadth, .15 inch. The last volution .88 of whole length.

Locality and Position. — This beautiful little species is found at Sage Creek, in connection with *Baculites ovatus*, *B. compressus* (Say), *Scaphites nodosus* (Owen), &c. Also at Great Bend of the Missouri. In the upper and lower parts of No. 4 of Section.

Buccinum? vinculum, *n. sp.*

Plate III. Fig. 5, *a*, *b.*

Shell below the medium size, elongate-ovate; spire moderately elevated; volutions about five or six, convex, regularly rounded; suture strongly impressed; surface marked by numerous strong longitudinal folds, and at irregular intervals with strong varices; fine lines of growth parallel to those ridges cover the entire surface; these are crossed by rounded, elevated revolving bands, separated by spaces less than twice their width. Aperture unknown; canal — ? Spiral angle about 4° 50′; length of imperfect shell, .6 inch. Last volution more than half the whole length; breadth, .35 inch.

This shell has the general aspect of Buccinum, though its superficial characters leave some doubts, which, from the imperfection of the base of the shell, cannot be entirely removed by the most careful examination of our specimen. The surface has been marked by several strong varices, which in this specimen are all exfoliated, leaving a groove, with several pits or indentations formed by the denticulations of the lip. The elevated revolving bands constitute a distinguishing feature of the shell, having a uniform character, and appearing like strips of enamel laid over the surface.

Locality and Position. — Great Bend. Lower part of division No. 4 of Section.

Fusus Shumardii, *n. sp.*

Plate III. Fig. 6, *a*, *b*, *c*.

Shell elongate fusiform; spire elevated; volutions six or more, moderately convex; suture defined, not deeply impressed; surface marked by strong longitudinal obtuse folds, which are equal to the spaces between them, and by finer lines of growth, crossed by strong elevated revolving bands wider than the spaces between them, with sometimes an intermediate smaller one. Aperture slightly oblique, narrow, obtusely angular behind, and gradually narrowing in front into the prolonged canal; canal slightly bent and twisted. Spiral angle about 35°. Length, .66 inch; width, .25 inch. The last volution .55 of the whole length.

The almost equal proportions between the spire and length of aperture, and the elongated form of the shell, are conspicuous features. The longitudinal folds are slightly curved on the volutions of the spire; the revolving bands are flat, and under a magnifier show well defined, angular edges.

Locality and Position. — Great Bend of the Missouri. Lower part of division No. 4 of Section.

Fusus constrictus, *n. sp.*

Plate III. Fig. 7, *a* – *d*.

Shell fusiform; spire moderately elevated (imperfect above in our specimen); volutions five or six, convex; suture distinct; surface marked by strong longitudinal rounded folds, which are about equal to the spaces between them; crossed by revolving bands, wider than the spaces between them, and distinctly defined upon the longitudinal folds and in the spaces. Aperture narrow, oblique, obtusely angular behind, gradually contracting in front into a narrow canal; outer lip thick; columella broad; a distinct spiral groove or constriction marking the junction of the canal with the inflated part of the last volution. Spiral angle, 52°. Breadth, .1 inch.

This shell presents all the external characters of Fusus, but the imperfection of the columella renders it impossible to determine fully its character. The impressed or constricted line at the base of the last volution passes around, parallel with the revolving lines, into the aperture, and may have produced a fold upon the inner lip, which might be a sufficient reason for removing it from this genus. The suture is a narrow constricted line, impressed nearly at right angles to the direction of the spire, and the depressions between the longitudinal folds are terminated abruptly above, before reaching the suture, by an irregular ridge caused by the extension and thickening of the upper extremities of the folds.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

Fusus? tenuilineata, *n. sp.*

Plate III. Fig. 8, *a* – *c*, and fig. 9, *a* – *c*.

Shell elongate-terete; volutions (number unknown) slightly convex in the middle, last one flattened, or sometimes slightly concave above the middle; aperture subrhombic, terminating in an acute angle behind, and narrowing in front into a canal; surface marked by very fine, undulating, closely arranged revolving lines, which are stronger immediately below the suture; suture plain, linear. Spiral angle about 25°; breadth, .37 inch.

The only specimen in our collection is a fragment consisting of about two and a half volutions, the last one too imperfect to admit of the determination of the form of the aperture. Another fragment, fig. 9, *a*, *b*, is from the collection of Dr. Evans, now in the possession of Dr. Shumard in St. Louis. The aperture in this one is nearly entire, and, where partially exfoliated, shows in some places a thickening of the shell, with impressions of crenulations, as if the growth had been interrupted at intervals. It is with much doubt that this shell is referred to the genus Fusus.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

Rostellaria fusiformis, *n. sp.*

Plate III. Fig.10, *a, b.*

Shell elongate, fusiform; spire elongated; volutions (number unknown) moderately convex, marked by numerous regular rounded oblique flexuous folds, which terminate abruptly above in small indistinct nodes, giving a sub-coronate aspect to the upper part of the volutions; surface unknown; suture distinct and separated from the row of nodes below it by a shallow depression; aperture elongate, widest near the middle, and narrowing anteriorly into a prolonged canal. Spiral angle 35°; breadth, 1.1 inch.

Our specimen is imperfect at both extremities, and so exfoliated as to preserve none of the surface markings. The folds on the last volution appear to grow more irregular and obscure towards the aperture. The outer lip is imperfect, and the adhesion of stony matter to the columella prevents the positive determination of the generic characters; but the general aspect of the surface, the longitudinal folds of the volutions, with the absence, as far as seen, of the characteristic features of other genera, induces its reference to the genus Rostellaria. In the broken upper extremity of the shell, a few faint spiral bands are visible, which, if continued, would mark the columella; but owing to the exfoliation of the specimen, they are not preserved.

Locality and Position. — Sage Creek. Upper clay or upper part of division No. 4 of Section.

Dentalium gracilis, *n. sp.*

Plate III. Fig. 11, *a – c.*

Slender, terete, gradually enlarging from the apex; section sub-oval, nearly circular; surface distinctly marked by rounded, threadlike striæ, which are irregular in size, and increase in number by implantation between the larger ones, from the apex towards the aperture, having about twenty-five near the apex and fifty-two at a point where the diameter is twice as great, and increasing in the same ratio as far as observed; crossed obliquely by extremely fine equal striæ, which ascend from the outer to the inner side of the curve. Spiral angle 3 to 3½°. Longest diameter of largest fragment, .2 inch; aperture of the same, .14 inch; diameter of smallest fragment, near the apex, .08 inch.

This we believe is the first species of this genus described from the cretaceous formation of this country.

Locality and Position. — Sage Creek. Upper part of division No. 4 of Section.

HELIX LEIDYI, *n. sp.*

PLATE III. FIG. 12, *a*, *b*.

Shell sub-globose, wider than long; spire elevated; volutions four or five, last one large and ventricose; suture distinct; surface unknown; aperture unknown; outer lip reflected; umbilicus small, or perhaps closed. Spiral angle about 105°. Length, .95 inch; breadth, 1.14 inches. The last volution .65 of the whole length.

Our specimen is merely an internal cast with a few fragments of the shell adhering, no portions of which retain the surface markings; but faint impressions of coarse, regular lines of growth are left by the interior of the shell upon the cast. The aperture is distorted; though it was apparently wider than long. At the base of the shell the cast shows a distinct reflection of the lip.

Locality and Position. — Near the head of Bear Creek, Mauvaises Terres, turtle and bone bed. Eocene Tertiary.

AMMONITES COMPLEXUS, *n. sp.*

PLATE IV. FIG. 1, *a–f*.

Discoid; umbilicus deep, outer volution covering one half to two thirds of the next one within; volutions five or more, ventricose, nearly twice as wide as high; ornamented on the ventral edge by about ten or twelve transverse nodes, slightly elevated, and extending outwards in bifurcating annulations, which cross the back of the shell, uniting again on the opposite side in the same manner. Between these annulations are often other intermediate ones, which are equally prominent on the back of the shell, and die out on the ventral edge.

These nodes, although existing in the young shell, are scarcely prolonged into annulating ridges, and the back of the shell is smooth, or marked only by the ordinary lines of growth.

In a young specimen of .64 inch in diameter, aperture .34 inch high, and .49 inch wide, septa formed of three symmetrical lobes on each side. Dorsal lobe as deep as the dorsal saddle, but wider, deeply divided at its extremity, and ornamented by two large terminal branches, the outer sides of which are deeply sinuate, a large lateral oblique branch midway between the apex and base of the lobe. Dorsal saddle deeply divided at the extremity into two unequal parts; the upper one again deeply bifurcate, divisions digitate at the extremities; ventral division bifid at the tip; a small branch on each side opposite the extremity of the auxiliary lobe. Superior lateral lobe extremely contracted in the middle by the lateral branches of the saddle; divided towards its extremity into three unequal branches, the terminal one trifid at its extremity, the lateral ones scarcely digitate; two smaller lateral branches towards the base. Lateral saddle in form like the dorsal saddle, with the ventral division larger and bipartite, corresponding to the dorsal division of the other. Inferior lateral lobe shorter than the superior; contracted near the middle, divided into three sub-equal branches, the lateral ones irregularly digitate, and the terminal one trifid. Ventral saddle oblique, divided by the auxiliary lobe into two branches, which are again bifurcate, with the extremities obtusely bifid. Ventral lobe much smaller and shorter than the inferior lateral lobe, sub-equally tripartite, with the divisions sub-digitate. A small bilobed saddle on the ventral side of the last lobe.

The characters here given are derived from a small specimen, (Pl. IV. fig. 1, *a*,) and from the inner volutions of an older one, (fig. 1, *b*, *c*,) while in the outer volutions of the same specimen the lobes and saddles become very much crowded together, and exceedingly complicated in their structure; the division in the dorsal lobe becomes much deeper, all the divisions already noticed are more complex, the sinuosities extended in depth, the simple digitations become complex ramifications, with each division again sinuous on the edges, illustrating in a remarkable manner the development of this complicated structure as the animal increases in age and dimensions. In the young specimen figured, the septa in the interior volutions present the simplicity of those of Goniatites; while the outer septa of the same specimen exhibit the structure described and figured.

In the older specimen, (Pl. IV. fig. 1, *b*,) the outer septa furnish the extremely complex structure given in figs. 1, *e*, and 1, *f*, which include the dorsal lobe and a part of the dorsal saddle, as well as the superior lateral lobe, disconnected from the preceding parts; this being as far as the imperfection of the specimen and the extreme complication of the structure would allow one to follow its divisions; while the inner volutions present precisely the same structure as the outer volution of the younger specimen.

This species resembles in general form and proportions the *A. Mantellii* of Sowerby, but the annulating ridges are less strong, and the nodes on the inner edge very distinct. There is a greater difference, however, between the two species in the form and details of the lobes of the septa.

Locality and Position. — Great Bend on the Missouri. Lower part of division No. 4 of Section.

Ammonites percarinatus, *n. sp.*

Plate IV. Fig. 2, *a–c.*

Discoidal, depressed; umbilicus wide and shallow; volutions about four or five, all visible in the umbilicus, scarcely one fourth of each embraced in the succeeding one; shell thin; surface marked by thirty-eight to forty-five prominent flexuous sharp ribs some of which originate in the umbilicus, and others upon the latero-ventral margin, and all extend to the dorso-lateral edge, where they bend abruptly forward, and terminate before reaching the dorsal line, which is marked by a thin sharp carina extending to the aperture. Ribs thickened and sometimes nodose towards the periphery.

Our specimens are all casts of the interior with fragments of the shell adhering, and the condition is such as to give no means of determining the character of the septa. Among American species, it resembles in general appearance the *A. abyssinius* of Morton, (*Jour. Acad. Nat. Sci.*, Vol. VIII. p. 209, Pl. X. fig. 4,) from which it may be at once distinguished by its wider umbilicus and dorsal carina. The same remarks would apply to a comparison of this species with the *A. splendens* of Sowerby, in its young state, as given by D'Orbigny (*Terrains Crétacés*, p. 222, Pl. 63, fig. 3). It differs also from the *A. helius*, D'Orbigny, (*loc. cit.*, p. 187, Pl. 57, figs. 1 and 2,) in its much wider umbilicus and more sharply elevated carina, while in the European species the annulations all reach the umbilicus. In the proportions of the umbilicus it resembles the *A. heliacus* and *A. angulicostatus*, D'Orbigny, (*loc. cit.*, Pl. 25 and 46,) but differs in its sharp dorsal carina, as well as in other characteristics. In external characters this species bears a close resemblance to *A. aalensis*, Zeit. (*A. candicans*), D'Orbigny, (*loc. cit.*, p. 238, Pl. 63,) from the upper Lias.

Locality and Position. — Five miles below the mouth of Vermilion River on the Missouri; in division No. 2 of Section.

Hamites Mortoni, *n. sp.*

Plate IV. Fig. 3, *a–c.*

Cylindrical, curved, increasing very gradually in diameter towards the larger extremity; surface crossed obliquely by sharp annulations, which are less strong upon the ventral side, and sharper and stronger upon the dorsal side. A few of these annulations are nodose on the back, and some of them also bifurcate and again unite after making half a revolution. Annulations narrower than the space between them. Dorsal lobe shorter than the superior lateral lobe, bifurcate (the two sides a little dissimilar in details); extremities digitate, the one on the right having two, and that on the left three divisions; sides irregularly sinuous; dorsal saddle as long but not as wide as the dorsal lobe, bipartite at the extremity, the right branch digitate and the left subdivided; superior lateral lobe longer and more diverging than the dorsal lobe or the dorsal saddle, deeply divided into two principal branches, each of which is again subdivided, with numerous shallow, irregular sinuosities along the margin. Lateral saddle very much contracted near the middle, shorter than the dorsal saddle, deeply divided into two branches, which are digitate. Inferior lateral lobe as long as the superior lateral lobe, but narrower, deeply divided into two branches, each of which is again divided, the divisions digitate. Ventral saddle shorter than the lateral saddle, oblique, divided into three lobes at top with smaller ones below. Ventral lobe little more than half as long as the inferior lateral lobe; bifid at the apex, and with three or four small divisions on each side.

This species resembles in its external characters the *H. torquatus* of Morton, (*Synopsis*, Pl. XX. fig. 4,) but the annulations are relatively closer together and less acute than those described by Dr. Morton, and differ in being sometimes distinctly nodose and bifurcating. The fragment possessed by us makes a shorter curve than the figure cited above. In addition to these differences, we may observe that our shell makes a broader or more circular curve than is usual in the species of Hamites, and moreover appears not to curve precisely in the same plane, resembling in this respect the genus Helioceras of D'Orbigny, while the septa correspond with those of Hamites.

Locality and Position. — Near Red Cedar Island, thirty-five miles below Fort Pierre, in division No. 4 of Section.

Ancyloceras? Nicolletii, *n. sp.*

Plate IV. Fig. 4.

The fragment in our collection appears to be a part of the outer chamber, including the abrupt curved portion, of a shell of this genus.

Section oval or sub-circular, shell thin, abruptly curved towards the aperture, surface marked by distinct annular costæ, which encircle the shell in a very oblique direction, and become obsolete on the ventral side of the curve, and very irregular in size and distance from each other upon the lateral portions of the shell, often bifurcating once or twice, with sometimes small nodes at the bifurcation, becoming more prominent and equidistant upon the dorsum.

This fossil resembles the fragment figured by Dr. Morton as *Ammonoceratites Conradii*, (*Jour. Acad. Nat. Sci.*, Vol. VIII. p. 212, Pl. X. fig. 1,) but differs from that in curving more abruptly, and could scarcely have formed a circle if continued. It differs also in the bifurcation of the costæ.

It is with some hesitation that we refer this fragment to the genus *Ancyloceras*, but the form of the curvature and character of the annulations more nearly resemble the species of this genus than any other which we know.

Locality and Position. — Great Bend of the Missouri. Division No. 4 of Section.

Baculites ovatus *and* B. compressus *of Say.*

These two species of Baculites were first described by Say, and subsequently recognized and redescribed by Dr. Morton, who quotes Say's descriptions, in his Synopsis of the Cretaceous Fossils of New Jersey. The *Baculites ovatus* had also been recognized by the last-named author as occurring in the cretaceous formation in Alabama, as well as in New Jersey and Delaware, showing a wide geographical distribution. The *B. compressus*, regarded by Dr. Morton as a closely allied or perhaps identical species, has been recognized only, so far as we know, in the cretaceous formation of the Upper Missouri, from whence it was first described by Mr. Say.

Dr. D. D. Owen, in his report on Wisconsin, Iowa, and Minnesota, has figured (Pl. VII. fig. 6) a specimen which he refers with doubt to *B. compressus* of Say. The specimen in question is from Sage Creek, Nebraska, and is a fragment apparently of the outer chamber with the shell preserved; and as no septa are shown, it is impossible to determine satisfactorily its relations. On the same plate, fig. 7, another fragment is given, also without septa, and, owing to the bad state of preservation, it shows no characters by which it can be identified with any known species.

The descriptions and figures above cited comprise the amount of our present knowledge of these two species of Baculites.

In our collections from Sage Creek, and from various localities along the Missouri River, we have a considerable number of well-preserved specimens of Baculites, which by their external characters are readily referred to two distinct species, one presenting in its section a regular ovate form, or sometimes a little flattened on the more obtuse or ventral side, the other presenting a section of very depressed ovate form. These two forms are found to be characterized by internal differences, which are constant in all the specimens examined.

We are inclined to recognize these as the *B. ovatus* and *B. compressus* of Say, although there are in the details of internal structure slight differences between the ovate forms from the Upper Missouri and authentic specimens of *B. ovatus* from New Jersey.

Inasmuch as the figures and descriptions heretofore published do not fully characterize the species, or enable the student to distinguish these from allied forms, we have endeavored in a manner to supply this deficiency.

Baculites ovatus.

Plate V. Fig. 1, *a*–*c*. Plate VI. Figs. 1–7.

B. ovatus, Say, Jour. Acad. Nat. Sci. Phil., Vol. VI. Pl. V. figs. 5, 6.
" " " Amer. Jour. Sci., Vol. XVIII. Pl. I. figs. 6, 7, 8.
" " Morton, Synopsis, 1834, p. 42, Pl. I. figs. 6, 7, 8.

Shell elongated, section ovate, sometimes a little flattened along the ventral side; dorsum marked only by lines of growth, which, passing around, continue obliquely downward for about two thirds of the distance across the side, where they curve gently upwards and pass over the ventrum in a broad arch, thus marking the outline of the aperture. The ventral half of the shell is marked by somewhat regular, transverse undulations, which follow a curve parallel to the lines of growth, dying out entirely or passing into the lines of growth on the dorsal half of the shell, but are sometimes more or less continued upon the ventrum. Aperture (as inferred from lines of growth) having a linguiform extension in front on the dorsum, deeply sinuated at each side on the ventral half, and broadly arched upwards on the ventrum.

Septa symmetrical, lobes in pairs (excepting the ventral lobe), of moderate depth; dorsal lobe wider than high, very little shorter than the lateral superior lobe, divided into two widely separated branches, each of which is tripartite, and the divisions subdigitate. Dorsal saddle as long as, and somewhat wider than, the superior lateral lobe; deeply divided at the top into two nearly equal parts by the accessory lobe, each part is again subdivided into three or four branches with sinuate margins. Superior lateral lobe as long as, but narrower than, the dorsal saddle, deeply divided at the extremity into two parts, and again laterally divided, so that each side presents two principal branches, the terminal ones of which are bifid at the extremities; all with margins sinuate and sub-digitate. Lateral saddle same in form as the dorsal saddle, and the details of the ventral side of the one agree with those of the dorsal side of the other respectively. Inferior lateral lobe wider than the superior lateral lobe; similar in its divisions, except that it is more deeply divided at its extremity in the centre, and the terminal divisions are less distinctly bifid; margins and extremities sinuate and digitate. Ventral saddle as wide as the inferior lateral lobe, two thirds as high as the lateral saddle, and less deeply divided at the top into two unequal parts, the right or dorsal division being again divided into two unequal parts, the lower division of which is somewhat bipartite. Ventral lobe narrow, about half as long as the ventral saddle, digitate at the extremity, and deeply sinuate on the sides. Angle of the apex, as deduced from the convergence of the dorsal and ventral margins by the measurement of several specimens, $3\frac{1}{2}$ to 4°. Longest diameter of largest specimens, 2.8 inches; shortest diameter of same, 1.7 inches. Shell on the ventrum, .13 inch thick; on the dorsum, .1 inch; and on the sides, about .05 inch thick.

In a septate portion of a specimen, the cast gave, in its largest diameter, 1.4 inch; shortest diameter, .9 inch; diameter of siphuncle, .1 inch.

Probable length of largest specimen in this collection, in its perfect state, $3\frac{1}{2}$ feet.

Locality and Position. — Great Bend of the Missouri, and various other localities on that river between Fort Pierre and the mouth of Big Sioux River. Fourth division, ranging through its entire thickness.

Baculites compressus.

Plate V. Fig. 2, *a*, *b*. Plate VI. Figs. 8, 9.

B. compressus, Say, Amer. Jour. Sci., Vol. II. p. 41.
" " Morton, Synopsis, 1834, p. 43, Pl. IX. fig. 1.
" " " Jour. Acad. Nat. Sci. Phil., Vol. VIII. p. 211, 1842.

Shell elongate, extremely compressed, gradually tapering from the base; section very compressed ovate; surface marked by lines of growth, which cross the dorsum, and, bending obliquely downwards, curve outwards till they pass the centre of the side, when they turn more abruptly outwards and again curve upwards, and cross the ventrum in a narrow arch. Lines of growth more prominent on the dorsum, forming faint undulations across the surface. Septa symmetrical; dorsal lobe very wide, and little more than half as long as the dorsal saddle, deeply divided into two widely separated branches, each of which is again divided into two unequal parts, which are sharply and unequally digitate. Dorsal saddle twice as wide as the superior lateral lobe, deeply divided by the acute, sharply digitate auxiliary lobe into two nearly equal parts, each of which is subdivided into three branches, the left or ventral division larger and more irregular than the other; extremities of the branches obtuse. Superior lateral lobe narrow, one third longer than the dorsal lobe, divided into three branches, the terminal one much the largest and deeply bifurcate, with the divisions smaller than the lateral branches; terminations sharply digitate. Lateral saddle slightly wider and higher than the dorsal saddle, auxiliary lobe longer and dividing it into two parts corresponding in their details to those of the dorsal saddle. Inferior lateral lobe shorter than the superior lateral lobe, and deeply divided into two unequal branches, that on the ventral side being unequally divided into three, and that on the dorsal side into two parts, all sharply digitate. Ventral saddle one third smaller than the lateral saddle, deeply and somewhat obliquely divided, by a sharply digitate, auxiliary lobe, into two nearly equal parts, each again less deeply subdivided and having the terminations all obtuse. Ventral lobe narrow, and of the same length as the auxiliary lobe of the dorsal saddle, sharply digitate, the divisions divaricate.

Angle of the apex (as deduced from measurements of imperfect specimens) about three degrees. The longest diameter of the largest fragment (a septate cast) in our collection is 2.16 inches, and the shortest diameter 1.07 inches; siphuncle of the same individual, .1 inch.

In addition to the external differences already mentioned, we may state that the *B. compressus* is never, in our specimens, marked by the strong undulations which characterize the ventral half of the side of *B. ovatus.* The internal differences are equally striking and characteristic. The dorsal lobe of *B. compressus* is proportionally much wider and less deep, and the two branches much more distant and more divergent than in *B. ovatus.* The central or siphuncular portion of the dorsal lobe in *B. compressus* presents three small auxiliary lobes, the two outer of which are divergent and digitate at their extremities, while outside of these, and between them and the main branches of the dorsal lobe, are one or two subordinate digitations; while in *B. ovatus* the same region is marked by only two short and parallel extensions with a minute point between them, or over the siphuncle, and some undulations on each side.

In *B. compressus* the lobes and auxiliary lobes are all more narrow, longer, and, together with all their subdivisions, much more acute, than those of *B. ovatus.* The superior lateral lobe in the two species likewise presents a striking difference. In *B. compressus* it is divided into three nearly equal branches, the terminal one of which is again deeply bifurcate; while in *B. ovatus* this lobe, in consequence of the greater depth of the terminal sinus, is divided into four nearly equal branches, the two terminal ones being bifurcated by a small sinus. Similar differences are noticed in the inferior lateral lobes of the two species. Another difference may be observed in the relative size of the siphuncles, that of *B. ovatus* being proportionally longer.

Locality and Position. — Sage Creek and Great Bend of Missouri River, etc. Fourth division of Section.

BACULITES GRANDIS, *n. sp.*

PLATE VII. FIG. 1, 2. PLATE VIII. FIG. 1, 2. PLATE VI. FIG. 10.

Shell elongate; section varying from ovate to sub-cordiform; surface of cast marked by very broad and strongly elevated undulations, which commence at the dorsum and pass obliquely downwards, increasing rapidly in size, and, crossing the side of the shell in a broad curve, terminate abruptly on the ventro-lateral region. Undulations less distinct towards the smaller extremity, and finally become obsolete. Septa very deeply lobed, principal divisions scarcely divergent. Dorsal lobe three fourths as long and twice as wide as the superior lateral lobe; terminated on each side by a narrow elongated branch, which is irregularly sinuate and digitate at the extremity. Dorsal saddle shorter and wider than the superior lateral lobe, formed of four branches, the two terminal ones much the larger, and each of them bifid at the extremity by a small sinus; the whole outline more or less sinuous and the extremities digitate. Superior lateral lobe longer by one fifth than the inferior lateral lobe, narrower than the ventral saddle, divided at its extremity by a deep sinus into two equal parts, which are simply digitate; above these are two unequal branches on each side; terminal sinus much deeper than the lateral ones. Ventral saddle longer and about as wide as the dorsal saddle, more deeply divided at its extremity by the auxiliary lobe into two nearly equal branches, each of which is bifid and the extremities digitate, ventral side with three, and dorsal side with two auxiliary branches. Inferior lateral lobe shorter and broader than the superior lateral lobe, divided at its extremity into two nearly equal branches, the one on the dorsal side bifid at the tip and the other digitate, with an auxiliary branch on the ventral side. Ventral lobe as long as the auxiliary lobe of the ventral saddle, but wider at the base, digitate at its extremity.

Angle of the apex about five degrees. Length, as deduced from the measurement of fragments, by the convergence of the dorsal and ventral sides, five and a half feet or more. Longest diameter of a fragment not distorted by pressure, 3.7 inches; shorter diameter from the surface of undulations, 3.3 inches; in the depressions between the undulations, 2.95 inches.

This species is nearly related to *B. ovatus* of Say, from which it differs in its much greater size, larger apicial angle, much stronger and more extended undulations, which cross the entire lateral surface of the shell. The section is more obtusely ovate; the lobes of the septa are much deeper, narrower, and less divergent in their branches; the digitations are sharper and more directly pointed in the longitudinal direction of the shell. The auxiliary lobe of the ventral saddle is longer in this species, while the extremities of the terminal branches are less deeply bifid than in *B. ovatus*. In this species the two terminal branches of the superior lateral lobe are simply digitate, while in *B. ovatus* they are deeply bifid, with obtuse sinuosities. Externally in its undulations on the sides, this species resembles *B. anceps* of Lamarck, but will be readily distinguished by the absence of a dorsal carina, and by its much deeper lobes with less divergent divisions. A comparison of the details of the divisions of the lobes and saddles shows a constant difference in the two species.

Locality and Position. — Mauvaises Terres, head of Bear Creek. Fifth or upper division of the section, and but a few feet below the base of the Titanotherium bed of the Tertiary formation. From this point it is known to extend downwards some twenty or thirty feet, and probably ranges through all the beds of the fifth division.

The occurrence of this fossil at this locality indicates very distinctly the line of demarcation between the Cretaceous and Tertiary formations of this region; and from the absence of other fossils in this division, as far as known, no well-defined line has heretofore been drawn between the deposits of the two periods; and no connection has hitherto been shown between the Eocene formation, containing Mammalian remains, with the Cretaceous formation below.

In examining this collection of specimens, we found no difficulty at the outset in distinguishing the *Baculites ovatus* and *B. compressus* in many large and medium sized shells. At the same time, numerous smaller specimens presented a structure so different, that we were inclined to refer them to distinct species, until a further examination of specimens still more minute satisfied us that they were all to be referred to the one species of *B. ovatus*, showing different degrees of development dependent upon age and growth. A careful examination under a magnifier of a specimen only one twentieth of an inch in diameter, showed the septa, which are so complicated in the mature specimen, to be extremely simple, the lobes and saddles represented by simple undulations. The two extremities of the same specimen also showed different degrees of development, as seen in Plate VI. fig. 1, *a*, and 1, *b*, which are from the smaller and larger extremities respectively of the specimen, fig. 1. An individual of larger growth (about .1 inch diameter) shows a still further advance in the development of the lobes and saddles, with their principal divisions, as shown in fig. 2, 2, *a*. A still further advance is shown in another individual of .16 inch diameter, in fig. 3, 3, *a*, while fig. 4, 4, *a*, 5, 5, *a*, show an increasing degree of this development as the size of the individual increases. In fig. 6 we have the parts fully developed, as shown in the specimen, Plate V. fig. 1, *a*, and 1, *b*, which is 1.7 inches in its shortest diameter. In all the smaller specimens the section is more broadly ovate, and in the minute ones nearly circular, while the angle of the apex is nearly double that which we have deduced from the measurement of parts of the adult specimens.

We subsequently ascertained that a similar progression in the development of the septa occurs in Ammonites and Scaphites from Nebraska; and in even a more remarkable degree than in the Baculites.*

These facts in relation to Ammonites we have shown in the *A. complexus*, which is represented in two stages of development; while the septa of the inner volutions of the small individual figured are no more undulated than some of the older and more simple forms of Goniatites, leading unavoidably to the conclusion that the animal, in its embryonic and extremely young state, is provided only with simple septa, like the more ancient and recent Nautili.

The *Scaphites nodosus* of Owen, which, in its adult state, has extremely complicated septa, has been proved, by a careful examination, to present in its successive stages of growth the same development as occurs in Baculites and Ammonites, showing that this law of development is common to these three genera; from which we may infer that it may pervade the entire family of Ammonitidæ.

These facts have an important bearing upon the study of this family of fossils, and show in a remarkable degree how beautifully the progression from lower to higher forms of animal organization, as exhibited in the introduction of successive creations upon the same general plan from the older to the more recent geological epochs, is here simulated and illustrated by the phases of development in a single individual in its progress from the young state to maturity.

* We are aware that the same characteristics have been shown in some European species of Ammonites; but these observations were made independently of any hints from other sources; and we are not able to ascertain from any publication within reach, that such features have been discovered in Baculites or Scaphites.

Section of the Members of the Cretaceous Formation as observed on the Missouri River, and thence Westward to the Mauvaises Terres.

Eocene Tertiary Formation.		Clays, sandstones, etc., etc., containing remains of Mammalia. The entire thickness of this formation in the Bad Lands is from 25 to 250 feet.
Cretaceous Formation.	5.	Arenaceous clay passing into argillo-calcareous sandstone. 80 feet.
	4.	Plastic clay with calcareous concretions containing numerous fossils. 250 to 350 feet. This is the principal fossiliferous bed of the cretaceous formation upon the Upper Missouri.
	3.	Calcareous marl, containing *Ostrea congesta*, scales of fishes, etc. 100 to 150 feet.
	2.	Clay containing few fossils. 80 feet.
	1.	Sandstone and clay. 90 feet.
		Buff-colored magnesian limestone of the carboniferous period.

List of Fossils heretofore identified and described from the Cretaceous Formation of Nebraska.

Nautilus Dekayii, Morton.
Ammonites placenta, Dekay.
" mandanensis, Morton.
" Nicolletii, "
" Conradii, "
" abyssinius, "
" cheyennensis, Owen.
" Nebrascensis, "
" lenticularis, "
" opalus, "
" moreauensis, "
Scaphites nodosus, "
" comprimus, "
Baculites ovatus, Say.
" compressus, Say.
Belemnites Americanus, Morton.

Rostellaria Nebrascensis, Evans and Shumard.

Solarium flexistriatum, Evans and Shumard.
Pholadomya elegantula, " "
Mytilus galpinianus, " "
Avicula linguæformis, " "
" triangularis, " "
" cretacea, Conrad.
Ostrea congesta, "
" vesicularis, Lamarck (on the authority of M. Nicollet's list).
Inoceramus Barabini, Morton.
(= I. Crispii? Mantell.)
" sagensis, Owen.
" Nebrascensis, Owen.
Cytherea Missouriana, Morton.
Tellina occidentalis, "
Cucullea Nebrascensis, Owen.
Anomia tellinoides, Morton.
Hypponix borealis, "

List of Species common to the Cretaceous Formations of Nebraska and New Jersey.

Nautilus Dekayii,
Ammonites placenta,
" Conradii, at Prairie Bluff, Alabama,
Baculites ovatus,
Belemnites Americanus,
Inoceramus Barabini,
Ostrea larva.

List of New Species of Fossils described in the Preceding Paper.

Lingula subspatulata,
Caprinella coraloidea,
Capulus occidentalis,
Avicula Haydeni,
Pecten rigida,
Lucina subundata,
Cytherea orbiculata,
" tenuis,
Crassatella Evansi,
Pectunculus Siouxensis,
Nucula subnasuta,
" ventricosa,
Inoceramus Conradi,
" tenuilineatus,
" convexus,
" sublævis,
" fragilis,

Natica concinna,
Natica obliquata,
" paludinæformis,
Actæon concinnus,
Buccinum vinculum,
Fusus Shumardi,
" constrictus,
" ? tenuilineata,
Rostellaria fusiformis,

Dentalium gracilis,

Helix Leidyi,
Hamites Mortoni,
Ammonites complexus,
" percarinatus,
Ancyloceras Nicolleti,
Baculites grandis,

Callianassa Danai.

Among all the collections made in Texas by Dr. Roemer and others, and of all those brought by the Boundary Survey Expedition, and other surveying and exploring parties, which we have seen, there is but a single species which we regard as doubtfully identical with one from Nebraska. This is the Inoceramus Barabini of Morton (= I. Crispii, Mantell [?]).

The most striking distinction between the fossils of the cretaceous formation of Nebraska, and that of New Jersey and other parts of the United States, is the almost total absence of Ostrea, only two small species being known in the Missouri region, while Exogyra is quite unknown.

The same region has not hitherto furnished a single Echinoderm in all the collections that have been made there during half a century.

Explanation of Plates.

Plate I.

Fig. 1, *a*. Fragment of *Callianassa Danai*, natural size.
" 1, *b*. The same, enlarged.

Fig. 2, *a*. *Lingula subspatulata.*
" 2, *b*. A portion of the surface, enlarged.

Fig. 3, *a*. *Caprinella coraloidea*, the external shell partially removed; showing the interior septate portion, with the thick fibrous shell attached on the inner side of the curve.
" 3, *b*. Exterior view of the inner septate portion denuded of the shell, and showing a shallow longitudinal groove from the base to near the apex.
" 3, *c*. Lateral view of the septate interior portion of the shell.
" 3, *d*. Transverse section of the shell at the larger extremity.
" 3, *e*. A portion of the fibrous or tubular part of the shell, enlarged, showing solid prismatic columns, which are marked by parallel divisional planes transverse to the longitudinal axis.
" 3, *f*. A single column still further enlarged, showing striæ parallel to the divisional planes.

Fig. 4, *a*. *Pecten rigida*, natural size.
" 4, *b*, *c*. The left and right valves, four times magnified.

Fig. 5, *a*. *Avicula Haydeni*, natural size.
" 5, *b*. The same, four times enlarged.

Fig. 6, *a*. *Lucina subundata*, natural size.
" 6, *b*. A portion of the surface, magnified.

Fig. 7. *Cytherea orbiculata*, natural size.

Fig. 8, *a*. *Cytherea tenuis*, natural size.
" 8, *b*. Same, four times magnified.
" 8, *c*. A portion of the surface, still further magnified.

Fig. 9, *a*. *Crassatella Evansi*, exterior or left valve.
" 9, *b*. Interior of same.
" 9, *c*. Surface-markings, enlarged.
" 9, *d*. A cast of same species.
" 9, *e*. Profile view of cast.

Fig. 10, *a*, *b*. *Nucula subnasuta.*
" 10, *c*. Surface-markings, magnified.

Fig. 11, *a*. *Nucula ventricosa*, natural size.
" 11, *b*. The same, greatly magnified.

" 12. *Pectunculus Siouxensis*, a cast of the left valve.

Fig. 13, *a*. *Capulus occidentalis*, east of interior of convex valve.
" 13, *b*. Profile view of same.
" 13, *c*. Base of same.
" 13, *d*. Surface-markings of the base, magnified.

Plate II.

Fig. 1, *a*. *Inoceramus sublævis*, right valve, nearly entire.
" 1, *b*. A portion of the surface magnified.

Fig. 2, *a*. *Inoceramus convexus*, left valve.
" 2, *b*. Profile of same, looking upon the hinge line.

Fig. 3, *a*. *Inoceramus tenuilineatus*, left valve.
" 3, *b*. A portion of the surface of the anterior part of the shell, magnified.

Fig. 4. A portion of the striated surface of the shell of *Inoceramus sagensis*, magnified.

Fig. 5, *a*. *Inoceramus Conradi*, the exterior portion of the shell of both valves, which are distorted by pressure.
" 5, *b*. Surface of same, magnified.

Fig. 6, *a*. *Inoceramus fragilis*, natural size.
" 6, *b*. Surface of same, magnified.

Plate III.

Fig. 1, *a*, *b*. *Natica obliquata*, two views of the same shell.

Fig. 2, *a*. *Natica concinna*, natural size.
" 2, *b*, *c*. Two views of the same, magnified.
" 2, *d*. The surface striæ, magnified.

Fig. 3, *a*, *b*. *Natica paludinæformis*, two views of individuals of different size.
" 3, *c*. The surface magnified, showing the cancellated striæ.

Fig. 4, *a*. *Actæon concinnus*, natural size.
" 4, *b*, *c*. Same, magnified nine times.
" 4, *d*. Surface-markings, highly magnified.

Fig. 5, *a*. *Buccinum vinculum*, natural size.
" 5, *b*. Magnified view of the same.

Fig. 6, *a*. *Fusus Shumardi*, natural size.
" 6, *b*. Magnified view of the opposite side of the same shell.
" 6, *c*. Surface-markings, magnified.

Fig. 7. *a*, *Fusus constrictus*, natural size.
" 7, *b*, *c*. Magnified views of the same.
" 7, *d*. Magnified views of surface-markings.

Fig. 8, *a*, *b*. *Fusus ? tenuilineatus*, two views of a fragment, preserving about two volutions and a half.
" 8, *c*. Surface-markings, highly magnified.
Fig. 9, *a*, *b*. Two views of a fragment of the same, showing the aperture. From the collection of B. F. Shumard.
" 9, *c*. Surface of same, magnified.

Fig. 10, *a*, *b*. *Rostellaria fusiformis*, two views of the same individual.

Fig. 11, *a*. *Dentalium gracilis*, fragments, natural size.
" 11, *b*. Transverse section of the larger extremity.
" 11, *c*. Magnified view of surface.

Fig. 12, *a*, *b*. *Helix Leidyi*, two views of the same individual. From the Eocene Tertiary of the Mauvaises Terres.

Plate IV.

Fig. 1, *a*. *Ammonites complexus*, a young individual.
" 1, *b*, *c*. Two views of a fragment of a larger shell.
" 2, *d*. Form of the septa, as shown in the young specimen.
Fig. 1, *e*. Superior lateral lobe of the adult specimen.
" 1, *f*. Dorsal lobe of the same individual.

Fig. 2, *a*, *b*, *c*. *Ammonites peracutus*, views of different individuals.

Fig. 3, *a*. *Hamites Mortoni*, a fragment.
" 3, *b*. Section of larger extremity.
" 3, *c*. Arrangement of septa in the same specimen.

Fig. 4. *Ancyloceras Nicolletii*, a fragment.

Plate V.

Fig. 1, *a*. *Baculites ovatus*, showing the form of aperture, surface striæ, and undulations upon the ventral half of the shell.
" 1, *b*. A fragment, showing septa.
" 1, *c*. Transverse section of the same.

Fig. 2, *a*. *Baculites compressus*, showing the form of the aperture, surface striæ, and arrangement of septa towards the base of the figure.
" 2, *b*. Transverse section of the same.

Plate VI.

Illustrations of the Septa in Baculites Ovatus, B. Compressus, and B. Grandis.

Fig. 1. *Baculites ovatus*, a fragment of an extremely young individual.
" 1, *a*. Plan of a septum in the smaller extremity of fig. 1.
" 1, *b*. A septum at the larger extremity of the same.

Fig. 2. A larger individual of the same species.
" 2, *a*. Plan of a septum in fig. 2.

Figs. 3, 4, and 5, are young individuals of larger growth than the preceding, and of which figs. 3, *a*, 4, *a*, and 5, *a*, respectively show plans of the septa.

Fig. 6. Plan of septum in an adult individual of *Baculites ovatus*.

Fig. 7. Superior lateral lobe of *Baculites ovatus*, for comparison with corresponding parts of *B. compressus*, fig. 9, and *B. grandis*, fig. 10.

Fig. 8. Plan of septum in a full-grown individual of *Baculites compressus*.

Fig. 9. Superior lateral lobe of *B. compressus*.

Fig. 10. Superior lateral lobe of *B. grandis*.

Plate VII.

Fig. 1. *Baculites grandis*, a fragment of the septate portion of the shell.

Fig. 2. Transverse section of *B. grandis*. The inner figure is a section of the smaller extremity of fig. 1. The second figure is of the smaller extremity of Pl. VIII., fig. 1, measured in the depressions between the undulating ridges; and the outer figure is the measurement over the ridges which give a different outline to the section.

Fig. 3 and 4. Tracks of Planarian worms?

Plate VIII.

Fig. 1. *Baculites grandis*; fragment of the outer chamber, showing the transverse undulating ridges which characterize this species externally.

Fig. 2. Plan of a septum of *B. grandis*.

ADDITIONS AND CORRECTIONS.

Since the preceding paper was communicated, we have had an opportunity of examining more extensive collections of specimens from the Nebraska Territory, brought down by Dr. Hayden. Among these are better preserved specimens of several species here described, which enable us to determine their characters with more precision than could be done with our former collections.

Page 391. Fusus constrictus. An examination of a larger and better preserved specimen induces us to regard this fossil as belonging to the genus Buccinum.

Page 393. Dentalium gracilis. Seventh line of description, for "spiral angle" read "apicial angle."

Page 394. Helix Leidyi. The aperture is ovate, subangular behind.

Page 396. Hamites Mortoni. This fossil presents some characters incompatible with the genus Hamites, and may be placed under Ancyloceras, if we adopt the characters of that genus as given by Pictet. In the same manner the *Ancyloceras? Nicolletii* will be included under the genus Ancyloceras as defined by Pictet, but not as limited by D'Orbigny.

Page 401. Last word on the page, for "longer" read "larger."

NOTE.

In the spring of 1853, the writer of this note was induced to provide the means for a collector to visit and explore some portions of the Mauvaises Terres of Nebraska. He was assured that no government expedition would be sent there that year; and being unable to learn that any private expedition was contemplated, he concluded that the field would be unoccupied, and hoped that some new light might be thrown upon these distant regions, which had but just begun to yield their treasures to the geologist and palæontologist. One of the principal objects of this expedition was the discovery of the fossil flora of this period, so prolific in remains of Mammalia, as well as to determine more clearly the relations between the Cretaceous formations of the Missouri Valley and those of the region especially known as the Mauvaises Terres.

Circumstances which it is not neccessary to detail here, and over which the writer or the exploring party had no control, frustrated in a great measure the original objects of the expedition.

The collections made, and facts ascertained, during the short period which the party remained on the ground, have contributed something to our knowledge of the geology of this region; and the preceding new species from the Cretaceous formation of the Northwest are not without interest. These would have been given to the public at an earlier period, but have been postponed at the especial request of other parties having new species from the same region. These have already been made known, and are cited in the list of published species given on page 405; there is, therefore, no longer any reason for delaying the publication of the foregoing species, which, it will be seen, comprise a number equal to all that have before been described from the Cretaceous formation of that country.

J. H.

XVIII.

Supplement to Memoir XI. *of this Volume, on "The Numerical Relation between the Atomic Weights, with some Thoughts on the Classification of the Chemical Elements."*

Since the printing of the above memoir, the author has altered the details of his classification so far as regards the *metallic elements*, — 1st, by transferring several members of the Four Series to the Three Series; 2d, by subdividing each of these series into groups. The classification as thus altered is presented in the table accompanying the memoir, and conforms to the principle of chemical series more closely than that given in the table originally intended to accompany the memoir, and subsequently published in the American Journal of Science and Arts, Second Series, Vol. XVII. p. 387. The serial relations of the metallic elements may be traced, in the first place, in the groups considered each as a whole, and, in the second place, in the members of any one group by itself. From the limited amount of space assigned to this supplement, it will not be possible to follow out these relations, but they will be suggested to any chemist on inspecting the table. Most of the rarer metals have been omitted in it, not only because their properties are generally very imperfectly known, but also because the table was chiefly intended for teaching elementary chemistry.

J. P. C.

Cambridge, April 5th, 1856.

ERRATA.

Page 239, *line* 18, *for* mutantis, *read* mutatis.
" 241, " 14, " Eight Series, " Nine Series.
" 256, " 15, " Rhombic, " Hexagonal.

STATUTES

AND

STANDING VOTES

OF THE

AMERICAN ACADEMY OF ARTS AND SCIENCES.

(*Adopted May 30th*, 1854.)

CHAPTER I.

Of Fellows and Foreign Honorary Members.

1. The Academy consists of *Fellows* and *Foreign Honorary Members.* They are arranged in three classes, according to the Arts and Sciences in which they are severally proficient; viz. Class I. The Mathematical and Physical Sciences; Class II. The Natural and Physiological Sciences; Class III. The Moral and Political Sciences. Each Class is divided into four Sections; viz. Class I. Section 1. Mathematics; Section 2. Practical Astronomy and Geodesy; Section 3. Physics and Chemistry; Section 4. Technology and Engineering. Class II. Section 1. Geology, Mineralogy, and Physics of the Globe; Section 2. Botany; Section 3. Zoölogy and Physiology; Section 4. Medicine and Surgery. Class III. Section 1. Philosophy and Jurisprudence; Section 2. Philology and Archæology; Section 3. Political Economy and History; Section 4. Literature and the Fine Arts.

2. Fellows resident in the State of Massachusetts can alone vote at the meetings of the

Academy.* They shall each pay to the Treasurer the sum of five dollars on admission, and an annual assessment of two dollars, with such additional sum, not exceeding three dollars, as the Academy shall, by a standing vote, from time to time determine.

3. Fellows residing out of the State of Massachusetts shall be known and distinguished as Associate Fellows. They shall not be liable to the payment of any fees or annual dues, but, on removing within the State, shall be admitted to the privileges, and be subject to the obligations, of Resident Fellows. The number of Associate Fellows shall not exceed *one hundred*, of whom there shall not be more than *forty* in either of the three classes of the Academy.

4. The number of Foreign Honorary Members shall not exceed *seventy-five;* and they shall be chosen from among persons most eminent in foreign countries for their discoveries and attainments in either of the three departments of knowledge above enumerated. And there shall not be more than thirty Foreign Members in either of these departments.

CHAPTER II.

Of Officers.

1. There shall be a President, a Vice-President, a Corresponding Secretary, a Recording Secretary, a Treasurer, and a Librarian, which officers shall be annually elected, by written votes, at the Annual Meeting, on the day next preceding the last Wednesday in May.

2. At the same time and in the same manner, nine Councillors shall be elected, three from each class of the Academy, who, with the President, Vice-President, and the two Secretaries, shall constitute a Council for Nomination. It shall also be the duty of this Council to exercise a discreet supervision over all nominations and elections, and to exert their influence to obtain and preserve a due proportion in the number of Fellows and Members in each of the sections.

3. If any office shall become vacant during the year, the vacancy shall be filled by a new election, at the next stated meeting.

CHAPTER III.

Of the President.

1. It shall be the duty of the President, and, in his absence, of the Vice-President or next

* The number of Resident Fellows is limited by the Charter to 200.

officer in order, as above enumerated, to preside at the meetings of the Academy; to summon extraordinary meetings, upon any urgent occasion; and to execute or see to the execution of the statutes of the Academy.

2. The President, or, in his absence, the next officer as above enumerated, is empowered to draw upon the Treasurer for such sums of money as the Academy shall direct. Bills presented on account of the Library, or the publications of the Academy, must be previously approved by the respective committees on these departments.

3. The President, or, in his absence, the next officer as above enumerated, shall nominate members to serve on the different committees of the Academy.

4. Any deed or writing, to which the common seal is to be affixed, shall be signed and sealed by the President, when thereto authorized by the Academy.

CHAPTER IV.

Of Standing Committees.

1. At the Annual Meeting there shall be chosen, upon the nomination of the President, the following Standing Committees, to serve for the year ensuing; viz.: —

2. The Rumford Committee, of five Fellows, to consider and report on all applications for the Rumford Premium.

3. The Committee of Publication, of three Fellows, to whom all memoirs submitted to the Academy shall be referred, and to whom the printing of memoirs accepted for publication shall be intrusted.

4. The Committee on the Library, of three Fellows, who shall examine the Library, and make an annual report on its condition and management.

5. An Auditing Committee, of two Fellows, for auditing the accounts of the Treasurer.

CHAPTER V.

Of the Secretaries.

1. The Corresponding Secretary shall conduct the correspondence of the Academy, recording or making an entry of all letters written in its name, and preserving on file all letters which are received; and at each meeting he shall present the letters which have been addressed to the Academy since the last meeting. With the advice and consent of the President, he may effect exchanges with other scientific associations, and also distribute copies of the publications of the Academy among the Associate Fellows and Foreign Honorary Members, as shall be deemed expedient; making a report of his proceedings at the Annual Meeting. Under the direction of the Council for Nomination, he shall keep a list of the Fellows, Associate Fellows, and Foreign Honorary Members, arranged in their classes and in sections in respect to the special sciences in which they are severally proficient; and shall act as secretary to the Council.

2. The Recording Secretary shall have charge of the Charter and statute-book, journals, and all literary papers belonging to the Academy. He shall record the proceedings of the Academy at its meetings; and after each meeting is duly opened, he shall read the record of the preceding meeting. He shall notify the meetings of the Academy, and apprise committees of their appointment. He shall post up in the Hall a list of the persons nominated for election into the Academy; and when any individual is chosen, he shall insert in the record the names of the Fellows by whom he was nominated.

3. The two Secretaries, with the chairman of the Committee of Publication, shall have authority to publish such of the Proceedings of the Academy as may seem to them calculated to promote the interests of science.

CHAPTER VI.

Of the Treasurer.

1. The Treasurer shall give such security for the trust reposed in him as the Academy shall require.

2. He shall receive officially all moneys due or payable, and all bequests or donations made to the Academy, and, by order of the President or presiding officer, shall pay such sums as the

Academy may direct. He shall keep an account of all receipts and expenditures; shall submit his accounts to the Auditing Committee; and shall report the same at the expiration of his term of office.

3. The Treasurer shall keep a separate account of the income and appropriation of the Rumford Fund, and report the same annually.

4. All moneys which there shall not be present occasion to expend shall be invested by the Treasurer, on such securities as the Academy shall direct.

CHAPTER VII.

Of the Librarian and Library.

1. It shall be the duty of the Librarian to take charge of the books, to keep a correct catalogue of the same, and to provide for the delivery of books from the Library. He shall also have the custody of the publications of the Academy.

2. The Librarian, in conjunction with the Committee on the Library, shall have authority to expend, as they may deem expedient, such sums as may be appropriated, either from the Rumford or the General Fund of the Academy, for the purchase of books and for defraying other necessary expenses connected with the Library. They shall have authority to propose rules and regulations concerning the circulation, return, and safe-keeping of books; and to appoint such agents for these purposes as they may think necessary.

3. Every person who takes a book from the Library shall give a receipt for the same to the Librarian or his assistant.

4. Every book shall be returned in good order, regard being had to the necessary wear of the book with good usage. And if any book shall be lost or injured, the person to whom it stands charged shall replace it by a new volume or set, if it belong to a set, or pay the current price of the volume or set to the Librarian; and thereupon the remainder of the set, if the volume belonged to a set, shall be delivered to the person so paying for the same.

5. All books shall be returned to the Library for examination, at least one week before the Annual Meeting.

CHAPTER VIII.

Of Meetings.

1. There shall be annually four stated meetings of the Academy; namely, on the day next preceding the last Wednesday in May (the Annual Meeting), on the second Wednesday in August, on the second Wednesday in November, and on the last Wednesday in January; to be held in the Hall of the Academy in Boston. At these meetings only, or at meetings adjourned from these and regularly notified, shall appropriations of money be made, or alterations of the statutes or standing votes of the Academy be effected.

2. Fifteen Fellows shall constitute a quorum for the transaction of business at a stated meeting. Seven Fellows shall be sufficient to constitute a meeting for scientific communications and discussions.

3. The Recording Secretary shall notify the meetings of the Academy to each Fellow residing in Boston and the vicinity; and he may cause the meetings to be advertised, whenever he deems such further notice to be needful.

CHAPTER IX.

Of the Election of Fellows and Honorary Members.

1. Elections shall be made by ballot, and only at the stated meetings in May, November, and January.

2. Candidates for election as Resident Fellows must be proposed by two or more Resident Fellows, in a recommendation signed by them, specifying the section to which the nomination is made; which recommendation shall be read at a stated meeting, and then stand on the nomination list during the interval between two stated meetings, and until the balloting.

3. The nomination of Associate Fellows shall take place in the manner prescribed in reference to Resident Fellows; and after such nomination shall have been publicly read at a stated meeting previous to that when the balloting takes place, it shall be referred to a Council for Nomination; and a written approval, authorized and signed at a meeting of said Council by at least seven of its members, shall be requisite to entitle the candidate to be balloted for. The

Council may in like manner originate nominations of Associate Fellows; which must be read at a stated meeting previous to the election, and be exposed on the nomination list during the interval.

4. Foreign Honorary Members shall be chosen only after a nomination made at a meeting of the Council, signed at the time by at least seven of its members, and read at a stated meeting previous to that on which the balloting takes place.

5. Three fourths of the ballots cast must be affirmative, and the number of affirmative ballots must amount to eleven, to effect an election of Fellows or Foreign Honorary Members.

6. Each section of the Academy is empowered to present lists of persons deemed best qualified to fill vacancies occurring in the number of Foreign Honorary Members or Associate Fellows allotted to it; and such lists, after being read at a stated meeting, shall be referred to the Council for Nomination.

CHAPTER X.

Of Amendments of the Statutes.

1. All proposed alterations of the statutes, or additions to them, shall be referred to a committee during the interval between two stated meetings, and shall require for enactment a majority of two thirds of the members present, and at least eighteen affirmative votes.

2. Standing Votes may be passed, amended, or rescinded, at any stated meeting, by a majority of two thirds of the members present. They may be suspended by a unanimous vote.

CHAPTER XI.

Of Literary Performances.

1. The Academy will not express its judgment on literary or scientific memoirs or performances submitted to it, or included in its publications.

STANDING VOTES.

1. Communications of which notice has been given to the Secretary shall take precedence of those not so notified.

2. Resident Fellows who have paid all fees and dues chargeable to them are entitled to receive one copy of each volume or article printed by the Academy, on application to the Librarian personally or by written order, within two years from the date of publication.

3. Resident Fellows may borrow and have out from the Library six volumes at any one time, and may retain the same for three months, and no longer.

4. Upon special application, and for adequate reasons assigned, the Librarian may permit a larger number of volumes, not exceeding twelve, to be drawn from the Library, for a limited period.

5. Works published in numbers, when unbound, shall not be taken from the Hall of the Academy, except by special leave of the Librarian.

6. The annual assessment upon Resident Fellows shall be five dollars, until otherwise ordered.

7. The annual meeting shall be holden at half past three o'clock, P. M. The other stated meetings at half past seven o'clock, P. M.

8. A meeting for receiving and discussing scientific communications shall be held on the second Tuesday of each month, excepting the three summer months.

RUMFORD PREMIUM.

In conformity with the last will of Benjamin Count Rumford, granting a certain fund to the American Academy of Arts and Sciences, and with a decree of the Supreme Judicial Court for carrying into effect the general charitable intent and purpose of Count Rumford, as expressed in his said will, the Academy is empowered to make from the income of said fund, as it now exists, at any annual meeting, an award of a gold and silver medal, being together of the intrinsic value of three hundred dollars, as a premium, to the author of any important discovery or useful improvement in light or in heat, which shall have been made and published by printing, or in any way made known to the public, in any part of the continent of America, or any of the American islands; preference being always given to such discoveries as shall, in the opinion of the Academy, tend most to promote the good of mankind; and to add to such medals, as a further premium for such discovery and improvement, if the Academy see fit so to do, a sum of money not exceeding three hundred dollars.

FELLOWS.

CLASS I.

Mathematical and Physical Sciences.

Section I.

Mathematics.

Benjamin A. Gould, Jr.,	Cambridge.
Thomas Hill,	Waltham.
Thomas Sherwin,	Boston.
Joseph Winlock,	Cambridge.

Section II.

Practical Astronomy and Geodesy.

William C. Bond,	Cambridge.
George P. Bond,	Cambridge.
J. Ingersoll Bowditch,	Boston.
Charles Henry Davis,	Cambridge.
William Mitchell,	Nantucket.
Miss Maria Mitchell,	Nantucket.
Robert Treat Paine,	Boston.

Section III.

Physics and Chemistry.

Joseph Hale Abbot,	Beverly.
John Bacon, Jr.,	Boston.
John H. Blake,	Boston.
William F. Channing,	Boston.
Josiah P. Cooke,	Cambridge.
William P. Dexter,	Boston.
Augustus A. Hayes,	Boston.
Albert Hopkins,	Williamstown.
Eben N. Horsford,	Cambridge.
Joseph Lovering,	Cambridge.
Francis Peabody,	Salem.

Section IV.

Technology and Engineering.

James F. Baldwin,	Boston.
Simeon Borden,	Fall River.
Edward C. Cabot,	Boston.
Henry L. Eustis,	Cambridge.
James B. Francis,	Lowell.
Nathan Hale,	Boston.
James Hayward,	Boston.
Charles Jackson,	Boston.
John C. Lee,	Salem.
William R. Lee,	Boston.
Charles S. Storrow,	Lawrence.
William H. Swift,	Boston.
John H. Temple,	Boston.
Daniel Treadwell,	Cambridge.
Morrill Wyman,	Cambridge.

CLASS II.

Natural and Physiological Sciences.

Section I.

Geology, Mineralogy, and Physics of the Globe.

Francis Alger,	South Boston.
Thomas T. Bouvé,	Boston.
Edward Hitchcock,	Amherst.
Jonathan P. Hall,	Boston.
Charles T. Jackson,	Boston.
Henry D. Rogers,	Boston.
William B. Rogers,	Boston.
Josiah D. Whitney,	Northampton.

Section II.

Botany.

Jacob Bigelow,	Boston.
George B. Emerson,	Boston.
Asa Gray,	Cambridge.
Benjamin D. Greene,	Boston.
John A. Lowell,	Boston.
John L. Russell,	Salem.
Edward Tuckerman,	Amherst.

Section III.

Zoölogy and Physiology.

Louis Agassiz,	Cambridge.
Thomas M. Brewer,	Boston.
Samuel Cabot, Jr.,	Boston.
Silas Durkee,	Boston.
Augustus A. Gould,	Boston.
Samuel Kneeland, Jr.,	Boston.
Charles Pickering,	Boston.
D. Humphreys Storer,	Boston.
Henry Wheatland,	Salem.
Jeffries Wyman,	Cambridge.

Section IV.

Medicine and Surgery.

Samuel L. Abbot,	Boston.
Henry J. Bigelow,	Boston.
Henry I. Bowditch,	Boston.
Benjamin E. Cotting,	Roxbury.
George Hayward,	Boston.
Oliver W. Holmes,	Boston.
James Jackson,	Boston.
John B. S. Jackson,	Boston.
Henry C. Perkins,	Newburyport.
Edward Reynolds,	Boston.
John Ware,	Boston.
Charles E. Ware,	Boston.
John C. Warren,	Boston.
Jonathan M. Warren,	Boston.

CLASS III.

Moral and Political Sciences.

Section I.

Philosophy and Jurisprudence.

William Allen,	Northampton.
Francis Bowen,	Cambridge.
Rufus Choate,	Boston.
Benjamin R. Curtis,	Pittsfield.
Mark Hopkins,	Williamstown.
Heman Humphrey,	Amherst.
Charles G. Loring,	Boston.
Ichabod Nichols,	Cambridge.
Joel Parker,	Cambridge.
Theophilus Parsons,	Cambridge.
Ephraim Peabody,	Boston.
George Putnam,	Roxbury.
Lemuel Shaw,	Boston.
William A. Stearns,	Amherst.
James Walker,	Cambridge.
Daniel A. White,	Salem.

Section II.

Philology and Archæology.

Albert N. Arnold,	Newton.
Charles Beck,	Cambridge.
Epes S. Dixwell,	Cambridge.
Cornelius C. Felton,	Cambridge.
Charles Folsom,	Cambridge.
William Jenks,	Boston.
George M. Lane,	Cambridge.
George Livermore,	Cambridge.
George R. Noyes,	Cambridge.
James Savage,	Boston.
Nathaniel B. Shurtleff,	Boston.
Samuel Swett,	Boston.
William Wells,	Cambridge.
Joseph E. Worcester,	Cambridge.

Section III.

Political Economy and History.

Nathan Appleton,	Boston.
Caleb Cushing,	Newburyport.
Edward Everett,	Boston.
Samuel Hoar,	Concord.
Levi Lincoln,	Worcester.
Francis Parkman,	Boston.
Willard Phillips,	Cambridge.
William H. Prescott,	Boston.
Josiah Quincy,	Boston.
John Reed,	Bridgewater.
Jared Sparks,	Cambridge.
Richard Sullivan,	Boston.
Robert C. Winthrop,	Boston.

Section IV.

Literature and the Fine Arts.

Francis J. Child,	Cambridge.
Samuel A. Eliot,	Boston.
Francis C. Gray,	Boston.
John C. Gray,	Boston.
Richard Greenough,	Boston.
Henry W. Longfellow,	Cambridge.
Francis C. Lowell,	Boston.
James Russell Lowell,	Cambridge.
Octavius Pickering,	Boston.
George Ticknor,	Boston.
Edward Wigglesworth,	Boston.

ASSOCIATE FELLOWS.

CLASS I.

Mathematical and Physical Sciences.

Section I.

Mathematics.

Charles Avery,	Clinton, N. Y.
Alexis Caswell,	Providence, R. I.
William Chauvenet,	Annapolis, Md.
Charles Davies,	Fishkill, N. Y.
Jeremiah Day,	New Haven, Conn.
Charles Gill,	Flushing, L. I.
J. S. Hubbard,	Washington, D. C.
William Smyth,	Brunswick, Me.
Theodore Strong,	New Brunswick, N. J.

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