PROCEEDINGS

OF THE

AMERICAN ACADEMY

OF

ARTS AND SCIENCES.

VOL. III.

FROM MAY, 1852, TO MAY, 1857.

BOSTON AND CAMBRIDGE:

METCALF AND COMPANY,

PRINTERS TO THE UNIVERSITY.

1857.

the *Scrophulariaceæ*, and to some observations made by his pupil, Mr. Clark, several years ago, upon *Mimulus*, showing that this genus of the *Antirrhinideæ* not rarely has the lobes of the lower lip of the coralla external in æstivation, as in the *Rhinanthideæ*. Professor Gray had recently noticed the same thing in an anomalous still unpublished *Pentstemon*, which presented both modes of æstivation in different flower-buds of the same inflorescence.

The Corresponding Secretary communicated, from the author, the following

"*Synopsis of the Cactaceæ of the Territory of the United States and Adjacent Regions*, by GEORGE ENGELMANN, M. D., of St. Louis, Missouri. 1856, cf Am. Journ. Sci. 2nd ser. 21-23, Jan. 1857.

"The only Cactus known to Linnæus from the countries north of Mexico was his *Cactus Opuntia* (*Opuntia vulgaris*). Long after him, more than forty years ago, Nuttall, the pioneer of West American botany, discovered two *Mamillariæ* and two *Opuntiæ* on the Upper Missouri, and again, twenty years later, in California, a new *Echinocactus*. About ten years ago we became acquainted with numerous new Cactaceæ, in Texas through Mr. F. Lindheimer; in New Mexico through Dr. A. Wislizenus; and in Northern Mexico through the same explorer and Dr. J. Gregg: some others (and among them the giant of Cacti) were indicated in the Gila country by the then Lieutenant W. H. Emory. Soon afterwards Mr. A. Fendler collected several new species about Santa Fé. Mr. Charles Wright, a few years later (1849), discovered in Western Texas and Southern New Mexico still other undescribed Cacti.

"But the greatest addition to our knowledge of the Cactaceæ of the southern part of the United States was made by the gentlemen connected with the United States and Mexican Boundary Commission, at first under Colonel Graham, and subsequently under Major Emory. Science is indebted principally to Dr. C. C. Parry, Mr. Charles Wright, Dr. J. M. Bigelow, Mr. George Thurber, and Mr. A. Schott, for valuable collections of living as well as dried specimens, and for full notes taken on the spot.

"About the same time, Mr. A. Trécul of France, and after him Dr. H. Poselger of Prussia, traversed Southern Texas and Northern Mexico, collecting many Cactaceæ, and increasing our knowledge of this interesting branch of botanical science.

"The Pacific Railroad expeditions since 1853 have opened fields not before explored; and Dr. Bigelow, the botanist and physician of Captain A. W. Whipple's expedition along the 35th parallel, availed himself of these opportunities in a most successful manner; while Dr. F. V. Hayden, almost unaided in his adventurous expedition, has extended our knowledge of the northernmost Cactaceæ in the regions of the Upper Missouri and Yellowstone Rivers.

"The last, but by no means least addition, was made in 1854 and 1855, by Mr. Arthur Schott, during the exploration under Major Emory of the country south of the Gila River, known as the Gadsden Purchase.

"Most of the materials brought together by these different explorers have come into the hands of the writer; but few of the discoveries made since 1847 and 1848 have been given to the public; — partly because the material on hand very often was incomplete, and partly because it seemed desirable to publish the whole in an elaborate form with the Reports of the Boundary Commission and those of the Pacific Railroad Surveys. These reports are now in preparation; but the splendid plates which are to illustrate the natural history of these plants cannot be finished for some time; it is therefore deemed advisable now to publish short descriptions of the new species, and systematically to arrange them with those before known.

CACTACEÆ.

Tribus I. TUBULOSÆ, Miquel.

Subtrib. 1. PARALLELÆ. Cotyledones margine hilum versus spectantes, lateribus seminis parallelæ.

I. MAMILLARIA, Haw.

Ovarium baccaque lævis. Semina fere exalbuminosa. Cotyledones abbreviatæ, plerumque erectæ, subconnatæ. — Plantæ mamillato-tuberculatæ; inflorescentia laterali s. verticali.

Subgen. 1. EUMAMILLARIA. Flores ex axillis tuberculorum anni prioris nunquam sulcatorum: ovarium plerumque immersum versus fructus maturitatem emergens.

§ 1. *Polyacanthæ*, Salm.

1. M. MICROMERIS, E. in Bound. Comm. Rep.: parvula, simplex, globosa; tuberculis minimis verrucæformibus confertissimis; areolis

junioribus solum lana laxa vestitis; aculeis setiformibus cinereis pluriseriatis, in plantis junioribus sub 20 æqualibus lineam longis, radiantibus in tuberculis floriferis 30 – 40 undique stellato-porrectis, superioribus 6 – 8 longioribus clavatis; floribus minimis subcentralibus.

Var. β. GREGGII: major, tuberculis majoribus aculeis paucioribus rigidioribus.

From El Paso eastward to the San Pedro River. Var. β. near Saltillo. From ½ to 1½ inches in diameter; β. often 2 inches or even more in diameter; tubercles ½ – 1 line long, spines ½ – 1½ lines long, in β. 1 – 2 lines long; uppermost spines of each areola in the fully developed plant 3 to 4 times as long as the others, and strongly clavate, surrounded by long and loose wool, which, together with the upper part of the long spines, breaks or falls off after fructification. Flowers (and even fruits) nearly central, 3 lines in diameter, light pink. — Near *M. microthele*, Muhlenp., which, however, has 2 central spines.

2. M. LASIACANTHA, E. l. c.: parvula, simplex, globosa; tuberculis teretibus; aculeis setiformibus pilosulis s. denudatis 40 – 80 pluriseriatis omnibus radiantibus; floribus lateralibus albidis.

On the Pecos River, in Western Texas: fl. in May. — Plant ½ to 1 or even 1½ inches high, and scarcely less in diameter; tubercles 2 – 3 lines long, spines 1½ – 2½ lines long. Flower whitish or very pale pink, 6 lines long. — *M. Schiedeana*, Ehrenb. seems to be similar, but is much larger, and has large tubercles with woolly axillæ, etc.

§ 2. *Crinitæ*, Salm.

A. *Aculeis centralibus rectis.*

3. M. PUSILLA, DC., var. TEXANA, E. l. c.: ovato-globosa, prolifera, cæspitosa; tuberculis teretibus axilla longe-lanatis; aculeis pluri-seriatis, extimis 30 – 50 capillaceis crispatis, interioribus 10 – 12 rigidioribus brevioribus albidis, intimis 5 – 8 longioribus rigidis rectis versus apicem fuscatis; floribus lateralibus rubellis.

On the Rio Grande, near Eagle Pass and southward: fl. April – June. — Plant 1 – 2 inches high; spines 3 – 6 lines, flowers 7 – 10 lines, long. — Seems scarcely distinct from the well-known West Indian *M. pusilla.*

B. *Aculeis centralibus uno alterove uncinato.*

4. ? M. BARBATA, E. in Wisl. Rep.: aculeis radialibus biseriatis, centrali singulo deorsum hamato; floribus subcentralibus; seminibus tenuiter scrobiculatis.

Cosiquiriachi, west of Chihuahua. This species has borne flower and fruit with me, and my notes and my recollections indicate that they were central: hence the mark of doubt above, as to the proper position of this species here, where all the other closely allied forms belong.

5. M. PHELLOSPERMA, E. in B. C. R. (M. tetrancistra, *E. in part, Sill. Jour. Nov.* 1852): ovata, subsimplex; tuberculis teretibus axilla lanata setigeris; aculeis radiantibus 40–60 biseriatis, exterioribus brevioribus tenuioribus, centralibus 3–4 robustioribus atrofuscis inferiore s. pluribus hamatis; floribus lateralibus; bacca pyriformi subsicca coccinea; seminibus globosis rugosis nigris massa fusca suberosa majore arilliformi auctis.

From the Gila to the eastern slope of the California mountains. — The name originally given had to be altered, because very rarely, if ever, are 4 hooked spines seen. In the original description this and the next species were confounded. — Plant 2–4 inches high. Radial spines 4–6 lines, central ones 5–9 lines long. — Apparently near *M. ancistroides*, Lem., which, however, has the radial spines all homogeneous.

6. M. GRAHAMI, E. l. c.: subglobosa, simplex s. demum e basi ramosa; tuberculis ovatis, axilla nudis; aculeis radiantibus 20–30 uniseriatis, centrali sursum hamato fuscato, additis sæpe 1–2 superioribus rectis; floribus lateralibus rubicundis; bacca ovata virescente; seminibus minutis scrobiculatis nigris.

Mountains from El Paso southward and westward to the Gila and Colorado, and up the latter river: fl. from June or July to August. — Plant 1–3 inches high; hooks much longer than the radial spines, which are 3–6 lines long. Flowers below the top, nearly one inch in diameter. Berry and seed small, the latter only 0.4 line long.

7. M. WRIGHTII, E. l. c.: depresso-globosa, simplex; tuberculis teretibus axilla nudis; aculeis radiantibus sub 12 albidis; centralibus sub-binis uncinatis fuscis vix longioribus; floribus lateralibus (?) purpureis; bacca subgloboso-ovata majuscula; seminibus scrobiculatis nigris.

New Mexico, on the Pecos and near the Copper Mines. — Plants $1\frac{1}{2}$–3 inches in diameter. Spines 4–6 lines long. Flowers fully one inch in diameter, bright purple, with narrow acuminate petals. Berry large and purple: seed 0.7 line long.

8. M. GOODRICHII, Scheer: ovato-globosa, subsimplex; tuberculis

brevi-ovatis axilla lanata setigeris; aculeis radiantibus 11 – 15 albidis, centralibus 3 – 4 fusco-atris, inferiore paulo longiore deorsum uncinato; floribus lateralibus.

San Diego, California. — Two or three inches high. Radial spines $2\frac{1}{2} - 3\frac{1}{2}$ lines long; the lower central spine a little longer. Flowers apparently yellowish-white, and half an inch in diameter.

§ 3. *Setosæ*, Salm.

9. M. BICOLOR, Lehm.: depressa, ovata, s. cylindracea, prolifera; axillis lanatis; tuberculis parvulis conicis; aculeis exterioribus 16 – 20 tenuissimis recurvato-radiantibus, centralibus 2 – 4 rigidis, majoribus albis apice nigris interdum subpollicaribus, supremo plerumque longissimo incurvo; floribus parvulis purpureis; stigmatibus 5.

Abundant on the calcareous hills of the Rio Grande below Laredo, Texas, *Dr. Poselger:* fl. June and July. — Plant 3 – 12 inches high, the larger specimens 2 – 3 inches in diameter; radial spines 1 – 2, lower central ones 4 – 5, the upper 6 – 10 lines long. Flower about 9 lines long.

§ 4. *Centrispinæ*, Salm. (All our species are simple and have a milky juice.)

10. M. HEYDERI, Muhlenpf. (1848): simplex, depresso-globosa; tuberculis elongatis pyramidatis subquadrangulatis; aculeis radiantibus 10 – 20 rectis, inferioribus longioribus, centrali singulo breviore; floribus lateralibus sordide rubellis; baccis elongato-clavatis; seminibus parvis rugulosis fulvis.

Var. *α.* APPLANATA (M. applanata, *E. in Pl. Lindh.* 1850): vertice applanato s. depresso, aculeis radialibus 15 – 22.

Var. *β.* HEMISPHÆRICA (M. hemisphærica, *E. l. c.*): vertice convexo, aculeis radialibus 9 – 12.

From San Antonio and New Braunfels, Texas, to Matamoras and westward to El Paso: fl. April, May. — Var. *α.* is the Northern and Western, and *β.* the Southern form. — *M. declivis*, Dietr. seems to belong here; but I have never met with a description of this plant.

11. M. MEIACANTHA, E. in B. C. R.: hemisphærica; tuberculis quadrangulato-pyramidatis compressis; aculeis paucis (5 – 9) rigidis rectis s. recurvatis, inferioribus paulo longioribus, centrali singulo erecto s. sursum flexo et cum cæteris radiante; floribus et baccis præcedentis.

Western Texas and New Mexico. — Very similar to the last; but tubercles larger, more compressed, more loosely arranged; the spines fewer and stouter; perhaps only a variety of it.

12. M. GUMMIFERA, E. in Wisl. Rep. Similar to the last two, but stouter; flower larger, darker, but otherwise little different. Radial spines 10 – 12; the lower ones much stouter and longer than the upper ones: central spines 1 or 2, shorter.

§ 5. *Longimammæ*, Salm.

13. M. SPHÆRICA, Dietr.: prolifera, cæspitosa; tuberculis ovato-elongatis acutatis; aculeis setaceis radialibus 12 – 14, centrali singulo subbreviore vix robustiore; floris magni tubo supra ovarium emersum constricto elongato; petalis flavis acuminato-aristatis.

Hill-sides on the Rio Grande near Eagle Pass; also Corpus Christi, on the Gulf. — Single specimens clavate, but often forming dense hemispherical masses. Tubercles 6 – 8 lines; spines 3 – 5 lines long. Flower 1½ – 2 inches long. Fruit not seen.

Subgen. 2. CORYPHANTHA. Flores e basi tuberculorum hornotinorum aculeiferorum sulcatorum, vel in vertice ipso oriundi: ovarium emersum.

§ 1. *Albifloræ.*

14. M. PAPYRACANTHA, E. in Pl. Fendl. (Mem. Amer. Acad. 1849). This interesting plant has been collected only in a single specimen, near Santa Fé, which, together with the dried flowers, is in my possession. Shape of tubercles not well distinguishable, doubtful whether sulcate or not; the lower ones proliferous. Spines compressed, flexible, of the consistency of stiff paper; 8 radiating and 3 or 4 central; the lowest one of these longest and broadest. Flowers white, central, an inch or more in length and width. Fruit not seen.

§ 2. *Flavifloræ.*

* *Laxifloræ.* (The originally central flowers are pushed aside by the continuous development of new tubercles.)

15. M. NUTTALLII, E.: simplex s. prolifera, cæspitosa; aculeis radialibus 10 – 17 setaceis rectis plerumque puberulis albidis, centrali singulo robustiore sæpius deficiente; sepalis fimbriatis et petalis flavidis apice parce denticulatis lanceolatis, s. lineari-lanceolatis acutis; stigmatibus 2 – 8 erectis vel patulis; bacca subglobosa tuberculis breviore coccinea; seminibus globosis scrobiculatis nigris.

Var. *a.* BOREALIS (M. Nuttallii, *E. l. c.* Cactus mamillaris, *Nutt. Gen.*, 1818, *non Linn.*): subsimplex; aculeis setaceis 13 – 17 cum centrali sæpe deficiente puberulis; stigmatibus 2 – 5; baccis seminibusque minoribus.

Var. β. CÆSPITOSA (M. similis, *E. in Pl. Lindh.* 1845): cæspitosa; aculeis radialibus 12 – 15 puberulis, centrali plerumque deficiente; floribus baccis seminibusque majoribus; stigmatibus 5 patulis.

Var. γ. ROBUSTIOR, E. in Pl. Lindh. 1850: subsimplex; tuberculis longioribus laxioribus, aculeis robustioribus lævibus, radialibus 10 – 12, centrali singulo; floribus majoribus; stigmatibus 7 – 8 patulis; seminibus ut in β.

Plains east of the Rocky and New Mexican Mountains. Var. α. on the Upper Missouri; β. from Kansas River to New Braunfels in Texas; γ. from the Canadian River to the Colorado of Texas. The heads are one or two inches in diameter; the cæspitose masses of β. often a foot broad; spines 3 – 8 lines long. Flowers 1 – 2 inches long and wide, of a greenish or reddish or pure pale yellow color. Seeds 0.8 – 1.1 lines in diameter, more regularly globose than in most other Cactacæ.

16. M. SCHEERII, Muhlenpf. 1847; β. ? VALIDA, E. in B. C. R.: magna, ovato-globosa, subsimplex, glaucescens; tuberculis remotis patulis magnis e basi lata subcylindricis supra sulco profundo glandulis paucis munito (juniore lanato) subbilobis; areolis junioribus dense lanatis; aculeis 10 – 20 rectis robustis basi bulbosis albidis s. citrinis apice fuscatis, radialibus 9 – 16; centralibus 1 – 5 validioribus angulatis; floribus flavis ex axillis junioribus tomentosissimis.

Sandy ridges in the valley of the Rio Grande near El Paso: fl. July. The largest of our Northern Mamillariæ, 7 inches high and 5 in diameter; tubercles 1 – 1½ inches long; spines 10 – 18 lines in length, very stout, especially the central and lower radial ones. Flower 2 inches long, yellow. Fruit not seen. — *M. Scheerii* from Chihuahua, according to Prince Salm's description, is a smaller plant, with single central spines one inch in length, and 8 – 11 much shorter radial spines; the areolæ are described as naked: — nevertheless our plant is probably only the northern form of this species.

17. M. ROBUSTISPINA, A. Schott, in litt.: simplex s. cæspitosa; tuberculis patulis teretibus magnis sulcatis; areolis junioribus dense tomentosis; aculeis radialibus 12 – 15 robustis inferioribus robustioribus sæpe curvatis, superioribus rectis fasciculatis paullo tenuioribus, centrali singulo valido compresso recurvato, omnibus subpollicaribus corneis apice atratis; floribus luteis ex axillis junioribus tomentosissimis; seminibus magnis obovatis fuscis lævibus.

Sonora, on grassy prairies: fl. July. Tubercles nearly an inch

long, and an inch distant from one another; spines 9 – 15 lines long. Flowers 2 inches long, characterized by a very slender, constricted tube, very different from the wide tube of the foregoing species. Seeds fully 1½ lines long, larger than those of any other Mamillaria examined by me: embryo with some albumen, curved; cotyledons foliaceous! approaching the structure of the seed of most Echinocacti.

18. M. RECURVISPINA, E. in B. C. R.: simplex, depresso-globosa; tuberculis ovatis profunde sulcatis confertis; areolis obliquis ovatis, aculeis radialibus 12 – 20 rigidis recurvis intertextis albidis corneisve, aculeo centrali singulo (raro binis) robustiore longiore decurvato; floribus flavicantibus extus fuscatis ex axillis junioribus villosissimis.

Sonora: fl. July. Single heads 3 – 8 inches in diameter; tubercles 5 – 6 lines long; spines 4 – 9 lines long, upper ones often a little longer than the lower ones; central spine 6 – 10 lines long, darker. Flowers 1½ inches long. — This plant bears the closest resemblance to the next species, and must perhaps be classed with it; but in the dry specimen before me the flowers are not exactly vertical, as in that species.

* * *Densifloræ.* (Flowers and fruit remain central in the very woolly vertex of the plant, no new tubercles being developed before the fruit falls off; berries of all the species known to me oval, green; seeds brown, smooth.)

19. M. COMPACTA, E. in Wisl. Rep.: simplex, depresso-globosa; tuberculis abbreviato-conicis sulcatis confertis; areolis ovato-lanceolatis, aculeis radialibus 13 – 16 rigidis recurvis intertextis albidis corneisve, aculeo centrali erecto plerumque deficiente; floribus flavis extus fuscatis minoribus.

Cosiquiriachi, west of Chihuahua: fl. June and July. Plant 2 – 4 inches in diameter; distinguished from the last species by the acutish (not obtuse) tubercles, the more elongated areola, the erect central spine, which however is wanting in most specimens, and principally by the smaller and truly vertical flowers. Spines 5 – 10 lines long; flower 1¼ – 1½ inches long and wide; seed 0.7 line long.

20. M. PECTINATA, E. in B. C. R.: simplex, globosa; tuberculis conicis abbreviatis, summis floriferis teretibus longioribus sulcatis; areolis oblongis; aculeis 16 – 24 rigidis recurvis intertextis subæqualibus s. in tuberculis summis superioribus longioribus fasciculatis omnibus radiantibus corneis s. albidis; floribus magnis sulphureis.

On the Pecos River, in Western Texas: fl. July. — Plant 1 – 2

inches in diameter. Lower tubercles 2 – 3, floriferous ones 5 – 6 lines long; spines 3 – 5, upper fasciculated ones 6 – 9 lines long. Flower 2½ – 3 inches in diameter; seed 0.9 line long.

21. M. ECHINUS, E. l. c.: simplex, globosa; tuberculis tereticonicis; areolis orbiculatis; aculeis rectis s. paullo curvatis intertextis albidis; radiantibus 16 – 30 summis paullo longioribus, centralibus 3 – 4, inferiore robustissimo subulato porrecto, superioribus 2 – 3 et cum radiantibus erectis; floribus magnis.

With the former. — Plant 1½ – 2½ inches in diameter; tubercles 5 – 6 lines long; lower and lateral spines 4 – 6, upper ones 6 – 10 lines long; upper central spines of the same length, and the lower central one a little shorter. This last one is unusually stout, subulate from a very thick base, and perpendicular on the centre of the plant, which gives it a very peculiar aspect. Flowers apparently about 1½ or 2 inches long.

22. M. SCOLYMOIDES, Scheidw. (1841): globosa s. ovata, subsimplex; tuberculis conicis, superioribus elongatis incurvis imbricatis; aculeis radiantibus 14 – 20 rectis s. plerumque recurvis albidis s. corneis, superioribus longioribus, centralibus 1 – 4 longioribus obscurioribus curvatis, superioribus sursum versis cum radialibus implicatis, inferiore robustiore longiore decurvo.

South of the Rio Grande; not yet discovered in our territory. — Plant 2 – 3 inches high; tubercles 5 – 8 lines long; radial spines 5 – 10 lines, the central ones 9 – 16 lines long. Flowers yellow, 2 inches long. — Perhaps this and both the foregoing species are only forms of the Mexican *M. cornifera*, of De Candolle. Only a close examination of these plants in their native wilds will enable us to decide this point.

23. M. CALCARATA, E. in Pl. Lindh. 2, 1850 (M. sulcata, *E. in Pl. Lindh.* 1, 1845. M. strobiliformis, *Muhlenpf.? non Scheer*): globosa, prolifera, cæspitosa; tuberculis e basi dilatata ovatis conicis; aculeis albidis, radialibus 8 – 10 rigidis subulatis rectis s. paullo recurvis, additis subinde ex summa areola aculeis adventitiis 3 – 5 fasciculatis tenuioribus, centrali singulo robustiore subulato recurvato, in plantis junioribus deficiente; floribus magnis sulphureis intus basi rubicundis.

Texas, from the Brazos to the Nueces rivers: fl. May. — Larger heads 2 – 2½ inches in diameter; cæspitose masses a foot or more large; tubercles spreading, or in older flowering plants often somewhat adpressed and imbricate, 7 – 9 lines long; spines 4 – 8 lines

long. Flower 2¼ – 2½ inches long, and of same diameter. Seeds a line long.

§ 3. *Rubrifloræ.*

* *Sepalis integerrimis.*

24. M. CONOIDEA, DC. (M. strobiliformis, *E. in Wisl. Rep. non Scheer*): found only south of the Rio Grande.

* * *Sepalis fimbriatis.*

25. ? M. POTTSII, Scheer: cylindrica, subramosa; tuberculis ovatis obtusis levissime sulcatis, axillis sublanuginosis; aculeis radialibus numerosissimis gracilibus albis, centralibus 6 – 12 validioribus expansis basi nodulosis apice sphacelatis; floribus magnis e viridi rubellis; baccis roseis.

Texas, on the Rio Grande, below Laredo, and from there to Chihuahua. — I have not seen this plant; the description is taken from Salm and Poselger.

26. M. TUBERCULOSA, E. in B. C. R.: ovata s. ovato-cylindrica, simplex s. ad basin parce prolifera; tuberculis e basi rhomboidea ovatis abbreviatis obtusis profunde sulcatis demum suberosis persistentibus confertis, axillis villosissimis; aculeis exterioribus 20 – 30 rigidis albidis, interioribus 5 – 9 robustioribus cæsio-purpureis sphacelatis, superioribus longioribus erectis, infimo breviore robusto porrecto s. deflexo; floribus in vertice densissime tomentoso centralibus pollicaribus dilute roseis; baccis elongato-ovatis rubris; seminibus minimis scrobiculatis.

On the mountains near El Paso, and eastward.: fl. May and June. Plant 2 – 5 inches high; tubercles 2½ – 3 lines long, dry and hard, not fleshy unless very young, nor shrivelling when old, but losing the spines and covering the lower part of the plant like corky protuberances. Outer spines usually 2 – 4, rarely 5 or 6, lines long; interior spines 4 – 9 lines long; those of the upper tubercles forming a tuft of grayish-purple color on top of the plant. Flowers very pale purple, one inch in diameter. Berry red, three fourths of an inch long, one fourth of an inch thick, crowned with the remains of the flower. Seeds short, thick, about half a line long. — The short, corky tubercles, with very deep grooves, and very woolly when young, together with the long red fruit, distinguish our species from all the allied forms.

27. M. DASYACANTHA, E. in B. C. R.: simplex, subglobosa; tuber-

culis teretibus laxis leviter sulcatis; axillis subvillosis; aculeis rectis tenuibus setaceis patulis, exterioribus 25 – 35 albidis, interioribus 7 – 13 longioribus purpureo-fuscis, centrali infero æquilongo; baccis centralibus ovatis; seminibus obovato-globosis nigricantibus scrobiculatis.

El Paso and eastward. — Specimens before me are $1\frac{1}{2} - 2\frac{1}{2}$ inches high, and a little less in diameter; tubercles 4 – 5 lines long; spines more slender and soft than in the allied species, often capillary, spreading, but not radiating, 6 – 12 lines long, only the lower exterior ones a little shorter. Seeds about half a line long. Very nearly allied to the next.

28. M. VIVIPARA, Haw.: simplex s. cæspitosa; tuberculis teretibus laxis leviter sulcatis; aculeis rectis rigidis, exterioribus patentissime radiantibus albidis 12 – 36, centralibus 3 – 12 robustioribus longioribus obscurioribus, singulo robustiore porrecto deflexove, ceteris sursum divergentibus; floribus subcentralibus purpureis magnis; baccis sublateralibus ovatis viridibus; seminibus obovatis scrobiculatis fulvis.

Var. *a.* VERA: depresso-globosa, simplex s. plerumque prolifera, cæspitosa; aculeis radialibus 14 – 20, centralibus 3 – 8.

Var. ? *β.* RADIOSA: ovata s. subcylindrica, simplex s. e basi ramosa; aculeis radialibus 12 – 36, centralibus 3 – 12. Subvar. *a.* RADIOSA BOREALIS: subglobosa; aculeis radialibus albidis 12 – 20, centralibus 3 – 6 purpureo-maculatis; floribus minoribus. — *b.* RADIOSA NEO-MEXICANA: ovata; aculeis radialibus albidis 20 – 36, centralibus 3 – 12 supra purpurascentibus sphacelatis; floribus majoribus. — *c.* RADIOSA TEXANA: ovato-cylindrica; aculeis radialibus albidis 20 – 30, centralibus 4 – 5 flavis s. fulvis; floribus seminibusque magnis. M. radiosa, *E. in Plant. Lindh.* 2. 1850.

In the Western plains, and on the Rocky Mountains: var. *a.* on the Upper Missouri and Yellowstone Rivers; *β. a.* in Northern New Mexico; *β. b.* from Western Texas to New Mexico and Sonora; *β. c.* in Texas, west of New Braunfels. — The extreme forms are certainly very unlike one another, but the transitions are so gradual that I cannot draw strict limits between them. Even the proliferous growth of the original *M. vivipara* is not constant, and I have seen many simple specimens from the Upper Missouri. The simple ones seem to flower better than the proliferous ones, which are often sterile. — Plants from 1 to 5 inches high, $1\frac{1}{2} - 2$ inches in diameter; tubercles 4 – 6 lines long; spines always rigid, 3 – 10 lines long. Flowers different in size, $1\frac{1}{2} - 2\frac{1}{2}$ inches in diameter, beautifully purple, with numerous narrowly lanceolate acuminate petals. Seeds $\frac{1}{2} - 1$ line long.

29. M. MACROMERIS, E. in Wisl. Rep. (M. dactylothele, *Lab.*): simplex s. e basi ramosa, ovata; tuberculis magnis patulis, laxis, tenuiter ultra medium sulcatis; aculeis tenuibus elongatis rectis s. paullo curvatis exterioribus 10 – 17 albidis, centralibus sub-4 longioribus robustioribus subangulatis, fuscis s. nigricantibus; floribus ex areolis supra-axillaribus in tuberculo ipso oriundis magnis; bacca subglobosa viridi; seminibus parvis lævibus fuscis.

In the valley of the Rio Grande, from Southern New Mexico to the middle course of the river near Presidio, and even lower down: fl. July and August. — A most remarkable species in many respects, and forming a transition to Echinocactus, though the mamillate form is so very striking. Plant 2 – 4 inches high; tubercles variable, 6 – 8 or 10 – 12 and even 15 lines long. Radial spines ½ – 1½ inches long; central ones often 1½ – 2½ inches in length. Axils always naked. Flower springing from the lower end of the groove, which runs down about two thirds of the tubercle, 2½ – 3 inches in diameter, rose-colored or purple; not rarely with a few sepaloid scales on the ovary (and fruit). Seeds thick, but only 0.6 – 0.8 line long.

Subgen. 3. ANHALONIUM. (Gen. Anhalonium, *Lem.* Ariocarpus, *Scheidw.*) Flores e basi tuberculorum hornotinorum triangularium subinermium vel in vertice ipso oriundi: ovarium emersum.

30. M. FISSURATA, E. in B. C. R.: simplex, depresso-globosa s. applanata; tuberculis e basi applanata crassis extus infraque lævibus, supra sulco centrali villoso lateralibusque glabris profunde quadripartitis sulcisque transversalibus superficialiter multifidis, inermibus; floribus e villo longo sericeo centralibus roseis; baccis ovatis virescentibus in lana densa occultis; seminibus nigris tuberculatis.

On the limestone hills, near the junction of the Pecos with the Rio Grande: fl. October. Heads 2 – 4½ inches in diameter; tubercles 6 – 10 lines long, and a little less broad; central longitudinal groove in the very young ones bearing dense silky wool over half an inch long, which by age becomes dirty and matted, and finally disappears entirely in the very old ones. The lower end of the groove, which only extends down as far as the rough or verrucose part of the tubercle goes (about two thirds downward), bears the flower and fruit, very much like the floriferous areola of the last-mentioned species. Flower about one inch long and wide. Seed very roughly tuberculated, different from that of any other *Mamillaria* examined by me, but quite similar to that of other *Anhalonia*.

II. ECHINOCACTUS, Link. & Otto.

Ovarium emersum baccaque sepalis stipata. Semina sæpe albuminosa. Cotyledones plus minus foliaceæ plerumque hamatæ. — Plantæ subglobosæ, costatæ; inflorescentia verticali.

§ 1. *Hamati*, Salm.

1. E. SCHEERII, Salm: globosus s. ovatus; costis 13 obtusis interruptis; tuberculis supra ad medium sulcatis; aculeis radialibus 15–18 setaceis, centralibus 3–4 angulatis variegatis, superioribus rectis longioribus sursum divaricatis, inferiore robustiore breviore hamato; floribus minoribus flavo-virescentibus; bacca virescente; seminibus fuscis.

About Eagle Pass, on the Rio Grande: fl. August to October. — A most elegant little species, 1½–2 inches high; larger spines black and white variegated; radial ones 3–6, central ones 6–12 lines long; floriferous areola united by a groove of 1–2½ lines in length with the spines, resembling the groove of the *Coryphanthæ*, especially of *Mamillaria macromeris*. Green flower an inch long, much less in diameter.

2. E. BREVI-HAMATUS, E. in B. C. R.: obovato-globosus; costis 13 compressis obtusis interruptis; tuberculis supra usque ad basin sulcatis; aculeis radialibus 12 teretibus albidis, centralibus 4 complanatis, lateralibus rectis sursum versis paullo longioribus, summo debiliore et infimo robustiore deorsum hamato brevioribus; floribus minoribus roseis.

On the San Pedro, and about Eagle Pass: fl. April. — Very similar to the last; but larger, 3–4 inches high, with fewer spines, the lower central usually hardly longer than the upper radial ones, about one inch long; lower radial spines shorter, and upper central ones longer. The rose-colored flowers are 12–16 lines long, much less wide. Fruit unknown.

3. E. WHIPPLEI, E. & B. in Pacific R. R. Rep.: ovato-globosus; costis 13–15 interruptis; aculeis radialibus 7 compressis albidis, centralibus 4 longioribus robustioribus compresso-quadrangulatis, summo latiore longiore, infimo robustiore deorsum hamato; seminibus magnis nigris.

On the Colorado-Chiquito, in Western New Mexico. — Plant 3–5 inches high; exterior spines 6–9 lines, upper central spine 12–18

lines long, and $\frac{1}{2}$ – $1\frac{1}{4}$ lines broad; other central spines a little shorter. Seed very large, over $1\frac{1}{2}$ lines in the longest diameter. — Principally characterized by the few radial spines and the very broad upper central one, which with the former forms an almost regular circle.

4. E. POLYANCISTRUS, E. & B. l. c.: ovatus, s. ovato-cylindricus; costis 13 – 17 interruptis; aculeis radialibus sub-19 complanatis albis, superioribus latioribus longioribus, inferioribus setaceis, centralibus difformibus, summo complanato elongato sursum curvato albo, reliquis 5 – 10 teretiusculis purpureo-fuscis, superioribus 2 rectis, ceteris uncinatis.

Eastern slope of the California mountains, at the head of the Mojave River. — Plant 4 – 10 inches high, 3 – 4 in diameter; radial spines $\frac{1}{2}$ – 2 inches long; upper central spine 3 – 5, the others $1\frac{1}{2}$ – $3\frac{1}{2}$ inches long, the lowest shorter than the others. The number of the hooked spines varies from 3 to 7, according to age and development.

5. E. UNCINATUS, Hopf., var. ? WRIGHTII, E. in B. C. R.: glaucescens, ovatus; costis 13 interruptis; tuberculis usque ad basin sulcatis; aculeis radialibus 8, inferioribus 3 uncinatis fuscis, reliquis 5 rectis, centrali singulo angulato complanato flexuoso hamato elongato erecto stramineo apice fusco; floribus fusco-purpureis minoribus.

Near El Paso and on the Rio Grande below: fl. March and April. — Plant 3 – 6 inches high, 2 – $3\frac{1}{2}$ inches in diameter; the tuft of long, erect, straw-colored spines is very characteristic. Lower hooked radial spines about an inch long; upper ones a little longer; central spine 2 – 4 inches long. Flowers 1 – $1\frac{1}{2}$ inches long. Berry fleshy, scaly. Seeds much compressed. — The Mexican *E. uncinatus* has 7 – 8 radial spines, similarly arranged, and 4 central spines; the three upper ones not much longer than the upper radial ones and straight, the lower one elongated and hooked. The flower and seed differ also to some extent.

6. E. SETISPINUS, E. in Pl. Lindh. 1845: globosus, ovatus s. subcylindricus; costis 13 compressis acutatis angulatis; tuberculis brevissime sulcatis; aculeis radialibus 10 – 16 setaceis; centrali subsingulo robustiore terete fusco uncinato s. flexuoso curvato; floribus magnis flavis intus coccineis; bacca pisiformi coccinea; seminibus tuberculatis.

Var. *a.* HAMATUS: aculeis radialibus sub 12, centrali hamato robusto. — E. hamatus, *Muhlenpf.* E. Muhlenpfordtii, *Fen.*

Var. *β.* SETACEUS: minor; aculeis pluribus, centralibus 1 – 3 tenuioribus vix hamatis.

Texas, from the Colorado to the Rio Grande, and westward as far as the San Pedro River: fl. April to October. — It is unnecessary further to describe this well-known and well-characterized species, which is now frequently cultivated; the compressed ribs, setaceous spines, small red berry, and tuberculated seeds easily distinguish it from all its allies.

7. E. SINUATUS, Dietr. (1851): globosus; costis 13 compressis acutiusculis interruptis; aculeis radialibus setaceis, 3 superioribus et 3 inferioribus rectiusculis fuscatis 1, lateralibus 2 – 6 tenuioribus albidis flexuosis, rarissime hamatis; centralibus 4 robustioribus, 3 superioribus rectis purpureo-variegatis, inferiore compresso seu canaliculato elongato flexuoso vel hamato stramineo; floribus magnis flavis; bacca ovata viridi; seminibus minutissime punctatis.

Country along the Rio Grande near Eagle Pass, and from there eastward. — Intermediate between the foregoing and the next species, and considered by Dr. Poselger a connecting link between them; but easily distinguished from the former by the larger size, thicker ribs, flattened central spine, and by the shining, finely dotted seeds; from the latter, to which it approaches much more closely, by the more compressed and less strongly tuberculated ribs, the smaller number of stigmata (8 – 12), smaller fruit, and much more finely dotted seed. — Poselger considers this a variety of *E. setispinus*. His *E. setispinus*, var. *robustus*, has the same seeds, and no doubt also belongs here; it is said to have all the 4 central spines, and some of the radial ones, hooked. *E. Treculianus*, Lab. belongs here, or perhaps to the next.

8. E. LONGEHAMATUS, Gal.: subglobosus; costis 13 – 17 obtusis tuberculato-interruptis; tuberculis breviter sulcatis; aculeis radialibus rigidis subteretibus, infimis summisque ternis, lateralibus 2 – 6 longioribus; centralibus 4 robustis angulatis annulatis, quorum infimus deorsum hamatus rectus seu flexuosus, additis subinde 2 – 4 superioribus cum radialibus superioribus fasciculatis; floribus magnis flavis; stigmatibus 15 – 18; bacca oblonga virescente squamosa; seminibus lucidis exsculptis.

Var. *a.* CRASSISPINUS: aculeis robustissimis radialibus 8 – 11, centralibus 4 angulatis, infimo flexuoso plus minus hamato. E. flexispinus, *E. in Wisl. Rep.* non *Salm.*

Var. *β.* GRACILISPINUS: aculeis gracilioribus 16 – 20, exterioribus 12 – 14, centralibus 4 – 8, infimo elongato hamato. E. hamatocanthus, *Muhl.*

Var. γ. BREVISPINUS: aculeis gracilioribus radialibus 8 – 11, centralibus 4 teretibus cum infimo hamato radiales vix superantibus.

East of El Paso, near the Pecos and San Pedro Rivers, and along the middle course of the Rio Grande: var. α. south of the Rio Grande. Fl. July and August. — Plants from ½ – 2 feet high; the larger ones ovate; areolæ distant; spines very different in size, in the different varieties; radial spines 1 – 3½, central spines 1½ – 6½ inches long; flowers 2½ – 3½ inches long; seeds similar to the last, but with much larger pits.

§ 2. *Cornigeri.*

A. *Heteracanthi.*

9. E. WISLIZENI, E. in Wisl. Rep.: giganteus, globoso-ovatus; costis 21 compressis crenatis; areolis elongatis; aculeis radialibus summis infimisque 6 robustis rectis seu curvatis, lateralibus 14 – 20 (additis subinde summis brevioribus fasciculatis) tenuibus elongatis flexuosis; centralibus 4 robustis angulatis annulatis rubellis, 3 superioribus rectis, inferiore canaliculato deorsum hamato; floribus flavis; bacca ovata squamosissima; seminibus reticulatis.

Valley of the Rio Grande about El Paso, and thence to the Upper Gila: fl. July and August. — Plant 2 – 4 feet high; diameter smaller; radial spines 1 – 2, central ones 1½ – 3 inches long. Flowers 2½ inches long.

10. E. LECONTEI, E. in P. R. R.: giganteus, obovato-claviformis; costis 20 – 30 compressis crenatis; areolis elongatis; aculeis radialibus summis infimisque 6 – 10 robustis angulatis plus minus curvatis, lateralibus 10 – 16 (addidis subinde summis brevioribus fasciculatis) tenuibus elongatis flexuosis, centralibus 4 robustis compressis annulatis corneis, 3 superioribus sursum inferiore subinde subhamato deorsum curvatis; floribus flavis; bacca ovata squamosa; seminibus scrobiculatis.

On the lower parts of the Gila and Colorado Rivers, and in Sonora: fl. August and September. Very similar to the last, but a more slender, often quite clavate plant; larger specimens 3 – 4 feet high, and of only one third that diameter; arrangement of spines similar, but generally 5 (not 3) radial spines below the lowest central one; central spines more compressed, upper ones curved, lower one rarely somewhat hooked; flower, fruit, and seed smaller; seed more oblong and pitted.

E. INGENS, Zucc., in the number and arrangement of spines, is the simple type of our more northern species: it has on the oval areolæ 4 stout cruciate central spines, 3 upper and 3 lower radial ones, and only 2 slender lateral spines. Seeds smooth. The flower seems to refer it, however, to the *Eriocarpi*.

B. *Homœacanthi.*

* *Lepidocarpi.*

11. E. EMORYI, E. (in Emory's Rep. 1848, and B. C. R.): grandis, ovatus; costis 13 – 20 obtusis tuberculatis; areolis ovatis; aculeis radialibus 7 – 8 subæqualibus robustis subangulatis annulatis paullo recurvatis rubellis 1 – 2 pollicaribus, centrali singulo recurvo s. subhamato paullo robustiore; floribus magnis purpurascentibus.

Lower Colorado, and principally in Sonora: fl. August and September. Larger plants 2½ – 3 feet high; spines usually 1 – 2, and, in a large specimen from Guaymas, nearly 3 inches long. Flowers about 3 inches long. Fruit unknown.

12. E. VIRIDESCENS, Nutt.: globosus, simplex seu raro ramosus; costis 13 – 21; aculeis robustis compressis annulatis plus minus curvatis rubellis, radialibus 12 – 20 infimo breviore magis curvato; centralibus 4 angulatis robustioribus longioribus, infimo rectiore longiore; floribus virescentibus; bacca squamosa; seminibus minutissime scrobiculatis.

San Diego, California. — Less than a foot in diameter, globose or flattened; radial spines 5 – 10 lines long, 3 upper central ones a little longer, and lower central spine 12 – 18 lines long. Flower 1½ inches long.

13. E. CYLINDRACEUS, E. in Sill. Jour. 1852: ovatus seu subcylindricus, plerumque e basi ramosus; costis 21 vel pluribus; aculeis robustis compressis annulatis plus minus curvatis flexuosisve rubellis, radialibus sub – 12, aculeis adventitiis sub – 5 gracilioribus supra sæpe adjectis, infimo hamato, centralibus 4 angulatis robustissimis cruciatis, superiore latiore sursum recto, inferiore decurvato; floribus flavis; bacca squamosa.

San Felipe, on the eastern slope of the Californian mountains: fl. in June. — The largest specimens seen were 3 feet high and one foot in diameter; the branches or young single plants are globose. Radial spines 1 – 2 inches long; central spines 1 – 1½ lines broad, about 2 inches long. Similar to the last, but well distinguished by the characters indicated.

* * *Eriocarpi.*

14. E. POLYCEPHALUS, E. & B. in P. R. R.: ovatus seu demum cylindricus, e basi ramosus; costis 13 – 21 acutis; aculeis robustis compressis annulatis plus minus curvatis rubellis, radialibus 4 – 8, infimo deficiente, superioribus (si exstant) gracilioribus; centralibus 4 angulatis compressis, superiore latiore suberecto vel sursum curvato, inferiore longiore decurvo; floribus flavis dense lanatis; bacca sicca; seminibus magnis angulatis.

On the Mojave, Colorado, and Gila Rivers: fl. February and March. — Single only when young, forming bunches of 20 – 30 cylindric equal-sized heads when older; the largest seen were 2 – 2½ feet high and about 10 inches in diameter. Exterior spines 1 – 2, interior ones 1½ – 3½, inches long. — Shape very much like the last, but the flower very distinct.

15. E. PARRYI, E. in B. C. R.: simplex, globosus vel depressus; costis 13 acutis; aculeis robustis angulatis annulatis albidis, radialibus 8 – 11, rectis s. paullo curvatis superioribus gracilioribus, infimo deficiente, centralibus 4 paullo longioribus robustioribus, infimo longiore decurvo; bacca sicca dense lanata.

West and southwest from El Paso. — Plant always single; largest specimens 8 – 12 inches high by 10 – 15 in diameter. — Very similar to the last; but apparently distinct by the manner of growth and the white spines. Unfortunately, no seeds were collected.

16. E. HORIZONTHALONIUS, Lem., var. CENTRISPINUS, E. in B. C. R.: glaucus, depressus seu demum ovatus; costis 8 obtusissimis latissimis; areolis orbiculatis basi truncatis; aculeis robustis compressis annulatis recurvatis rubellis demum cinereis, radialibus 5 – 7 superioribus debilioribus, infimo deficiente, centrali singulo robustiore decurvato; floribus purpureis dense lanatis; bacca sicca lanata; seminibus magnis angulatis.

From Doñana, above El Paso, to the Pecos, and southward: fl. April and May. — Plant 2 – 8 inches high and 3 – 6 in diameter; spines ¾ – 1½ inches long, nearly equal. Flower 2½ inches long, but partly enveloped in dense wool. The original *E. horizonthalonius* is said to have no central spine, and linear-lanceolate acuminate pale rose-colored petals: in our plant the petals are oblong-lanceolate and obtuse.

17. E. TEXENSIS, Hopf. (E. Lindheimeri, *E. in Pl. Lindh.* 1845):

depressus; costis 13 – 27 acutis undulatis; areolis cordatis; aculeis robustis annulatis, plus minus curvatis rubellis, radialibus 6 – 7 infimo deficiente, centrali singulo robustiore compresso decurvato; floribus roseis dense lanatis; petalis laciniatis aristatis; bacca coccinea lanata; seminibus lævibus lucidis.

Southern Texas, and Northeastern Mexico, from the Colorado to Saltillo; not westward beyond the San Pedro River: fl. April and May. — Heads 8 – 12 inches in diameter, flat, or very old ones sometimes globose; spines from ½ – 2 inches long. Flowers about 2 inches long.

§ 3. *Theloidei*, Salm.

18. E. BICOLOR, Gal., var. SCHOTTII, E. in B. C. R.: ovatus; costis 8 obtusis interruptis; aculeis radialibus 15 – 17 rectis, summis 2 – 4 longioribus latioribus compressis, centralibus 4, summo latiore longiore; floribus majoribus purpureis.

Mier, on the Rio Grande: fl. September. — Plant 4 – 6 inches high, 2 – 3 in diameter; upper radial spines about 1 inch, upper central one 1½ inches long; lower radial and central spines reddish variegated. Flower 2 – 3 inches long, bright purple or rose-colored. — Distinguished from the Mexican *E. bicolor*, principally by the larger number of radial spines, and the greater length of the upper central spine, which is carinate underneath.

§ 4. *Intertexti.*

19. E. INTERTEXTUS, E. in B. C. R.: minor, ovato-globosus; costis 13 acutis interruptis; tuberculis sulcatis; aculeis rigidis rubellis apice fuscatis, radialibus 16 – 25 arcte adpressis, superioribus 5 – 9 tenuioribus subfasciculatis, infimo robusto brevi; centralibus 4, superioribus 3 radiales superiores excedentibus cum iis implicatis, inferiore singulo abbreviato porrecto; floribus parvis in vertice dense lanato congestis roseis; bacca vix squamata sicca; seminibus lucidis scaphoideis.

Var. β. DASYACANTHUS, E. l. c.: ovatus; aculeis setaceis longioribus purpureo-cæsiis, radialibus patulis, centrali inferiore ceteris paullo breviore.

From El Paso to the Limpio, and southward to Chihuahua: var. β. more common about El Paso: fl. March and April. — Plant 1 to 4, the var. β. even 6 inches high, 1 – 3 in diameter; spines 2 – 6, central ones 1 – 9 lines long, in β. 6 – 8 and central spines 9 – 11 lines long. Flower about 1 inch long. Fruit 4 lines in diameter.

E. UNGUISPINUS, E. in Wisl. Rep., from the country between Chihuahua and Parras, belongs here. The fruit described as belonging to this species is that of *E. uncinatus*.

Subtrib. 2. CONTRARIÆ. Cotyledones facie hilum versus spectantes, lateribus seminis parallelæ.

III. CEREUS, Haw.

Ovarium baccaque sepalis squamiformibus in axillis plerumque pulvilligeris stipatæ. Stamina tubo floris breviori seu elongato infundibuliformi gradatim adnata. Semina fere exalbuminosa. Cotyledones abbreviatæ seu foliaceæ, plerumque hamatæ. — Plantæ costatæ, inflorescentia laterali.

Subgen. 1. ECHINOCEREUS, E. in Wisl. Rep.: ovarium aculeolatum: tubus floris abbreviatus, subcampanulatus: stigmata crassa viridia: semina tuberculosa: cotyledones suberectæ. — Plantæ humiles, sæpe subglobosæ, e basi ramosæ vel ramosissimæ.

§ 1. *Pectinati*, multicostati; areolis confertissimis plerumque elongatis, aculeis rigidis brevibus pectinatis.

* *Viridiflori.*

1. C. VIRIDIFLORUS, E. in Wisl. Rep.: ovatus seu demum cylindricus, simplex vel parce ramosus; costis sub-13; areolis ovato-lanceolatis; aculeis arcte radiantibus 12 – 18 cum superioribus 2 – 6 setaceis, lateralibus cæteris longioribus, inferioribus plerumque purpureo-fuscis, cæteris albidis, centrali plerumque nullo, subinde singulo robustiore variegato; floribus versus apicem lateralibus e flavo virescentibus minoribus; baccis ellipticis parvis; seminibus tuberculatis.

Var. *α.* MINOR: subglobosus; aculeis gracilibus brevibus.

Var. *β.* CYLINDRICUS: major, elongatus; aculeis rigidioribus longioribus.

Throughout Western Texas and New Mexico. Var. *α.* about Santa Fé and northeastward: *β.* east of El Paso. Fl. May and June. — The small form is 1 – 2 inches high, with spines rarely more than 2 lines long: the larger form, *β.* is 3 – 6 or more inches high, its spines 2 – 5 or 6 lines long: central spines, when present, longer and stouter. Flower about 1 inch long.

2. C. CHLORANTHUS, E. in B. C. R.: cylindricus, simplex, seu parce ramosus; costis 13 – 18; areolis ovatis; aculeis laxe radiantibus 12 –

20 cum superioribus 5 – 10 setaceis plerumque albidis; centralium 3 – 5 superioribus 2 brevioribus purpurascentibus, inferioribus 1 – 3 longioribus deflexis albidis; floribus in caule inferiore lateralibus e flavo virescentibus minoribus; baccis parvis; seminibus tuberculato-scrobiculatis.

Common about El Paso: fl. April. — Stems 3 – 10 inches high, 1½ – 2 inches in diameter; radial spines 2 – 5, central ones 9 – 15, lines long. Flowers very similar to those of the last species, but seeds different.

* * *Flaviflori.*

3. C. DASYACANTHUS, E. in Wisl. Rep.: subcylindricus, simplex vel e basi ramosus; costis 16 – 21; areolis ovatis; aculeis 20 – 30 patulis cinereis apice sæpe rubellis, interioribus 3 – 8 paullo robustioribus deflexis; floribus subterminalibus magnis; bacca subglobosa; seminibus tuberculatis.

Var. β. MINOR: aculeis paucioribus; bacca minore.

Common about El Paso: fl. April. — Plant 5 – 12 inches high, densely covered with numberless spines. Flowers 3 inches wide, yellow, an uncommon color in *Cerei*. Fruit an inch in diameter; in var. β. only half as large.

4. C. CTENOIDES, E. in B. C. R.: subsimplex, ovatus, 15-costatus; areolis lanceolatis; aculeis albidis, radialibus 14 – 20 pectinatis, centralibus 2 – 3 uniseriatis brevibus; floribus magnis.

Eagle Pass on the Rio Grande: fl. June. — Plant 2 – 4 inches high, thick in proportion; spines 1 – 4 lines long. Flower large. — Similar to the last, but distinguished by the characters given, which, with the exception of the yellow flower, bring it close to *C. pectinatus.*

* * * *Rubriflori.*

5. C. PECTINATUS, E. (Echinocactus pectinatus, *Scheid.*): ovato-cylindricus, 18 – 23-costatus; areolis lanceolatis; aculeis radialibus 16 – 20 subrecurvis pectinatis apice roseis, centralibus 2 – 5 brevissimis uniseriatis; tubo floris purpurei pulvillis 60 – 70 aculeolos rigidos 10 – 15 gerentibus stipato.

Var. β.? ARMATUS, Poselg.: costis 15 – 16; aculeis radialibus 16 – 20, centrali singulo cæteris longiore.

Var. γ.? RIGIDISSIMUS, E. in B. C. R.: costis 20 – 22; aculeis e basi bulbosa subulatis rigidissimis albidis seu rubellis 15 – 22 centralibus nullis; florum subverticalium tubo pulvillis 80 – 100 dense stipato.

South of the Rio Grande, Chihuahua, &c. — The var. β. from Monterey may belong either here or to the next species. The var. γ. from Sonora, without any central spines, and with very rigid radial ones, 1 – 4½ lines long, is not yet sufficiently known to decide about its affinities.

6. C. CÆSPITOSUS, E. in Pl. Lindh. 1845: ovato-cylindricus, 12 – 18-costatus; areolis lanceolatis; aculeis radialibus 20 – 30 rectis seu subrecurvis pectinatis albidis, centrali nullo vel raro, uno alterove brevissimo; tubo floris purpurei pulvillis 80 – 100 aculeolos capillares 6 – 12 obscuros lanamque longam cineream gerentibus dense stipato.

Var. α. MINOR: aculeis brevioribus gracilioribus non intertextis; floribus minoribus.

Var. β. MAJOR: aculeis longioribus robustioribus intertextis; floribus majoribus.

Var. γ. CASTANEUS: aculeis rubellis seu castaneis.

From the Canadian near Delaware Mount, to the Rio Grande, and south to Monterey; west not farther than the San Pedro River: fl. in May and June. — This species, now not rare in cultivation, seems to be sufficiently distinct from the preceding, and may always be recognized by the characters indicated.

7. ? C. ADUSTUS, E. in Wisl. Rep.: ovatus, 13 – 15 costatus; areolis ovatis seu ovato-lanceolatis; aculeis radialibus 16 – 20 adpressis albidis apice adustis, lateralibus inferioribusque longioribus, summis setaceis brevissimis, centrali nullo seu valido porrecto atrofusco.

Mountains west of Chihuahua: flower and fruit unknown. — *Echinocereus radians*, E. is the form with stout central spines.

8. ? C. RUFISPINUS, E. l. c.: ovato-cylindricus, 11-costatus; areolis lanceolatis; aculeis radialibus 16 – 18 adpressis intertextis, lateralibus cæteris multo longioribus fuscis recurvatis, centrali singulo valido fusco porrecto; flore infundibuliformi, tubo subelongato, limbo patulo; stigmatibus 8 tenuibus albidis.

Mountains west of Chihuahua: fl. in May. — Stem four inches high: radial spines 4 – 9 lines, central one about an inch, long. Flower different from that of all other *Echinocerei* in the length of the tube (over 2 inches long, and half as wide) and the whitish stigmata. Seems to form a transition to other sections of the genus.

9. ? C. LONGISETUS, E. in B. C. R.: subsimplex, ovato-cylindricus; costis 11 – 14 tuberculatis; areolis orbiculatis; aculeis setaceis albis,

radialibus 18 – 20, centralibus 5 – 7, quorum 3 inferiores elongati deflexi.

Santa Rosa, south of the Rio Grande. — Stem 6 – 9 inches high; tubercles well marked; lower radial spines 5 – 7 lines long, much longer than the upper ones; lower central spines 1 – 2 inches long. Flower said to be red.

§ 2. *Decalophi.*

* *Purpurei; floribus diurnis.*

10. C. Fendleri, E. in Pl. Fendl.: ovato-cylindricus; costis 9 – 12; areolis subconfertis; aculeis basi bulbosis, radialibus 7 – 10 rectis seu curvatis albidis et fuscis, inferioribus robustioribus, centrali valido sursum curvato atrofusco plerumque elongato; floribus sub vertice lateralibus magnis; seminibus obliquis tuberculato-scrobiculatis.

New Mexico, from Santa Fé to below El Paso, and from east of the Pecos to Zuni: fl. in May and June. — Stems 3 – 8 inches high, not many from the same base; spines very variable, but always very bulbous at the base, and some of them white, some deep brown or black, and others party-colored; radial ones ½ – 1 inch, and the central one 1 – 2 inches long. Flower 2½ – 3½ inches in diameter, of a deep purple color. Berry 1 – 1¼ inch long, edible. Seed deeply and irregularly pitted by the confluence of many of the tubercles, unusually oblique.

11. ? C. Mojavensis, E. & B. in P. R. R.: ovatus, dense cæspitosus, glaucescens, 10 – 12 costatus; areolis remotis; aculeis validis curvatis, radialibus 7 – 8, lateralibus robustioribus longioribus, centrali singulo sursum curvato elongato.

Var. β. ? Zuniensis: 10-costatus; aculeis debilioribus 4-angulatis bulbosis rectis vel flexuosis, radialibus 8, summo longiore robustiore; centrali recto seu sursum curvato longiore, omnibus bulbosis.

On the Mojave River in California, and β. farther east, on the Colorado Chiquito. Ovate heads 2 – 3 inches high, forming dense cæspitose masses; upper and lower spines 9 – 15 lines, lateral ones 15 – 25 lines long, central spine 1½ – 2½ inches long, dusky. Var. β. is distinguished by having the upper radial spine almost as stout and long as the central spine, the former being 12 – 18, the latter 18 – 24 lines long. Both seem to be distinguished from the nearly allied *C. Fendleri* by having the lowest spines weakest, while in that species they are the stoutest of the exterior ones. The resemblance to *C.*

Fendleri induces me to place this species here, though the flower remains unknown.

12. C. ENNEACANTHUS, E. in Wisl. Rep.: ovato-cylindricus, viridis, cæspitosus, 7 – 10 costatis; aculeis rectis, radialibus 7 – 12 (plerumque sub-8) albis, inferioribus longioribus; centrali singulo (rarius 2 – 3) basi bulboso teretiusculo seu compresso angulato albido vel stramineo; ovario pulvillis 25 – 35 aculeolos 6 – 12 gerentibus stipato; seminibus tuberculatis.

In the Rio Grande valley from El Paso to Laredo, and lower down, and far into Mexico: fl. April and May. — A very cæspitose plant, of a wrinkled or withered appearance; 3 – 6 inches high; spines above 3 – 5, below 8 – 16 lines long; lateral ones intermediate; central spine extremely variable, in smaller specimens terete, in very perfect ones elongated, flattened, 8 or 10 – 15 or 20 lines long. Flowers 2 – 3 inches long and equally wide: ovary and tube covered with numerous bunches of spines. Fruit about an inch long, edible.

13. C. STRAMINEUS, E. in B. C. R.: ovato-cylindricus, cæspitoso-conglomeratus, 11 – 13-costatus, læte viridis; aculeis radialibus 7 – 10 rectis vel curvatis albis subæqualibus, centralibus 3 – 4 angulatis elongatis sæpe flexuosis; floribus magnis purpureis; ovario pulvillis 30 – 40 aculeolos subsingulos gerentibus stipato; bacca magna fasciculis aculeolorum elongatorum stipata; seminibus tuberculatis.

Mountain slopes, from El Paso to the Pecos and Gila Rivers: fl. June. Often from 100 to 200 heads in one hemispherical mass, each 5 – 9 inches high; radial spines mostly 8, $\frac{3}{4}$ – $1\frac{1}{4}$, central ones 2 – $3\frac{1}{2}$ inches long, younger ones dirty yellow and brown, like old straw. Flower 3 – 4 inches long, very full, bright purple. Berry $1\frac{1}{2}$ – 2 inches long, luscious.

14. C. DUBIUS, E. in B. C. R.: ovato-cylindricus, cæspitosus, pallide viridis, 7 – 9 costatus; aculeis radialibus 5 – 8 albidis, superioribus sæpe nullis, centralibus 1 – 4 angulatis plus minus elongatis sæpe curvatis; floribus pallide purpureis; ovario pulvillis sub-20 aculeolos 1 – 2 gerentibus stipato; bacca minore aculeolata; seminibus tuberculato-scrobiculatis.

Sandy bottoms of the Rio Grande at El Paso: fl. May and June. Stems 5 – 8 inches high, somewhat cæspitose, of a pale green color, and a soft flabby texture: ribs broad, fewer; radial spines 6 – 12 or 15 lines long; central spines $1\frac{1}{2}$ – 3 inches long, flowers $2\frac{1}{2}$ inches long, with fewer and narrower petals. Fruit 1 – $1\frac{1}{2}$ inches long, covered

with bunches of spines which, as in the last species, on the flower are indicated only by few and short bristles. Seed with tubercles confluent, and leaving pits between them. Nearly allied to the two last, but sufficiently well distinguished by the characters given.

15. C. ENGELMANNI, Parry in Sill. Journ. 1852: ovato-cylindricus, 11 – 13 costatus; aculeis radialibus sub-13 albidis, superioribus cæteris multo brevioribus, centralibus 4 longioribus angulatis rectis, 3 superioribus fulvis arrectis, inferiore longiore albido porrecto seu deflexo; floribus lateralibus; seminibus tuberculato-scrobiculatis.

Var. β. CHRYSOCENTRUS, E. & B. in P. R. R.: aculeis radialibus 12 – 14 albidis, centralibus 3 superioribus validis vitellinis erectis, inferiore albo compresso deflexo.

Var. γ. VARIEGATUS, E. & B. l. c.: aculeis radialibus sub-13 albidis, centralibus 3 superioribus recurvatis divaricatis nigris corneo-variegatis, inferiore longiore albo decurvo.

Lower Gila, Colorado, and westward to the California mountains: fl. June and July. — Stems 5 – 10 inches high; radial spines slender, 3 – 6 lines, central ones 1 – 2 inches long. Fruit near the top of the plant. — Dr. Bigelow collected a little farther north, on Bill Williams's Fork, the two forms which I have put under β. and γ.; though they differ from the species by having the fruit lower down on the plant; the arrangement of the spines, however, is entirely identical. Var. β. has very stout central spines, 2 – 3 inches long, of a deep golden-yellow color, and the lower one shorter. In var. γ. the central spines are only 1 – 2 inches long, much curved, and the upper ones white and black mottled.

* * *Coccinei; floribus diu noctuque apertis.*

16. ? C. GONACANTHUS, E. & B. in P. R. R.: ovatus, subsimplex, 7-costatus; areolis remotis; aculeis robustis angulatis sæpe curvatis, radialibus 8 flavidis sæpe basi obscuris, summo cæteris multo majore centralem multangulatum validum sæpe flexuosum subæquante.

Near Zuni, in Western New Mexico, under cedars. — Radial spines 8 – 15 lines long, upper one and central spine 1½ – 2½ inches long, remarkably stout, angular and channelled. — I have not seen the flower of this plant, but place it here from its resemblance to the next species; on the other hand, it seems to be allied to *C. Mojavensis*.

17. C. TRIGLOCHIDIATUS, E. in Wisl. Rep.: ovato-cylindricus, 6 – 7 costatus, parce ramosus; areolis remotis; aculeis 3 – 6 robustis an-

gulatis compressis rectis seu curvatis laxe radiantibus; floris coccinei staminibus petala obtusa subæquantibus; stigmatibus 8 – 10.

Northern New Mexico, at Santa Fé, and to the east and westward: fl. June. — Stems 4 – 6 inches high, 2 – 3 in diameter, with sharp ridges and very shallow grooves; spines 6 – 15 lines long. Flower 2 – 3 inches long; petals rigid. Fruit unknown.

18. C. PHŒNICEUS, E. in P. R. R. (C. coccineus, *E. in Wisl. Rep. non Salm.*): ovatus seu subglobosus, obtusus, cæspitosus, 9 – 11-costatus; areolis ovato-orbiculatis subconfertis; aculeis setaceis rectis, radialibus 8 – 12 albidis, superioribus cæteris paullo brevioribus, centralibus 1 – 3 basi bulbosis teretibus paullo robustioribus; staminibus petalis brevioribus; stigmatibus 6 – 8.

Northern New Mexico, from the Upper Pecos to Santa Fé, Zuni, and the San Francisco mountains: fl. May and June. — Heads 2 – 3 inches high, 2 inches thick, generally forming dense hemispherical masses, often of a foot or more in diameter; radial spines 3 – 6, central ones 5 – 10 lines long. When there are several, the lowest one longest. Fruit unknown.

C. CONOIDEUS, E. & B. l. c.: ovatus, versus apicem acutatus, conoideus, e basi parce ramosus 9 – 11 costatus; aculeis radialibus 10 – 12 gracilibus rigidis, summis brevioribus, centralium 3 – 5 infimo 4-angulato elongato demum deflexo.

Rocky places on the Upper Pecos, and perhaps San Francisco mountains. — Heads 3 – 4 inches high, few, of unequal height from one base; upper radial spines 2 – 5 lines, lateral ones 6 – 15 lines long; upper central spines hardly longer than the lateral ones; lower one 1 – 3 inches long, angular and often compressed. The Mexican *C. acifer*, Otto, seems similar, but is a higher plant, with much stouter spines. *C. Rœmeri*, Muhlenpf. A. G. Z. 1848, from Western Texas, may belong here or to *C. enneacanthus*. A specimen among Dr. Bigelow's collections seems to unite this form with *C. phœniceus*, where for the present it is perhaps best to leave our plant, as a variety or sub-species.

19. C. POLYACANTHUS, E. in Wisl. Rep.: ovato-cylindricus, cæspitosus, subglaucescens, 9 – 13 costatus; aculeis robustis rigidis rectis albidis seu rubello-cinereis, centralibus 3 – 4 bulbosio paullo robustioribus æquilongis seu longioribus, junioribus sæpe fusco-variegatis; stigmatibus 8.

Common about El Paso, and thence to the mountains of Chihuahua:

fl. March and April. — Heads 5 – 10 inches high, 2½ – 4 in diameter; upper radial spines ½, lateral and lower ones ¾ – 1 inch long; central spines hardly longer, or the lower sometimes 1½ – 2½ inches long. Flowers 2 – 3 inches long, profusely covering the plant for four or six weeks. Seed the largest of any *Echinocerei* known to me, 0.8 – 0.9 of a line long.

20. C. Rœmeri, E. in Pl. Lindh. 1850: ovatus, cæspitosus, læte viridis; costis 7 – 9 tuberculatis interruptis; areolis orbiculatis, junioribus breviter tomentosis; aculeis teretibus robustis albidis seu junioribus flavidulis demum cinereis, radialibus sub-8, centrali singulo robustiore porrecto; floribus lateralibus infundibuliformibus limbo erectiusculo; pulvillis ovarii tubique 16 – 18 albo-tomentosis aculeolos 3 – 5 gerentibus; sepalis interioribus 7 – 8 ovato-oblongis carinatis obtusis mucronatis; petalis 9 – 12 obovato-spathulatis obtusis integris concavis rigidis suberectis; stylo longe supra stamina albida sursum rosea exserto; stigmatibus 6 – 7 petala æquantibus erecto-patulis viridibus acutiusculis.

In the granitic region about the Llano River, Western Texas: fl. May: fruit unknown. — Often 5 – 12 from the same base, densely cæspitose; single heads 3 – 4 inches high, 2 – 2½ in diameter; areolæ 6 – 8 lines apart; radial spines 5 – 12 lines long, upper ones usually a little shorter than the rest; central spine 10 – 15 lines long. Flower 2 inches long and only one in diameter, remaining open day and night for a whole week, if the weather is not too warm. — Allied to the last species; but distinct by the shorter heads, fewer ribs, fewer and paler spines, and smaller flower, with less numerous parts.

21. ? C. paucispinus, E. in B. C. R.: ovato-cylindricus, parce ramosus vel simplex, 5 – 7-costatus; areolis remotis; aculeis robustis 3 – 6 radiantibus fuscatis, centrali nullo vel raro robusto subangulato.

Western Texas, from the San Pedro to the mouth of the Pecos. — Stem 5 – 9 inches high, 2 – 3 in diameter; spines 9 – 16 lines long, dark-colored, the central one almost always wanting. Flower and fruit unknown.

22. ? C. hexaedrus, E. & B. in P. R. R.: ovatus subsimplex, 6-costatus; areolis remotis; aculeis rectis rigidis tenuibus angulatis, radialibus 5 – 7 flavo-rubellis, inferiore breviore, centrali paullo robustiore (juniore fuscato) sæpe deficiente.

Near Zuni, in Western New Mexico. — Heads few in each plant, or single, 4 – 6 inches high, 2 – 2½ inches in diameter. Radial spines

mostly 6 lines, lower ones 6 – 10 lines, upper ones 8 – 15 lines long; central spine, if present, 12 – 15 lines long.

§ 3. *Pentalophi.*

23. C. BERLANDIERI, E. in B. C. R.: humilis, perviridis; caule diffuso subtereti articulato ramosissimo; tuberculis conicis 5 – 6-fariis; aculeis 6 – 8 setaceis brevibus radiantibus albidis, centrali singulo multo longiore fusco; floribus magnis; petalis angustis recurvatis; seminibus tuberculatis.

On the Nueces, in Southern Texas: fl. May and June. — Stems 1½ – 6 inches long, one inch thick; radial spines 4 – 5 lines long, central one 6 – 12 lines long, toward the base of the branches shorter. Flower 2 – 4 inches long.

24. C. PROCUMBENS, E. in Pl. Lindh. 1850: humilis, perviridis; caule diffuso subtereti 4 – 5 angulato articulato ramosissimo; aculeis 4 – 6 radiantibus albidis, centrali nullo vel singulo paullo longiore obscuro; floribus magnis; petalis obovato-spathulatis patulis seu subrecurvis; seminibus tenuissime verrucosis.

On the Rio Grande, below Matamoras: fl. May and June. — Similar to the last; but more slender, 6 – 8 lines in diameter; radial spines 1 – 2 lines long, central one, if present, 2 – 3 lines long. Flower above 3 inches long.

§ 4. *Graciles.*

25. C. TUBEROSUS, Poselger: e radice tuberosa tenuissimus, teres, sursum incrassatus, demum articulatus, 8-costatus; aculeis minutis setaceis, 9 – 12 radiantibus, centrali singulo longiore sursum adpresso; flore subterminali; seminibus minutis scrobiculatis.

Between Laredo and Mier on the Rio Grande. Tuberous root ½ – 1½ inches thick. Stem above 4 – 8 lines thick; radial spines hardly 1 line, central ones 2 – 3 lines long. Seed smaller than in any other *Echinocereus*, 0.4 line long, with the tubercles confluent.

Subgen. 2. EUCEREUS. Caulis elongatus: fasciculi aculeorum steriles et florigeri similes: floris tubus elongatus, sæpissime aculeolis capillaceis munitus: stigmata pallida: semina lævia seu raro rugosa: embryo hamatus.

26. C. EMORYI, E. in Sill. Journ. 1852: prostratus; ramis adscendentibus 15-costatis; areolis confertis; aculeis setaceis rigidis flavis,

radialibus 40 – 50 stellatis, centrali unico longiore robustiore; flore flavo breviusculo; bacca aculeatissima; seminibus magnis lucidis.

On hills near San Diego, California, growing in thick patches. — Stems several feet long; branches 6 – 9 inches high, 1½ inches in diameter. Fruit very spinose, with seeds over one line in length.

27. C. VARIABILIS, Pfeiff.: erectus, 3 – 4 angulatus; areolis remotis; aculeis 4 – 6 brevibus radiantibus, 2 – 4 interioribus validis elongatis inæqualibus divaricatis, centrali deflexo; flore magno albo nocturno; bacca coccinea aculeolata; seminibus magnis lævibus.

On the lower Rio Grande: fl. in May and June. — Well known from all parts of tropical America. Fruit 3 to 10 feet high, 2 inches in diameter; larger spines 12 – 18 lines long. Fruit 2 – 3 inches long, nearly 2 inches in diameter.

28. C. GREGGII, E. in Wisl. Rep.: gracilis, e radice crassa napiformi erectus; ramis 3 – 6-angulatis, rufescentibus; areolis confertis; aculeis e basi bulbosa abrupte subulatis brevissimis nigricantibus, radialibus 6 – 9, centralibus 1 – 2; floris elongati albidi tubo aculeolis capillaceis flexuosis munito; bacca sessili obovata apice rostrata; seminibus rugosis.

Var. *α.* CISMONTANUS: areolis elongatis; petalis latioribus.

Var. *β.* TRANSMONTANUS: areolis ovato-orbiculatis; petalis angustioribus.

From Western Texas to Sonora, and south to Chihuahua: fl. May and June. — Root a large fleshy tuber, sometimes 6 inches in diameter. Stems 2 – 3 feet high, 9 – 12 lines thick, usually 4- or 5-angled; spines ½ – 1 line long, very sharp; lower ones longer. Flower 6 or 8 inches long, 2 – 2½ wide. Fruit 1 – 1½ inches long. Seed 1¼ – 1½ lines long.

Subgen. 3. LEPIDOCEREUS. Caulis elongatus: fasciculi aculeorum steriles et florigeri similes: floris tubus brevior squamosus: phylla numerosissima: stigmata pallida: semina lævia: embryo hamatus.

29. C. GIGANTEUS, E. in Emory's Rep. 1848: erectus, elatus, parce erecto-ramosus, 18 – 21-costatus; aculeis 12 – 16 radialibus inæqualibus, centralibus sub-6 robustis basi bulbosis corneis basi nigris cæteros superantibus, infimo longiore deflexo; floribus subterminalibus albidis; bacca obovata demum 3 – 4-valvi.

From the Lower Gila north to Williams's River (better known

among western travellers as Bill Williams's Fork), and south into Sonora: fl. May – July; fr. July and August. — A now well-known plant to travellers and botanists, 30 – 50 feet high, 1 – 2 feet in diameter; central spines $1\frac{1}{2}$ – $2\frac{1}{2}$ inches long. The yellowish-white flower 3 – 4 inches long. Fruit 2 – 3 inches long, often pear-shaped, and opening with 3 or 4 irregular recurved valves.

30. C. Thurberi, E. in Sill. Journ. 1854: caulibus erectis vel adscendentibus pluribus elatioribus articulatis 13 – 14-costatis; aculeis 7 – 15 gracilibus fusco-atris valde inæqualibus; ovario tuboque imbricato-squamato; bacca globosa magna.

Sonora, west of the Sierra Madre: fl. June and July. — Stems 5 – 15 from one root, 10 – 15 feet high, 4 – 6 inches in diameter; spines slender, flexible, from 5 – 18 lines long. Flowers 3 inches long, white. Fruit like a large orange, of delicious flavor.

Subgen 4. Pilocereus. Caulis elatus: fasciculi aculeorum steriles a floriferis tenuioribus longioribus distincti: floris tubus brevis squamosus: phylla pauciora: stigmata pallida: semina lævia: embryo hamatus (in specie nostra !).

31. C. Schottii, E. in B. C. R.: caulibus erectis vel adscendentibus pluribus elatioribus articulatis 4 – 7-costatis; areolis in articulis sterilibus remotis; aculeis brevibus robustis, radialibus 4 – 6, centrali unico; areolis in articulis floriferis confertis; aculeis 15 – 25 longioribus setaceis flexuosis e rubello cinereis; floribus carneis minoribus, tubo gracili decurvo; bacca parva.

Sonora, towards Santa Magdalena: fl. July. Stems 8 – 10 from the same base, often growing in dense clusters, 8 or 10 feet high, with 2 – 4 articulations, 4 or 5 inches in diameter. Spines of the sterile part of the plant 3 – 4 lines long, on the fertile joints 1 – 4 inches long, pendulous, forming a reddish-gray beard, in which the flower (not 2 inches long) is somewhat hidden. Seeds large: cotyledons hooked, exactly as in the last two species. This is evidently a *Pilocereus*, but with the seed of a true *Cereus*, thus reuniting the former with the latter.

Trib. II. ROTATÆ, Miquel.

Aphyllæ seu foliosæ. Flores tubo abbreviato subrotati. Cotyledones facie versus hilum spectantes seminis lateri contrariæ (incumbentes).

IV. OPUNTIA, Tourn.

Ovarium sepalis subulatis caducis axillâ pulvilligeris instructum. Semina magna, compressa, discoidea, sæpe marginata, albida. Cotyledones foliaceæ, circa albumen curvatæ, plerumque incumbentes. — Plantæ articulatæ; articulis complanatis seu teretibus plus minus tuberculatis; foliis subulatis caducis axillâ pulvillos setosos plerumque aculeiferos gerentibus; aculeis apice retrorsum hispidis.

ANALYSIS.

I. Petala parva, subulata, suberecta. — Subgen. 1. STENOPUNTIA.

II. Petala lata, obovata seu obcordata.

1. Articuli complanati: embryo circa albumen parcum spiraliter convolutus. — Subgen. 2. PLATOPUNTIA.

A. Bacca succosa: margo seminum plerumque angustior (*Sarcocarpeæ*).

a. Glabræ.

* Bacca parva subglobosa. — § 1. *Microcarpeæ*.

** Articuli magni: aculei pauci compressi. — § 2. *Grandes*.

*** Articuli minores: aculei setiformes. — § 3. *Setispinæ*.

**** Articuli minores: aculei pauci, robusti, teretes. — § 4. *Vulgares*.

b. Pubescentes. — § 5. *Pubescentes*.

B. Bacca sicca: margo seminum plerumque latissimus. — § 6. *Xerocarpeæ*.

2. Articuli cylindracei: embryo circa albumen copiosius subcircularis. — Subgen. 3. CYLINDROPUNTIA.

A. Articuli abbreviati, clavati. — § 1. *Clavatæ*.

B. Articuli cylindracei, elongati. — § 2. *Cylindricæ*.

Subgen. 1. STENOPUNTIA, E. in B. C. R. Articuli complanati: flores parvi: petala subulata: stigmata pauca.

1. O. STENOPETALA, E. l. c.: prostrata; articulis magnis; aculeis 1 – 3 cum minoribus 1 – 3 ancipitibus deflexis atrofuscis; ovario pulvillis confertis stipato; sepalis petalisque subulatis suberectis; stylo inflato; stigmate simplici.

On the battle-field of Buena Vista, south of Saltillo. Nearly allied to the Mexican *O. grandis*, Hort. Angl., which has very similar flowers, but is an erect plant, with few and white spines, and 2 or 3 acute stigmata.

Subgen. 2. PLATOPUNTIA, E. l. c. Articuli complanati: flores magni: bacca pulposa vel rarius sicca: semina late marginata: embryo plusquam circularis circa albumen parcum spiraliter convolutus: cotyledones semper contrariæ.

§ 1. *Microcarpeæ:* suberectæ: aculei plurimi, colorati: bacca parva subglobosa.

2. O. STRIGIL, E. in B. C. R.: suberecta, articulis ovatis orbiculatisve; pulvillis confertis; aculeis 5–8 radiantibus deflexis rufis apice flavis; bacca parva late umbilicata rubra; seminibus parvis anguste marginatis.

Between the Pecos and El Paso. — Plant 2 feet high; joints 4–5 inches long; spines an inch or less in length. Fruit 6–7 lines long.

§ 2. *Grandes:* erectæ seu procumbentes: articuli magni: aculei pauci, validi, compressi, plerumque colorati: bacca major vel magna, plerumque ovata.

* *Subinermes.*

3. O. FICUS-INDICA, Mill: cultivated south of the Rio Grande, under the name *Nopal Castillano.*

* * *Flavispinæ.*

† *Erectæ.*

4. O. TUNA, Mill: cultivated about the old missions in the southern parts of Upper California, under the name *Tuña.* Specimens gathered at Beaufort, on the coast of South Carolina, (probably introduced,) may belong here.

5. O. ENGELMANNI, Salm: erecta, grandis; articulis obovatis; pulvillis remotis setas stramineas rigidas inæquales aculeosque 1–3 compressos stramineos basi rufos gerentibus; floris flavi intus rubelli ovario subgloboso; stigmatibus 8–10; bacca obovata late umbilicata; seminibus minoribus.

From the Canadian River to the mouth of the Rio Grande, and westward from the Gulf to Chihuahua and El Paso: fl. May and June. — Plant 4–6 feet high; joints a foot long or less; leaves subulate, 3–4 lines long; larger spines 1–1½ inches long. Flower 2½–3 inches in diameter. Fruit usually 2 inches long, 1½ in diameter, juicy, but of a somewhat nauseous taste. Seeds 1½–2 lines in diameter. A plant observed by Dr. Blackie on Bayou Bœuf, Western Louisiana, 5½ feet high, joints 9 inches long, reddish-yellow flowers, is probably this species.

O. Lindheimeri, E. Pl. Lindh., is partly this same plant, partly a hybrid form between it and perhaps *O. Rafinesquii*, with narrow clavate fruit.

O. ENGELMANNI, var.? CYCLODES, E. & B. in P. R. R.: articulis orbiculatis; aculeis validioribus subsingulis; bacca parva globosa; seminibus majoribus.

On the Upper Pecos, in New Mexico. Joints 6 – 7 inches, and fruit 1 or 1¼ inches in diameter.

O. DULCIS, E. in B. C. R., is a doubtful plant, of which we have not material enough. It has been found near the middle course of the Rio Grande, near Presidio del Norte, &c. It is similar to *O. Engelmanni*, and may be a form of it; but it is lower, more spreading, with a similar but very sweet fruit, and small, regular seeds.

The following may be considered as a subspecies: —

O. OCCIDENTALIS, E. & B. in P. R. R.: erecta, patulo-ramosissima; articulis grandibus obovatis vel rhomboideis; pulvillis remotis setas graciles confertas et aculeos 1 – 3 validos compressos deflexos albidos basi obscuriores et inferiores paucos graciliores gerentibus; floris flavi intus rubelli ovario obovato; bacca obovata late umbilicata; seminibus majoribus.

On the western slope of the California mountains, near San Diego and Los Angeles: fl. June. — Plant 4 feet high, forming large thickets; the joints 9 – 12 inches long; pulvilli with very fine closely-set bristles; spines about one inch long. Apparently distinct from *O. Engelmanni* by its manner of growth, the very fine bristles, and the larger seeds.

There are also some indications of another form, growing on hills and plains near San Diego, California, and on the neighboring seabeach, with higher and more upright growth, and coarser bristles on the pulvilli, but which I cannot well distinguish from *O. Engelmanni*. I have seen no fruit or seed of it.

6. O. CHLOROTICA, E. & B. in P. R. R.: caule erecto aculeis flavis numerosissimis fasciculatis armato; articulis orbiculato-obovatis pallidis; pulvillis subremotis setas difformes confertas aculeosque 3 – 6 inæquales compressos stramineos gerentibus; floris flavi ovario pulvillis confertis stipato; petalis spathulatis.

Western Colorado country, between New Mexico and California, from the San Francisco mountains to Mojave Creek. — Plant 4 – 6 feet high, forming large and sometimes spreading bushes; the trunk

covered with spines 1 – 2 inches long; joints 8 – 10 by 6 – 8 inches in length; spines ½ – 1½ inches long. Ovary with nearly 50 pulvilli, while the foregoing species have not more than 20.

†† *Procumbentes.*

7. O. PROCUMBENS, E. & B. l. c.: prostrata; articulis orbiculato-obovatis grandibus pallide viridibus; pulvillis remotis setas stramineas rigidas valde inæquales et aculeos 2 – 4 validos compressos angulatos stramineos basi obscuriores gerentibus.

San Francisco mountains to Cactus Pass, in Western New Mexico. Joints 9 – 13 inches long, always edgewise; pulvilli 1½ – 2 inches apart; spines 1 – 2 inches long. Similar to *O. Engelmanni*, but prostrate, with more distant pulvilli, and stouter spines. No flower or fruit seen.

8. O. ANGUSTATA, E. & B. l. c.: prostrata vel adscendens; articulis elongato-obovatis versus basin angustatis; pulvillis remotis setas fulvas graciles aculeosque paucos (2 – 3) validos compressos stramineos seu albidos versus basin rufos deflexos gerentibus; bacca obovata tuberculata; seminibus magnis.

From Zuni, west of the Rio Grande, westward to the Cajon Pass, in the California mountains. — Joints 6 – 10 inches long, only 3 or 4 wide. Spines similar to those of the last species; bristles much more delicate. Fruit 1½ inches long; the umbilicus flat, but immersed. — Well distinguished by the shape of the joints.

* * * *Fulvispinæ.*

9. O. MACROCENTRA, E. in B. C. R.: adscendens; articulis magnis suborbiculatis tenuibus; pulvillis subremotis setas graciles breves fulvas gerentibus, summis solum aculeos 1 – 2 prælongos subcompressos fusco-atros proferentibus; floris flavi ovario ovato; stigmatibus 8; seminibus majusculis.

Sand-hills on the Rio Grande near El Paso: fl. May. — Two or three feet high, with very striking round joints, 5 – 8 inches in diameter, and blackish spines as much as 2 or 3 inches long. Nearly allied to the next species.

10. O. PHÆACANTHA, E. in Pl. Fendl.: diffusa, adscendens; articulis obovatis crassis glaucescentibus; pulvillis subremotis setas graciles stramineas seu fuscatas longiores gerentibus, plerisque aculeos 2 – 5 plus minus compressos fuscos proferentibus; floris flavi ovario abbreviato; stigmatibus 8; bacca cuneata pyriformi; seminibus majusculis.

Var. *α.* NIGRICANS: aculeis brevioribus acute angulatis et nigricantibus.

Var. *β.* BRUNNEA: pulvillis remotioribus; aculeis longioribus obtuse angulatis brunneis sursum albidis.

Var. *γ.* MAJOR: suborbiculata; pulvillis remotis; aculeis brevioribus paucioribus pallidioribus.

New Mexico: fl. May. Var. *α.* is found on the Rio Grande near Santa Fé; *β.* in similar sandy locations near El Paso; and *γ.* in mountainous regions near Santa Fé. — Joints 4 – 6, or in *γ.* even 8, inches long; spines mostly 1 – 2 inches in length. Flower about 2 inches in diameter, with a short ovary. Fruit 1¼ – 1½ inches long, slender, much contracted at base so as to appear almost stipitate.

O. MOJAVENSIS, E. & B. in P. R. R.: prostrata; articulis grandibus suborbiculatis; pulvillis remotis; setis fulvis; aculeis 3 – 6 validis infra fuscis.

On the Mojave, west of the Colorado. — The material is too scanty to make out where it belongs; but perhaps it is only a form of *O. phœacantha.*

11. O. CAMANCHICA, E. & B. in P. R. R.: prostrata; articulis adscendentibus majusculis suborbiculatis; pulvillis remotis plerisque armatis; setis stramineis fulvisve parcis; aculeis 1 – 3 compressis fuscis apice pallidioribus, superioribus elongatis suberectis, cæteris deflexis; bacca ovata late umbilicata; seminibus majusculis angulatis hilo excisis.

Llano Estacado, on the Upper Canadian River. A large, extensively spreading plant; the joints 6 – 7 inches long; spines 1½ – 2 or even 3 inches long. Fruit large, juicy. Seeds 2 – 3 lines in diameter, very irregular and deeply notched at the hilum.

12. O. TORTISPINA, E. & B. l. c.: prostrata; articulis adscendentibus majusculis suborbiculatis; pulvillis subremotis; setis stramineis seu fulvis; aculeis 3 – 5 majoribus angulatis sæpe tortis albidis cum 2 – 4 gracilioribus; bacca ovata late umbilicata; seminibus majusculis orbiculatis.

On the Camanche plains, east of the elevated plateau of the Llano Estacado. — Similar in size and habit to the last species, its western neighbor, with more numerous spines than any other of our *Opuntiæ* with juicy fruit. Seeds regular, and only very slightly notched at the hilum.

§ 3. *Setispinæ:* adscendentes: articuli plerumque minores: aculei pauci, teretes seu vix angulati, graciles, flexiles, pallidi: bacca minor.

13. O. TENUISPINA, E. in B. C. R.: articulis majusculis obovatis basi attenuatis læte viridibus; pulvillis subapproximatis setas graciles breves fulvas gerentibus plerisque armatis; aculeis 1 – 2 elongatis albidis cum 1 – 4 brevioribus inferioribus; floris flavi ovario clavato; petalis obovatis retusis; bacca oblonga profunde umbilicata; seminibus minoribus.

Sand-hills near El Paso: fl. May. — Joints 3 – 6 inches long, 2 – 4 wide; leaves very slender, hardly 2 lines long; upper spines suberect, or spreading, $1\frac{1}{2}$ – $2\frac{1}{2}$ inches long; flower $2\frac{1}{2}$ – 3 inches in diameter; seeds less than 2 lines in diameter, very irregular. — Similar in many respects to *O. phœacantha*, which grows with it; but readily distinguished by the spines and fruit.

14. O. SETISPINA, E. in Salm, H. D.: articulis suborbiculatis parvis glaucis; pulvillis confertis setas flavidas gerentibus, omnibus armatis; aculeis 1 – 3 longioribus subangulatis et 3 – 7 brevioribus plus minus deflexis, omnibus gracillimis.

Pine woods in the mountains west of Chihuahua, *Dr. Wislizenus.* Joints not over 2 inches long; pulvilli only 3 – 4 lines apart; longer spines 1 – $1\frac{1}{2}$ inches long, very slender, like bristles. Flower and fruit unknown.

15. O. FILIPENDULA, E. in B. C. R.: glauca; radicibus nodoso-incrassatis; articulis minoribus orbiculatis seu obovatis seu oblanceolatis tenuibus; pulvillis approximatis setas virescenti-flavas graciles numerosas gerentibus armatis vel inermibus; aculeis, si adsunt, 1 – 2 elongatis subangulatis cum 1 – 2 minoribus, omnibus albidis; floris purpurascentis ovario gracili; stigmatibus 5; seminibus minoribus tumidis.

Alluvial bottoms of the Rio Grande near El Paso, and eastward on the Pecos: fl. May and June. — The long knotted roots, the small bluish joints, with the very small leaves and very long bristles, together with the purple flower, and thick very narrowly margined seeds, distinguish this species from all others. Plant 6 – 12 inches high, joints $1\frac{1}{2}$ – 3 inches long, 1 – 2 wide; pulvilli 4 – 6 lines apart; lower spines 1 – 2 inches long. Flower $2\frac{1}{2}$ inches in diameter. Seed hardly 2 lines in diameter.

§ 4. *Vulgares:* procumbentes vel adscendentes: articuli plerumque minores: aculei validi, subteretes vel nulli, albidi vel obscuriores: bacca clavata.

16. O. RAFINESQUII, E. in P. R. R.: diffusa; radice fibrosa; articulis obovatis vel suborbiculatis perviridibus, foliis elongatis patulis; pulvillis subremotis setas graciles rufas gerentibus plerisque inermibus; aculeis paucis marginalibus validis rectis singulis erectis patulisve, uno alterove minore deflexo subinde adjecto, rufo variegatis; alabastro acuto; ovario clavato pulvillis 20 – 25 stipato; petalis 10 – 12; stigmatibus 7 – 8; bacca clavata.

Var. MICROSPERMA: subinermis: seminibus minoribus angustius marginatis.

Sterile, sandy, or rocky soil in the Mississippi valley, from Kentucky to Missouri, and from Minnesota southward: fl. May and June. — Joints 3 – 5 inches long; leaves 3 – 4 lines long; spines 9 – 12 lines long, sometimes entirely wanting. Flowers 2½ – 3½ inches in diameter, yellow, often with a red centre. Seed 2½ lines, or in the variety less than 2 lines in diameter. — This species had been confounded with the Eastern *O. vulgaris* by all our botanists, with the exception of Rafinesque, who pretended to distinguish three species, viz. *O. humifusa*, *O. cæspitosa*, and *O. mesacantha* (sometimes erroneously accredited to Nuttall), which cannot be made out, and which I have again united under their author's name. — The following is probably only a Southern variety of this species: —

O. GRANDIFLORA, E.: subadscendens; articulis majusculis; pulvillis remotis; setis tenuissimis; aculeis subnullis; floris grandis ovario elongato; petalis sub-10 latissimis; stigmatibus 5; bacca elongata clavata.

On the Brazos, Texas. — Joints often 5 – 6 inches long; pulvilli nearly an inch apart. Flowers 4½ – 5 inches in diameter, red in the centre; petals 2 inches long or more, and 1½ wide.

Dr. Bigelow collected on his tour from Arkansas to Santa Fé several forms, which, though somewhat distinct, are perhaps not entitled to be considered species. The true *O. Rafinesquii* does not seem to occur west of the western line of Missouri and Arkansas. The Western forms or subspecies are: —

O. CYMOCHILA, E. & B. in P. R. R.: diffusa; articulis orbiculatis; pulvillis subremotis stramineo- seu fulvo-setosis plerisque armatis; aculeis 1 – 3 robustioribus albidis basi fulvis patentibus deflexisve, additis

sæpe 2–3 minoribus; stigmatibus 8; bacca obovata; seminibus undulato-marginatis majusculis.

Var. β. MONTANA: subinermis; stramineo-setosa.

Along the Canadian River east of the Llano Estacado, and on that plain. Var. β. near Albuquerque. — Joints 2½–3 inches in diameter, in β. larger; longer spines 1–2 inches long. Fruit short, pulpy, sweet. Seed 2½ lines in diameter, with a very sharp irregularly wavy or twisted border. — The var. β. seems to unite the common *O. Rafinesquii* with this form.

O. STENOCHILA, E. & B. l. c.: prostrata; articulis obovatis; pulvillis remotis stramineo-setosis, superioribus solum armatis; aculeis singulis albidis patulis, 1–2 minoribus deflexis sæpe adjectis; bacca obovata clavata; seminibus crassis anguste marginatis.

Zuni, Western New Mexico. — Joints 4 inches long and 3 wide; spines 1–1½ inches long. Fruit green or pale red, very juicy, 1½ or sometimes even 2½ inches long. Seeds quite peculiar, regular, much thicker in proportion than those of most other *Opuntiæ*, and with a very narrow edge. — Another form, with smaller and rounder joints, more spines, smaller fruit, but similar seeds, was found in the same neighborhood.

All the forms described above have fibrous roots. The following are principally characterized by their bulbous or tuberous roots, but can hardly be otherwise distinguished from the forms already described. Both are found westward of the range of *O. Rafinesquii* proper, and may be considered as subspecies, the peculiarities of which are readily propagated by seeds.

O. MACRORHIZA, E. in Pl. Lindh. part 1: prostrata, sæpe adscendens, radicibus tuberosis; articulis obovato-orbiculatis perviridibus; pulvillis subremotis rufo-setosis, superioribus solum armatis; aculeis singulis validis sæpe variegatis patulis, 1–2 gracilioribus deflexis subinde additis; alabastro acuminato; petalis circiter 8 sulphureis basi miniatis; stigmatibus 5; bacca obovata basi clavata, umbilico lato; seminibus subregularibus compressis minoribus.

Sterile, rocky places on the Upper Guadalupe River, in Texas: fl. May and June. — Roots in young specimens fusiform, in old ones enlarged to fleshy tubers, sometimes 2 or 3 inches in diameter. Joints 2½–3½ inches long, the leaves and bristles the same as in *O. Rafinesquii*. Flowers 3 inches in diameter. Fruit green or pale purple, smaller and sweeter than that of *O. Rafinesquii*.

O. FUSIFORMIS, E. & B. l. c.: subprostrata; radicibus elongato-fusiformibus; articulis orbiculatis; pulvillis setas elongatas virescenti-fuscas gerentibus, plerisque vel solum superioribus armatis; aculeis 2 – 3 gracilibus albidis deflexis seu patentibus; floribus minoribus; stigmatibus 8; bacca ovata; seminibus majusculis subregularibus.

Kansas and Nebraska, in the regions of the Cross-Timbers, from the Canadian to the Big Bend of the Missouri. — Roots elongated tubers ½ – 1 inch in diameter; joints about 3 – 4 inches long; spines an inch or a little more in length, slenderer and paler than in *O. Rafinesquii.* Flowers 2 – 2½ inches in diameter. Seed 2¾ lines wide. This plant has been distributed by me under the name of *Opuntia bulbosa.*

17. O. FUSCO-ATRA, E. in P. R. R.: diffusa; articulis orbiculato-obovatis tuberculatis; pulvillis subremotis magnis griseo-tomentosis, inferioribus solum inermibus; setis numerosis robustis longiusculis fuscis; aculeis subsingulis robustis fusco-atris suberectis, altero breviore deflexo sæpe adjecto; floris flavi ovario conico pulvillos 12 – 18 fulvo-villosos et fusco-setosos gerente; stigmatibus 5.

Sterile places in prairies, west of Houston, Texas: fl. May. — The stout brown, or above almost black spines, and the thick bunches of unusually stout brown bristles on the small joints, give this plant a very distinct appearance. Joints 2½ – 3 inches long; pulvilli 6 – 9 lines apart; bristles 2 – 3 lines long; spines 1 – 1¼ inches long, the lower one, when present, about half as long, but hardly less stout. Flower nearly 3 inches in diameter; ovary an inch long, rather slender, its pulvilli covered with long grayish-brown wool, and the upper ones with a few bright-brown bristles.

18. O. VULGARIS, Mill.: diffusa, prostrata; radice fibrosa; articulis obovatis seu suborbiculatis crassis læte seu pallide viridibus plerumque inermibus; foliis ovatis cuspidatis fere adpressis; pulvillis subremotis parvis subimmersis setas paucas abbreviatas virescenti-stramineas gerentibus; aculeis rarissimis singulis robustis variegatis suberectis; alabastro subgloboso obtuso; ovario clavato pulvillis sub-10 stipato; petalis sub-8; stigmatibus 5; bacca obovata clavata; seminibus regularibus crassis crasse marginatis.

From the southeastern coast of Massachusetts to Georgia and Florida; apparently only in the low countries east and southeast of the Alleghany Mountains, generally not far from the sea-coast: fl. May and June. — Joints 2 – 4 inches long and 2 – 2½ in diameter, rather thick and fleshy. Leaves 2 – 2½ lines long, generally appressed, only in

very vigorous specimens more patulous: spines, when present, less than 1 inch long, but stout. Flower about 2 inches in diameter, pale yellow. Seed 2½ lines in diameter. It seems to be well distinguished from *O. Rafinesquii* (which grows only west of the Alleghanies) by the smaller size, paler color, small pulvilli, usually the absence of spines, the smaller flower, with all the parts less numerous, and especially by the short, thick, and more or less appressed leaves.

§ 5. *Pubescentes:* erectæ seu procumbentes: articuli pubescentes: folia minuta: aculei subnulli.

* *Flaviflorœ.*

19. O. MICRODASYS, Lehm.: erecto-patula; articulis oblongis obovatis seu orbiculatis pubescentibus læte viridibus; foliis minutis; pulvillis confertis inermibus lanam flavidam setasque numerosas gracillimas flavas gerentibus.

Only south of the lower Rio Grande, near Rinconada, etc. — Plant 2–4 feet high; joints 2–3 inches long, 1½–2 wide; pulvilli ¼–⅓ of an inch apart.

20. O. RUFIDA, E. in B. C. R.: erecto-patula; articulis late-obovatis seu suborbiculatis pubescentibus; foliis longe acuminatis; pulvillis confertis setas rufidas graciles numerosissimas gerentibus inermibus; floris flavi ovario obovato pulvillis numerosis instructo; stigmatibus 7 in capitulum congestis.

Common about Presidio del Norte, on the Rio Grande: fl. May. — Stem 2–4 feet high, much branched; joints 3–6 inches long; leaves 2½ lines long. Flower 2½ inches in diameter, with 40–50 pulvilli on the ovarium. — Apparently near *O. microdasys* and *O. puberula;* distinguished from the former by the rounded joints, larger leaves, and red-brown bristles; from the latter by the entire absence of spines, and of the purplish spot which in that species surrounds the pulvillus. Further investigations are necessary to decide about these closely allied forms, as about most species of this intricate genus.

* * *Rubriflorœ.*

21. O. BASILARIS, E. &. B. l. c.: humilis; articulis obovatis seu triangularibus glaucescentibus pubescentibus e basi proliferis; foliis minutis; pulvillis subconfertis fulvo-villosis setas gracillimas demum numerosissimas fulvidas et subinde aculeolos setiformes caducos gerentibus; floris purpurei ovario obovato pulvillis plurimis instructo;

stigmatibus 8 in capitulum congestis; bacca obovata late umbilicata (sicca?); seminibus magnis crassis subregularibus.

On Williams's River, the Colorado, and the Mojave, and down to the Gila: fl. April and May. — Habit very different from any other of our *Opuntiæ;* the stout obovate or fan-shaped joints (5 – 8 inches long) originate from a common base, forming a sort of rosette. Leaves only one line long, 4 – 6 lines apart; pulvilli red-brown, somewhat immersed. Flower about 2½ inches in diameter; ovary with 40 – 60 pulvilli. Fruit apparently dry, thereby approaching the next section. Seed 3 lines in diameter, 2 lines thick.

Mr. Schott has observed, on the dividing ridge of the California mountains, west of the mouth of the Gila, and again in the Santa Cruz Valley, Sonora, a very similar but suberect species, 3 feet high, spineless, inclined to assume a purplish hue, which he seems to have confounded with *O. basilaris.* Can it be *O. rufida*, or is it an undescribed species?

§ 6. *Xerocarpeæ:* diffusæ: articuli suborbiculati vel tumidi: aculei plurimi: bacca sicca aculeolata: semina eburnea, magna, plerumque latissime marginata.

* *Articuli compressi suborbiculati.*

22. O. HYSTRICINA, E. & B. l. c.: diffusa; articulis obovato-orbiculatis; pulvillis subconfertis setas pallidas rutilasve gerentibus, omnibus armatis; aculeis 5 – 8 superioribus validis elongatis angulatis seu tortis patulis vel deflexis, inferioribus 5 – 7 gracilioribus radiantibus; bacca ovata aculeolata, umbilico planiusculo; seminibus maximis.

West of the Rio Grande, to the San Francisco mountains. — Joints 3 – 4 inches long; pulvilli 5 – 6 lines apart, unusually large; longer spines 1½ – 3 and even 4 inches long, brownish; lower radiating ones white, 4 – 9 lines long. Fruit an inch long; upper pulvilli with 4 – 6 bristly spines. Seeds 3½ lines in diameter, among the largest in this genus.

23. O. MISSOURIENSIS, DC. (Cactus ferox, *Nutt. Gen.*): prostrata; articulis obovatis vel suborbiculatis tuberculatis; foliis minutis; pulvillis subconfertis stramineo-setosis, omnibus armatis; aculeis 5 – 10 exterioribus radiantibus setiformibus albidis, 1 – 5 interioribus robustis albidis seu rufescentibus; floris flavi intus aurantiaci ovario obovato vel subgloboso spinuloso; stigmatibus 5 – 10 viridibus; bacca spinosa, umbilico plano; seminibus magnis irregularibus.

Var. α. RUFISPINA, E. & B.: articulis orbiculatis; aculeis interioribus 3 – 5 validis fuscis; bacca ovata.

Var. β. PLATYCARPA, E.: articulis obovato-orbiculatis; aculeis interioribus subsingulis validis fuscis; bacca depresso-globosa late umbilicata.

Var. γ. MICROSPERMA, E.: articulis aculeisque præcedentis; bacca ovata breviter aculeolata; seminibus minoribus anguste marginatis.

Var. δ. SUBINERMIS, E.: articulis elongato-obovatis, pulvillis subremotis inferioribus inermibus, superioribus aculeos paucos breves gerentibus.

Var. ε. ALBISPINA, E. & B.: articulis late obovatis; aculeis 6 – 12 omnibus albis gracilioribus; bacca ovata.

Var. ζ. TRICHOPHORA, E. & B.: articulis ovatis; pulvillis confertis; aculeis 10 – 18 setiformibus (in articulis vetustis numerosioribus) capillaceis flexuosis; bacca ovata; seminibus maximis.

From the Upper Missouri to the Canadian; principally occupying the western plains, but also on the mountains towards Santa Fé and west of it. — The last-mentioned variety (which I would consider a distinct species, were it not for the var. *albispina*, which seems to unite it with the others) has been found only on the mountains near Albuquerque: all the other forms occur on the Upper Missouri, and α. and ε. also on the Canadian. Other and intermediate forms of this variable but nevertheless well-characterized species will no doubt be found in the wide territory inhabited by it. It flowers in May and June. — Joints 2 – 4, rarely 4 – 6 inches long, and 2 – 3½ inches wide, light green; leaves 1½ – 2 lines long; larger spines 1 – 1½, rarely 2 inches long, in δ. not more than 3 – 6 lines long. Flowers 2 – 3 inches in diameter, with short green stigmata forming a compact head. Fruit 1 – 1¼ inches long, with shorter or longer spines, and a rather shallow umbilicus. Var. β. has a remarkably large flat fruit. Seed generally about 3 lines, but in γ. only 2 lines, in diameter.

24. O. SPHÆROCARPA, E. & B. l. c.: diffusa; articulis orbiculatis tuberculatis; pulvillis confertis stramineo-setosis plerisque inermibus, summis solum aculeos 1 – 2 deflexos patulosve majores gerentibus, adjectis sæpe 1 – 3 brevioribus; bacca globosa vix aculeolata; seminibus mediis.

Mountains near Albuquerque, New Mexico. — Joints 3 inches in diameter, strongly tuberculated; pulvilli 4 or 5 lines apart; spines 6 – 12 lines long, reddish-brown, often single or 2 or 3 together, with

or without smaller ones, which never occurs in any form of *O. Missouriensis*, where a large number of small setaceous spines is found, whether larger ones are present or not. Fruit 9 lines in diameter, with a small flat umbilicus. Seeds $2\frac{1}{2}$ lines in diameter.

* * *Articuli tumidi ovati.*

25. O. ERINACEA, E. & B. l. c.: adscendens; articulis ovatis seu teretiusculis; pulvillis confertissimis omnibus armatis; aculeis 5 – 10 gracilibus rubellis, 3 – 5 elongatis; bacca ovata aculeolata; seminibus magnis subregularibus.

Near the Mojave, between the Colorado and the Californian mountains. — Joints $2 - 2\frac{1}{2}$ inches long, $1 - 1\frac{1}{2}$ broad, and $\frac{1}{2} - \frac{3}{4}$ thick, sometimes almost cylindrical, densely covered with large white pulvilli, which are only 2 – 3 lines apart. Spines 6 – 14 or even 20 lines long, slender but stiff. Fruit an inch or more in length. Seeds nearly 3 lines in diameter.

26. O. ARENARIA, E. in B. C. R.: adscendens; articulis obovatis compressis seu teretiusculis tuberculatis; foliis minutis; pulvillis subconfertis pallide setosis; aculeis 1 – 4 robustioribus albidis fuscatisve, cum inferioribus brevioribus 2 – 6 albis; floris sulphurei ovario obovato; petalis emarginatis; stigmatibus 5; bacca oblonga spinulosa; umbilico infundibuliformi; seminibus magnis irregularibus.

Sandy bottoms of the Rio Grande near El Paso: fl. May. — Spreading 2 – 3 feet, $\frac{1}{2} - 1$ foot high; roots stout, creeping horizontally; joints $1\frac{1}{2} - 3$ inches long, 1 – 2 inches wide, and $\frac{1}{2} - \frac{3}{4}$ thick, more strongly tuberculated than the allied species; leaves only a line long; pulvilli 3 – 5 lines apart, very bristly, especially on the old joints; upper spines 9 – 15 lines long. Flower $2 - 2\frac{1}{2}$ inches in diameter. Fruit about an inch long. Seeds $2\frac{1}{2} - 3$ lines in diameter. This is the only one of our Cactaceæ on which the Cochenille has been found.

27. O. FRAGILIS, Haw. (Cactus fragilis, *Nutt.*): subdecumbens; articulis parvis ovatis subcompressis tumidis vel subglobosis vix tuberculatis nitide viridibus; foliis minutis; pulvillis subconfertis magnis albo-tomentosis, vix setulosis; aculeorum 1 – 4 robustiorum summo valido angulato fuscato porrecto, ceteris debilioribus pallidioribus patulis seu radiantibus; aculeis inferioribus 2 – 6 gracilibus albis radiantibus; floribus minoribus; bacca ovata vix spinulosa, umbilico infundibuliformi; seminibus paucis magnis subregularibus.

Fertile prairies, or sterile places, on the Upper Missouri and Yellowstone, to the mountains and south to Santa Fé. — Size and shape of the joints variable; fruit-bearing joints compressed, $1\frac{1}{2}-2$ inches long, $1-1\frac{1}{4}$ wide, and $\frac{1}{2}-\frac{3}{4}$ thick; others smaller and more tumid. Leaves a line long, hardly longer than the large pulvilli, red. Pulvilli 4 – 6 lines apart, bristles very few, short, whitish, on the old joints a little more numerous, coarser, dirty yellow. Lower radiating spines 2 – 4 lines long; central spines 6 – 10 lines long, the other interior spines 3 – 8 lines long, often similar to the smaller lower spines. Fruit rather fleshy through the winter, getting dry in spring, nearly an inch long, with 20 – 25 pulvilli, of which only the upper ones bear a few short spines. Seeds few, usually only 5 or 6 in each fruit, 3 lines in diameter, with a wide and thick obtuse corky margin. — Often sterile, but abundantly propagated by the fragile joints.

28. O. BRACHYARTHRA, E. & B. l. c.: adscendens; articulis ovatis orbiculatisve tumidis sæpe subglobosis tuberculatis; pulvillis confertis parce setulosis; aculeis 3 – 5 validioribus 1 – 2 fuscatis patulis vel suberectis, cæteris deflexis; floris parvi ovario subgloboso pulvillos 12 – 15 vix aculeolatos gerente; stigmatibus 5.

Inscription Rock near Zuni. — The short and tumid joints (10 – 15 lines long) resemble the joints of a finger; the pulvilli 2 – 4 lines apart, even in the oldest parts of the plant with very few bristles; longer spines 9 – 12 lines long, terete. Ovary less than half an inch long. Flower apparently an inch in diameter. — Perhaps too near *O. fragilis;* but in the absence of good flowers and fruit, it is impossible to say whether it does not belong to even a different section, perhaps to the *Glomeratæ*, Salm.

Subgen. 3. CYLINDROPUNTIA, E. in B. C. R. Articuli cylindracei: flores magni vel parvi: bacca plerumque sicca: semina immarginata seu vix marginata: embryo circa albumen copiosius subcircularis; cotyledones contrariæ seu obliquæ, subinde parallelæ.

§ 1. *Clavatæ:* prostratæ: articuli breves, clavati, adscendentes, textura lignosa laxe reticulata: flores flavi majusculi: bacca sicca, pulvillis numerosis setosissimis stipata, floris rudimentis persistentibus coronata.

29. O. CLAVATA, E. in Wisl. Rep.: articulis breviter clavatis læte viridibus; tuberculis ovatis; foliis subulatis minutis; aculeis albidis

scabrellis, interioribus 4 – 7 complanatis, inferioribus deflexis latioribus supra striatis subtus carinatis, superiore triangulato erecto; aculeis exterioribus 8 – 10 gracilioribus undique radiantibus; baccæ pulvillis setosissimis; seminibus rostratis.

Santa Fé and Albuquerque, on the plateaux: fl. in June and July. — Dense spreading masses, with joints 1½ – 2 inches long; tubercles 6 – 8 lines long; larger spines 6 – 15 lines long, and the broadest one ¾ – 1½ lines wide. Flower 2 inches in diameter. Fruit yellow, 1½ – 1¾ inches long, an inch in diameter, covered with 30 – 50 large pulvilli. Seed 2½ – 3 lines in the longest diameter. Cotyledons mostly oblique, or, as in most other *Opuntiæ*, incumbent. (The expression is not etymologically correct, but I use it to designate the direction of the face of the cotyledons towards the radicle.)

30. O. Parryi, E. in Sillim. Journ. 1852: prostrata; articulis ovatis basi clavatis; tuberculis oblongo-elongatis; setis paucis; aculeis angulatis scabris rubellis demum cinereis, interioribus sub-4 validioribus compressis, exterioribus 4 – 8 divergentibus, extimis 6 – 10 gracilibus radiantibus; bacca ovata pulvillis sub-40 setosissimis stipata; seminibus erostratis.

On the Mojave, west of the great Colorado. — Joints 2½ – 3 or 4 inches long, attenuated below and somewhat so above; tubercles 9 lines long; inner spines 12 – 16 lines long, and the larger ones somewhat flattened, but less than a line wide; exterior spines 3 – 8 lines long, in two series. Fruit 1½ inches long. Seeds about 2 lines in diameter. — The original specimens of Dr. Parry were found farther south, near San Felipe. He describes the joints as 4 – 8 inches long, with shorter whitish spines or tubercles 6 – 12 lines long, and the flower as greenish-yellow. The Mojave plant is nearly allied to the last species, but may be distinguished by the shape of the joints, the narrower, darker-colored, more numerous spines, and the smaller and more regular seeds.

31. O. Emoryi, E. in B. C. R.: articulis cylindricis basi clavatis glaucis; tuberculis oblongo-linearibus elongatis; setis paucis; aculeis plurimis rufis, interioribus 5 – 9 validioribus triangulatis, compressis, exterioribus 10 – 20 pluriseriatis undique radiantibus; floribus flavis extus rubellis; bacca pulvillos 35 – 50 setosissimos inferiores aculeolatos gerentibus; seminibus valde inæqualibus irregularibus.

Arid soil, from El Paso through Sonora to the desert of the Colorado: fl. August and September. — The stoutest species of this sec-

tion. Joints 4 – 6 inches long, curved, 1 – 1½ inches in diameter; tubercles 1 – 1½ inches long; longest spines 1½ – 2½ inches long, ¾ – 1 line wide; the exterior spines gradually smaller, and less angular. Fruit 2 – 2½ inches long, partly armed with spines 4 – 8 lines long. Seeds from 2¼ to 3¼ lines in diameter. Cotyledons oblique or accumbent.

32. O. Schottii, E. l. c.: articulis clavatis; tuberculis elongatis; pulvillis pauci-setosis; aculeis rubellis scaberrimis, interioribus sub-4 cruciatis, superiore triangulato, cæteris supra planis subtus convexis, latioribus; exterioribus 8 – 10 radiantibus gracilibus; bacca ovata pulvillos 35 – 40 pauci-setosos gerente; seminibus rostratis.

On the arid hills near the mouth of the San Pedro and Pecos, Western Texas. — Distinguished by the broad and very rough spines, which are dirty red, the larger ones with a white margin, and by the smaller number of bristles both on the pulvilli of the joints and of the fruit, where they are mostly turned upwards. Joints 2 inches long; tubercles 8 – 9 lines long; spines 1½ – 2 inches long; the radiating ones only 4 – 9 lines long. Seeds 2 lines in diameter. Cotyledons oblique.

Dr. Gregg has collected a similar plant near San Luis Potosi; which at present I know not how to distinguish from *O. Schottii*. The spines are stout, perhaps less rough, and narrower, 12 – 15 in number; some of them borne on the upper margin of the pulvillus, which I have never seen in *O. Schottii*. Tubercles an inch long.

33. O. Grahami, E. l. c.: radicibus fusiformibus; articulis clavatis; tuberculis oblongis; foliis ovatis cuspidatis; setis demum plurimis; aculeis gracilibus rubellis, interioribus 4 – 7 teretiusculis angulatisve, exterioribus 4 – 6 brevibus; bacca pulvillos sub-30 setosissimos gerente; seminibus erostratis.

Sandy bottoms of the Rio Grande near El Paso: fl. June. — Joints 1½ – 2 inches long; tubercles 6 – 7 lines long; leaves thicker and in proportion shorter than in most other species, nearly 2 lines long. Fruit similar to that of *O. clavata*. Seed 2½ lines in diameter or more. Cotyledons regularly incumbent.

34. O. bulbispina, E. l. c.: radicibus fusiformibus; articulis parvis ovatis sæpe ex apice proliferis fragilibus; tuberculis ovatis brevibus; pulvillis parce setosis; aculeis teretiusculis scabrellis basi bulbosis, interioribus 4 cruciatis, inferiore longiore, exterioribus 8 – 12 radiantibus.

Saltillo, Mexico. — Spreading masses with joints an inch long or less; tubercles 4 – 6 lines long; interior spines 4 – 6, exterior ones 1½ – 3 lines long. Apparently near the South American *O. pusilla*, Salm., and perhaps belonging to the *Opuntiæ glomeratæ*, rather than here. Fruit unknown.

§ 2. *Cylindricæ:* adscendentes vel erectæ: articuli longiores, ovato-cylindrici seu elongati: textura lignosa compacta, tubum reticulatum vel truncum compactum formans: flores magni seu parvi, purpurei vel raro flavi: bacca sicca vel subcarnosa, floris rudimenta plerumque dejiciens, aculeata seu inermis.

* *Polyacanthæ:* lignum plerumque reticulato-tubulosum; articuli crassiores distincte tuberculati: aculei plures seu plurimi: flores plerumque rubri: semina immarginata.

† *Humiliores:* diffuse ramosæ: articuli subclavati: flores plerumque flavidi: baccæ siccæ, aculeatæ.

35. O. Davisii, E. & B. in P. R. Rep.: caule dense lignoso ramosissimo divaricato; articulis junioribus erectis elongatis basi attenuatis; tuberculis oblongo-linearibus; aculeis interioribus 4 – 7 subtriangularibus rufis vagina straminea laxa indusiatis divergentibus; aculeis inferioribus 5 – 6 gracilibus; bacca ovata pulvillis sub-25 aculeigeris stipata.

On the Llano Estacado, near the Upper Canadian River; common. — Spreading and somewhat procumbent, about 18 inches high; the only one in this section with dense wood. Joints 4 – 6 inches long, rather slender; tubercles 7 – 8 lines long; interior spines 1 – 1½ inches in length; lower ones 3 – 6 lines long. Fruits (all sterile, and perhaps not properly developed) an inch or more in length.

36. O. echinocarpa, E. & B. l. c.: erectiuscula; ramis numerosis patentissimis; articulis ovatis basi clavatis; tuberculis ovatis confertis; aculeis majoribus sub-4 albidis stramineo-vaginatis, 8 – 16 minoribus undique radiantibus; flore flavo (?); bacca globosa depressa seu hemisphærica late profundeque umbilicata pulvillis sub-40 aculeatissimis stipata; seminibus late commissuratis.

Var. β. major: elatior; articulis elongatis; aculeis longioribus laxius vaginatis paucioribus; baccis globosis pulvillos pauciores (25) gerentibus.

In the valley of the Lower Colorado; β. in Sonora. — Var. *a.* is a

low shrub, 6 – 18 inches high; joints 1 – 2½ inches long; tubercles 4 – 5 lines long; spines not over an inch in length. Flower apparently yellow, about 1½ inches in diameter and somewhat persistent on the fruit. Fruit very shallow, saucer-shaped, with few large seeds. Var. β. is 4 or 5 feet high; joints 8 – 10 inches long; interior spines 1 – 1¾ inches long. Fruit globose or even ovate, with 25 pulvilli. Seeds the same in both.

37. O. SERPENTINA, E. in Sill. Journ. 1852: erectiuscula seu subprostrata; articulis elongatis cylindricis; tuberculis ovatis; aculeis 7 – 9 albido- seu rufido-vaginatis; flore flavo extus rubello; bacca subhemisphærica late et profunde umbilicata villosa aculeatissima.

Near the sea-coast about San Diego, California. — Sometimes 4 – 5 feet high, but often prostrate; joints 6 – 12 inches long; spines less than one inch long. Flower cup-shaped, 1¼ inch wide. Fruit apparently like that of the last species, but "long woolly" and with fewer pulvilli, also often crowned with the persistent flower. Seed unknown; said to be large. — Closely allied to the foregoing species. Can this be Nuttall's *Cactus Californicus* (Cereus, *Torr. & Gr. Fl.*), with cylindric branches, yellow flower, and spiny fruit?

†† *Deciduæ:* arborescentes: articuli tumidi, perfragiles: tubercula depressa: flores purpurei: baccæ sæpissime steriles, proliferæ.

38. O. PROLIFERA, E. l. c.: ramis divaricatis; articulis ovatis seu ovato-cylindricis perviridibus versus ramorum apicem congestis; tuberculis obovato-oblongis prominulis; aculeis 8 – 10 obscuris stramineo- seu rufo-vaginatis, singulo centrali, cæteris patulis; flore rubro; bacca ovata aculeolata plerumque sterili prolifera.

On arid hills about San Diego, California, forming extensive thickets. — Stems 2 – 4, and sometimes even 6 – 7, inches in diameter, 3 – 10 feet high; joints 3 – 6 inches long and 1½ – 2 in diameter; tubercles about 6 lines long; spines 6 – 14 lines long, the lower ones shorter. Flowers red, salver-form, 1½ inches in diameter.

39. O. FULGIDA, E. in B. C. R.: ramis divaricatis; articulis ovatis seu ovato-cylindricis glaucescentibus versus ramorum apicem congestis; tuberculis ovato-oblongis prominulis; aculeis 5 – 9 subæqualibus laxe vaginatis undique stellato-porrectis; flore purpureo parvo; bacca ovata inermi vix tuberculata; seminibus parvis rostratis.

Mountains of Western Sonora: fl. July and August. — Plant 5 – 12 feet high; joints 3 – 8 inches long; tubercles rather elongated, 6 – 7

lines long; spines 1 – 1¼ inches long, hiding the whole plant with their lustrous sheaths. Flower about one inch or less in diameter. Fruit fleshy, 1 – 1¼ inches long, usually sterile. Seeds smaller than in any other Opuntia examined, 1 – 1½ lines long.

40. O. Bigelovii, E. in P. R. R.: ramis erectis adscendentibusve; articulis ovato-cylindricis pallide virescentibus congestis; tuberculis subhemisphæricis depressis confertis; aculeis 6 – 10 robustioribus et totidem gracilioribus inferioribus; ovario tuberculato; bacca tuberculata subinde (sterili ?) aculeolata; seminibus parvis.

On Williams's River, of the Californian Colorado. — Stem 3 – 4 inches thick and 10 – 12 feet high; the branches forming a dense contracted head, with joints 2 – 6 inches long; tubercles 3 – 4 lines long; larger spines about an inch long, smaller ones 4 – 7 lines long.

The three foregoing species represent this subsection west of the California mountains, and east of them both south of the Gila and north of it, and seem to be well distinguished from one another by the characters indicated.

††† *Cristatæ:* frutescentes vel arborescentes: articuli cylindrici: tubercula plerumque cristata prominula: flores purpurei: baccæ inermes seu rarius aculeatæ.

41. O. Whipplei, E. & B. in P. R. R.: caule erecto seu rarius subprocumbente divaricato-ramoso; articulis cylindricis; tuberculis ovatis confertis; aculeis brevibus cinereo- seu stramineo-vaginatis, 1 – 4 majoribus, 2 – 8 brevioribus deflexis vel radiantibus; flore rubro; bacca subglobosa tuberculata flava inermi; seminibus regularibus.

Var. *α.* lævior: humilior, aculeis paucis deflexis.

Var. *β.* spinosior: elatior, aculeis plurimis radiantibus.

From Zuni westward to Williams's River (*α.*), and south of the Gila (*β.*): fl. in June. — The first state is from a few inches to 3 – 6 feet high; the second forms small trees 8 – 10 feet high. Joints ½ – ¾ inch in diameter; tubercles about 5 lines long; spines very variable, between 3 and 9 lines long. Flower (of var. *β.*) 1¼ – 1½ inches in diameter. Fruit about an inch long.

42. O. arborescens, E. in Wisl. Rep. (*O. stellata*, Salm.): arborescens; ramis verticillatis horizontalibus vel pendulis; articulis verticillatis cylindricis; tuberculis cristatis prominentibus; aculeis 8 – 30 stellato-divaricatis; flore purpureo magno; bacca subhemisphærica tuberculato-cristata flava inermi; seminibus regularibus.

From north and east of Santa Fé and the Llano Estacado, to Zuni; extending southward deep into Mexico: fl. May – July. — Northward 5 – 6, south 10 – 20 or more, feet high; easily characterized by the horizontal and verticillate branches, etc.

43. O. ACANTHOCARPA, E. & B. in P. R. R.: arborescens; ramis alternis adscendentibus; articulis cylindricis; tuberculis elongatis; aculeis 8 – 25 stellato-divaricatis; bacca subglobosa tuberculata aculeata; seminibus multangulatis.

Mountains of Cactus Pass, between Santa Fé and the Western Colorado. — Stems 5 – 6 feet high; branches few, alternate, and separating from the stem at an acute angle. Joints (as in the preceding) 4 – 6 or 8 inches long, about 1 inch in diameter; tubercles 9 – 10 lines long; interior spines 1 – 1½ inches, exterior ones 4 – 10 lines, long. Spines of fruit on the depressed tubercles 3 – 6 lines long. Seeds large, unlike those of any other Opuntia seen by me.

44. O. MAMILLATA, A. Schott in litt., B. C. R.: arborescens, divaricato-ramosissima; articulis crassis abbreviatis perviridibus; tuberculis tumidis; aculeis 4 – 6 brevibus plerisque deflexis; flore parvo purpureo; bacca obovata inermi; seminibus parvis.

Sonora, on the Sierra Babuquibari, in fertile soil: fl. July and August. — Stems 5 – 6 feet high; joints 3 – 4 inches long, 1½ inches in diameter; the swelling tubercles very prominent; spines 3 – 9 lines long, sometimes almost wanting. Flowers an inch or less in diameter.

45. O. THURBERI, E. in B. C. R.: frutescens, erecta; articulis cylindricis gracilibus elongato-tuberculatis; aculeis 3 – 5 brevibus divergento-deflexis; flore miniato.

Bacuachi, Sonora: fl. June. — Much more slender than any species yet enumerated in this subgenus. Joints ½ inch in diameter; tubercles 9 lines long; spines 3 – 8 lines long, the lowest one the stoutest. Flower 1½ inches in diameter.

* * *Monacanthæ:* lignum densum: articuli graciliores obscure tuberculati: aculei singuli: flores flavi seu rubri; semina plus minus marginata.

46. O. WRIGHTII, E. l. c.: frutescens, erecta; articulis cylindricis gracilibus elongato-subtuberculatis; aculeis subsingulis porrectis vel subdeflexis; flore miniato.

On steep mountain-sides, from the Limpio to the Pecos, and in Northern Mexico: fl. June and July. — Shrub 2 – 4 feet high, 1 – 1½

inches thick. Joints 4 lines in diameter; tubercles depressed, 7 – 9 lines long; spines 8 – 10 lines long. Flower about 1 – 1½ inches in diameter.

47. O. ARBUSCULA, E. l. c.: arborescens, erecta, capitato-ramosissima; articulis læte viridibus elongato-subtuberculatis; aculeis subsingulis porrectis vel subdeflexis; flore flavo-virescente.

On the Lower Gila, near Maricopa village: fl. June. — A truly arborescent form, with a solid trunk of 4 or 5 inches in diameter, 7 – 8 feet high; joints 2 – 3 inches long, about 4 lines in diameter; tubercles indistinct, about 6 lines long; spine 9 – 12 lines long, often with 1 or 2 smaller ones under it. Flower 1½ inches in diameter.

48. O. VAGINATA, E. in Wisl. Rep. (partim): frutescens, erecta; ramis erectiusculis; articulis subtuberculatis; aculeis subsingulis; bacca obovata tuberculata coccinea.

Albuquerque, New Mexico, and southward. — Shrub 3 – 5 feet high, 1 – 1½ inches thick; joints 3 – 4 lines in diameter; tubercles rather distinct, 6 – 9 lines long. Fruit 8 – 9 lines long. Seed about 2 lines in diameter. Perhaps a stout form of the next species.

49. O. FRUTESCENS, E. in Pl. Lindh. 1845: frutescens, erecta; ramis erectiusculis; articulis teretibus; aculeis subsingulis; flore parvo virescente; bacca obovata haud tuberculata coccinea.

Var. *α.* LONGISPINA: articulis nascentibus stipitatis; aculeis validioribus longioribus laxe vaginatis.

Var. *β.* BREVISPINA: articulis nascentibus sessilibus; aculeis gracilioribus brevioribus arcte vaginatis.

From the Colorado of Texas to Matamoras and Saltillo, westward to Sonora and the Californian Colorado: fl. June to August. — Var. *α.* is the usual Western form; *β.* occurs only in Texas and Eastern Mexico. — Shrub 3 – 5 feet high, stem 1 – 1½ inches thick; joints 2 – 3 lines in diameter; indistinct tubercles 3 – 5 lines long; spines in *α.* 1 – 2 inches, in *β.* 4 – 6 lines, long. Flower 7 – 9 lines in diameter. Fruit 5 – 9 lines long. Seeds few, usually 1½ lines in diameter.

50. O. TESSELLATA (O. ramosissima, *E. in Sill. Journ.* 1852): frutescens, erecta seu diffusa, divaricato-ramosissima; articulis gracilibus tessellato-tuberculatis cæsiis; tuberculis 5 – 6 angulatis planis inermibus seu aculeum elongatum paucosque minutos gerentibus; flore purpurascente parva; bacca setosissima sicca.

Valley of the Lower Colorado from Sonora to the California moun-

tains: fl. May to September. — Stems 2 – 6 feet high, at the base 1 – 3 inches thick; joints 3 – 3½ lines in diameter, ashy gray; the singular flattened and angular tubercles 2½ – 3 lines long; spines 1½ – 2 inches long, crowded together at the upper end of each year's growth, very loosely sheathed. Flower purple, half an inch in diameter. Fruit 9 – 10 lines long, covered with reddish-brown bristles. Seed 2 lines or less in diameter.

*** The material for the present study of our *Cactaceæ* is not as full as would have been desirable in the examination of so difficult a family. Hence it may sometimes have happened, that what I have endeavored to distinguish as species are forms which properly belong together; or I may have combined as one species incomplete specimens of quite distinct plants. The fear of confusing heterogeneous plants under one name, and the desire to indicate to future explorers all the different forms known to me, combined to induce me to proceed as I have done.

For those who naturally may be horrified at the idea of 117 species of *Cactaceæ* in a territory where, a few years ago, scarcely half a dozen were known, I will indicate how the mass of material may be comprehended under fewer types.

Of *Mamillariæ* the species 1 – 9 are quite distinct, and can in no manner be united; 10 – 12 might perhaps be considered as forms of a single species; 13 – 17 are all very distinct; 18 and 19, 20 – 23, 25 and 26, 27 and 28, may possibly be forms of only four types, instead of 10, as I have enumerated them, thus referring my 30 species to 22 types.

In the genus *Echinocactus* the following species might be united: 1 and 2, 7 and 8, 9 and 10, 12 and 13, 14 and 15, — leaving 15 instead of 20 types.

The following species of *Cereus* will perhaps bear reduction: Nos. 1 and 2, 3 and 4, 5 – 7, 10 and 11, 12 – 14, 16 and 17, 18 – 22 (though some of them, of which I do not even know the flowers, may prove to belong even to different sections!), 23 and 24, — thus reducing my 31 species to 18 types.

Opuntia is a still more difficult genus, and mistakes are here most easily made. Many of them are as yet very incompletely known; and without being able to compare a great number of living specimens

in their native state and in all stages of development, it can hardly be expected that any one should know beforehand what constitutes the specific characters in these plants. I have tried to unite the forms which seemed to justify such a proceeding (see, e. g. *O. Rafinesquii*, here made to comprise quite a suite of forms as subspecies). Still it may be thought that a greater reduction was yet desirable; but with our present data this would involve great danger of jumbling heterogeneous materials together. Nos. 5 and 7 (of which latter neither flower nor fruit is known) can perhaps be united; also 9 and 10, 11 and 12, 13 and 14, 16 and 17, 19 and 20, 22 – 24, 25 – 28, 29 and 30, 31 – 33, 35 – 37, 38 – 40, and 48 and 49, — leaving 31 types, 29 of which are indigenous to our territory, and two cultivated.

Geography of the Cactus Region of the United States.

The localities where our *Cacti* grow are so little known to those who have not made the geography of the West a particular study, or are familiar with the publications of our Western explorers, that it seems necessary to add a few explanatory remarks.

Texas, as at present organized, is bounded southeasterly by the Gulf of Mexico, into which the following rivers mentioned in the foregoing pages empty, following the order from east to west: the Brazos, the Colorado with the Llano, the Guadalupe with the Pierdenales and San Antonio, the Nueces, and the Rio Grande. The latter forms the southern and southwestern boundary as high up as El Paso. On it are the towns of Matamoras (not far from its mouth), Mier, Laredo; and higher up, Presidio del Rio Grande; then Fort Duncan or Eagle Pass (southwest of which is Santa Rosa, in the State of Coahuila); next comes the mouth of the San Pedro or Devil's River (a small river or rather torrent running southward), and not far from it the mouth of the Pecos or Puerco, which rises at the north-northwest in the upper parts of New Mexico. Between the mouth of the Pecos and El Paso we notice only Presidio del Norte, San Elizario, and a "cañon" below the latter. The valley of the Limpio, a little more to the northward between the Pecos and El Paso, is a remarkable locality; probably because there porphyritic rocks take the place of the cretaceous formation of the more eastern districts.

Chihuahua is the well-known capital of the Mexican State of the same name, south of El Paso.

The Canadian River is a southern tributary of the Arkansas, running eastwardly very nearly under the 35th degree of latitude, and bounding on the north the elevated plains known as the *Llano Estacado*, in the northwestern parts of Texas and the adjoining regions of New Mexico.

The Upper Rio Grande runs through New Mexico from north to south; the capital, Santa Fé, is not far from the river, in lat. 35½°; and the town of Albuquerque is a little below. Doñana is a small place on the river, above El Paso. El Paso itself, where the Rio Grande breaks through the mountain ranges, changing its heretofore southern to a southeastern course, is the central point of our Cactus region, partly from its geographical position, and partly because many of our explorers have made it the centre of their operations.

The present southwestern boundary of the United States runs from El Paso irregularly westward through the former Mexican State of Sonora, to the Colorado "of the West," or "of California," which comes from the South Pass in the Rocky Mountains, and runs southwestward and southwardly. Its principal tributaries rise in the east; those most important to us are the Little Colorado or Colorado Chiquito, under the 35th and 36th degree of latitude; Bill Williams's Fork, or Williams's River, as it is lately styled, further south; and in lat. 33° the Gila River, which rises near the "Coppermines," northwest of El Paso.

Proceeding from Santa Fé westward, we find the Indian town of Zuni, on the head-waters of the Little Colorado; then the San Francisco mountains; the Cactus Pass, at the head of Williams's River, and this stream itself. All this territory is at present included in the political organization of New Mexico, though uninhabited by whites.

West of the Colorado, in lat. 35°, is the Mojave or Mohave River, rising in the Sierra Nevada near the Cajon Pass; lower down, opposite the mouth of the Gila, the country is a sandy desert extending westward nearly to San Felipe, on the eastern slope of the California mountains in the same latitude. On the western sea-coast the town of San Diego is the only interesting point for the plants under review.

Geographical Distribution of the Cactaceæ in the Territory of the United States.

As to the geographical distribution of the *Cactaceæ*, our territory may properly be divided into eight regions, viz.: —

1. The Atlantic Region; which has only a single *Opuntia*, and that peculiar to it. Along the Southern coast some West Indian species may yet be expected.

2. The Mississippi Region, including the Western States, produces another *Opuntia*, which, in different distinct forms, extends into the 3d, 4th, and 5th regions.

3. The Missouri Region; namely, the Northwestern or Upper Missouri Territory to the Rocky Mountains. It furnishes

Two *Mamillariæ* of the subgenus *Coryphantha*, both extending into the 4th and 5th region; and

Three *Opuntiæ*, one of which only is peculiar.

4. The Texan Region; namely, the eastern and inhabited parts of Texas, westward to the San Pedro, and northward including the territory south of the Arkansas River. This region produces

Five *Mamillariæ*, two of them peculiar to this district;

Three *Echinocacti*, none of which are found in any other of our regions;*

Six *Cerei* (five *Echinocerei* and one *Eucereus*), all of them peculiar to this district; and

Six *Opuntiæ*, of which only three are restricted to it; among them is only a single cylindric *Opuntia*.

This region contains therefore altogether twenty species, fourteen of which are peculiar to it.

5. The New-Mexican Region; namely, Western, uninhabited, mountainous Texas, and Eastern New Mexico to the eastern headwaters of the Colorado of California. This region is our richest Cactus district. It has furnished sixty-five species, fifty-five of which are peculiar to it, viz.: —

Nineteen *Mamillariæ* (eight *Eumamillariæ*, ten *Coryphanthæ*, and one *Anhalonium*), of which sixteen are peculiar;

Nine *Echinocacti*, all of them belonging to this district only;

Sixteen *Cerei* (fifteen *Echinocerei*, fourteen of which are peculiar, and one *Eucereus*, common also to other regions); and

Twenty-two *Opuntiæ*; of these twelve are flat-jointed, four clavate, and five cylindrical ones: seventeen of these species are peculiar.

6. The Gila Region, comprising the whole valley of the Colorado

* Always excepting Mexico itself, south of the Rio Grande, into which many, if not most, of our species extend.

south of lat. 36°, and the country of the Gila, its large southern tributary. This has thus far furnished thirty-six Cactaceæ, viz.: —

Five *Mamillariæ*, three of them peculiar species;

Six *Echinocacti*, none of them found elsewhere;

Seven *Cerei*, representatives of each of our four subgenera, and five of them peculiar;

Eighteen *Opuntiæ*, of which six (all peculiar) belong to the *Platopuntiæ*, two to the clavate and ten to the cylindric *Cylindropuntiæ*; one of the former and nine of the latter peculiar.

7. The Californian Region, namely, California west of the Sierra Nevada, and comprising the southwestern part of the present State of California, produces six *Cactaceæ*, five of which are peculiar. They are, —

One *Mamillaria*;

One *Echinocactus*;

One *Cereus* of the section *Eucereus*; and

Three *Opuntiæ*; one of them a *Platopuntia*, probably only a form of a more eastern species, and two peculiar *Cylindropuntiæ*.

8. The Northwestern Region, comprising the northern parts of the State of California, the Territories of Utah, Oregon, and Washington. This region has so far furnished only a single *Opuntia* (from Eastern Oregon), common also to the Missouri Region. — Mr. Geyer, in his account of his expedition to Oregon in 1843, mentions two *Mamillariæ* and a "*Melocactus*" (?), which latter he has not seen himself, nor are there any known specimens in existence.

Corrections and Additions.

P. 267. *Mamillaria scolymoides* has been collected by Mr. Wright, on the Pecos, in Western Texas.

P. 273. 9th line from top, dele "1" after "fuscatis."

P. 278. 5th line from top, for "parallelæ" read "contrariæ."

P. 286. *Cereus Berlandieri* is very near *C. pentalophus*, DC., but Prince Salm, who has cultivated both side by side, considers them well distinguished.

P. 300. *Opuntia Missouriensis* has been sent from Clear Water, on the Kooskooskie, in Oregon, by the Rev. Mr. Spalding.

Four hundred and twenty-ninth meeting.

August 13, 1856. — STATED MEETING.

The PRESIDENT in the chair.

Professor Treadwell, from the committee on the subject of meteorological observations, reported that Mr. Hall's observations are in due process of preparation for the press.

Professor W. B. Rogers made the following communication: —

"*Proofs of the Protozoic Age of some of the Altered Rocks of Eastern Massachusetts, from Fossils recently discovered.*

"It is well known that the altered slates and gritty rocks which show themselves interruptedly throughout a good part of Eastern Massachusetts, have, with the exception of the coal-measures on the confines of this State and Rhode Island, failed hitherto to furnish geologists any fossil evidences of a paleozoic age, although from aspect and position they have been *conjecturally* classed with the system of rocks belonging to this period. Indeed, the metamorphic condition of these beds generally, traceable no doubt to the sienitic and other igneous masses by which they are traversed or enclosed, would naturally forbid the expectation of finding in them any distinguishable fossil forms.

"Lately, through the kindness of Peter Wainwright, Esq., residing in the neighborhood, I have been led to examine a quarry in the belt of siliceous and argillaceous slate which lies on the boundary of Quincy and Braintree, about ten miles south of Boston, and, to my great surprise and delight, I found it to be *a locality of trilobites.*

"It appears that for several years past the owner of the quarry, Mr. E. Hayward, and his family, have been aware of the existence of these so-called *images* in the rock, which from time to time they have quarried as a ballasting-material for wharves; but *until now the locality has remained entirely unknown to science.*

"The fossils are in the form of casts, some of them of great size, and lying at various levels in the strata. So far as I have yet explored the quarry, they belong chiefly, if not altogether, to one species, which, on the authority of Professor Agassiz, as well as my own comparison with Barrande's descriptions and figures, is a species of *Paradoxides.* Of its specific affinities I will not now speak, further

than to remark that the specimens agree more closely with Barrande's P. spinosus than with any other form which I have seen figured or described.

"The rock in which these fossils occur is a compact, dense, rather fine-grained silico-argillaceous slate or slaty sandstone, containing little or no carbonate of lime. In the quarry it displays two systems of joints, in one of which are seen the usual parallel markings due to the movement of contiguous surfaces upon each other under pressure, and it is much broken up by irregular cleavage planes. The strike of the beds appears to be about N. 70° E., and their dip towards the north and west at an angle of about fifty degrees. The narrow belt of slates and grits, of which the fossiliferous strata form a part, extends for some distance towards the north and east, and has also, it is said, been traced for several miles in the opposite direction. But as yet the discovery of fossils has been confined to the one locality.

"In crossing the belt either towards the northwest or in the opposite direction, we find the slates and grits to become more indurated and otherwise modified, after which, passing into beds of a semi-crystalline character, they give place to ranges of sienite. Thus the fossiliferous belt in this part of its course *is actually included between great masses of igneous rocks;* and it is not a little surprising, that, under conditions so favorable for metamorphic action, the fossil impressions should have been so well preserved.

"In regard to the distribution of the genus Paradoxides, Barrande, in his great work the 'Système Silurien de la Bohème,' has the following important observations: —

"'In Bohemia the genus Paradoxides characterizes exclusively the primordial Fauna, and does not extend beyond our protozoic schists (C). The twelve species which we have determined divide themselves almost equally between the two slaty belts of Ginetz and Skrey, and two are common to them both. In these two belts we find P. spinosus in all the localities which have afforded fossils, while each of the other species is restricted to a few points, principally those of Ginetz and Skrey.

"'In Sweden the Paradoxides belong exclusively to the local formations designated by Angelin as Regions A and B, representing jointly our protozoic slate formation (C) above mentioned. The region A is the lowest fossiliferous belt of Sweden, as it rests directly on the azoic rocks.

"'In Great Britain we know, according to the papers of Mr. Salter, that Paradoxides has been found in the Trappean group (Lingula flags of the Survey), which is the *oldest fossiliferous rock* of Wales, resting on the azoic sandstones of Harlech and Barmouth. There is therefore a perfect agreement in these three regions as to the geological horizon of the genus now under consideration. This agreement acquires still further importance from the affinities displayed equally and everywhere by the other types which accompany the Paradoxides; for instance, in Sweden we have Olenus and Conocephalites; in England, Olenus as recognized in the Trappean group.'

"As thus the genus Paradoxides is peculiar to the lowest of the paleozoic rocks in Bohemia, Sweden, and Great Britain, marking the primordial division of Barrande and the Lingula flags of the British Survey, we shall probably be called upon to place the fossil belt of Quincy and Braintree on or near the horizon of our lowest fossiliferous group; that is to say, somewhere about the level of the primal rocks, the Potsdam sandstone, and the protozoic sandstone of Owen containing Dikelocephalus in Wisconsin and Minnesota. *Thus for the first time are we furnished with data for fixing conclusively the paleozoic age of any portion of this tract of ancient and highly altered sediments, and, what is more, for defining in regard to this region the very base of the paleozoic column, and that too by the same fossil inscriptions which mark it in various parts of the Old World.*

"Referring to the occurrence of Paradoxides in the protozoic rocks of Europe, Barrande observes: 'The presence of this genus has not been satisfactorily proved in any other Silurian region, although this generic name has been applied to North American forms, such as Paradoxides Boltoni, P. Harlani, &c. The first of these is known to be a Lichas, and we know nothing of the others. The care with which J. Hall has described the trilobites of the Lower Silurian rocks of the country in question, is sufficient proof that he had not discovered any trace of Paradoxides at the time of publishing the first volume of the Paleontology of New York.' I may add to this, that in no subsequent publication have I seen any reference to the finding of fossils of this genus in the rocks of North America.

"One of the most curious facts relating to the trilobite of the Quincy and Braintree belt is its seeming identity with the P. Harlani described by Green in his Monograph of North American Trilobites.

This description, which is quite imperfect, was made out from a specimen of *unknown locality*, procured, some twenty-five years ago, by Dr. Harlan, from the collection of our well-known mineralogist, Mr. Francis Alger. That it is the same with the more conspicuous of our Quincy fossils is, I think, established by the comparison of a nearly complete specimen of the latter with the cast of P. Harlani taken from Mr. Alger's specimen, the original never having been returned. Considering the perfect agreement in lithological characters of the matrix as described by Green with that of the Quincy fossils, and the immediate recognition of this identity of mineral features by Mr. Alger on seeing my Quincy specimens, we can hardly doubt that the original specimen of P. Harlani came, either directly or through the drift scattered in the vicinity, from the same fossiliferous belt. Thus it appears that this vagrant fossil, so long without a local habitation, although not without a name, has at length been restored to its native seat, where it takes a prominent place in the dynasty of ancient living forms that marked the earliest paleozoic history of New England.

"In this connection I find a remark in Barrande which, besides being historically curious, has an interesting bearing on the specific affinities of our fossil: 'We see in different collections, and especially in that of the School of Mines and the British Museum, under the name of P. Harlani, from the United States, a cast of a trilobite which appears to us to be identical with P. spinosus, of great size, such as found at Skrey in Bohemia.' The cast here referred to, like that used in my comparison with the Quincy fossil, was doubtless one of the series of plaster copies prepared by Dr. Green to accompany his monograph. Its agreement with the P. spinosus harmonizes well with my own observation, already stated, of the close resemblance between the Quincy fossil and this Bohemian species.

"The occurrence of well-preserved fossils among rocks so highly altered, and so contiguous to great igneous masses, as are the fossiliferous slates of Quincy, may well encourage us to make careful search in other parts of New England where heretofore such an exploration would have been deemed useless. Although we cannot hope to build up the geological column of New England from the protozoic base just established to the carboniferous rocks, supposing all the intervening formations to be represented in this region, we may at least succeed in determining, by fossils hereafter discovered, some of the principal stages in its structure, and in thus relating its strata definitely to the great paleozoic divisions of our Appalachian geology."

Professor Agassiz expressed his great satisfaction at the announcement of Professor Rogers. Geologically speaking, its importance could hardly be over-estimated. We have now, he remarked, a standard level upon which to build up the formation of the metamorphic rocks. It also confirms the universal law, as elsewhere illustrated, of the creation and development of animal life.

Dr. Kneeland presented, in the name of Dr. Augustus C. Hamlin, of Bangor, Maine, very perfect casts of an inscription, supposed to be Runic, upon a rock on an island near Monhegan, Maine.

Dr. Jenks expressed his gratification at having at last an opportunity of examining so perfect a copy of the inscriptions in question. He had not, although he had been quoted as so doing, given any decided opinion as to their character. Copies had been transmitted to Copenhagen, and he hoped before long information would be received which would throw light upon these interesting inscriptions.

The thanks of the Academy were voted to Dr. Hamlin for his valuable donation.

Professor Agassiz made a few remarks upon the *Orthagoriscus mola*, of which he had recently had an opportunity of dissecting a specimen. This fish, which has been well described by Dr. Storer, and figured by Dr. J. Wyman in the Journal of the Boston Society of Natural History, has been placed heretofore in the same family with Diodon and Tetraodon. Professor Agassiz found that its internal structure was such as to be entirely incompatible with such a classification. The stomach he has ascertained to be directly continuous with the intestine, without any indication of difference, either in form, or structure of the mucous membrane; the whole tract resembling a long hose from one orifice to the other. He therefore considered it as the type of a distinct family, but want of time prevented his going into further details of its anatomy.

Professor W. B. Rogers gave an explanation of the causes

of the motion of the Gyroscope, an instrument which is attracting considerable attention at the present time; ascribing the credit of its invention to the late Professor Walter R. Johnson of Philadelphia.

Four hundred and thirtieth meeting.

September 8, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

The Corresponding Secretary read letters from Thomas B. Cary, Rev. George E. Ellis, Charles J. Sprague, and John B. Henck, accepting their appointment as Associate Fellows.

A circular was read from the Committee on the Inauguration of the Statue of Franklin, inviting the Academy to join in the procession on the day of that ceremony. It was accordingly voted, —

"That the Academy accept the invitation thus politely extended to them; and that the Committee for placing the Statue be invited to make use of the rooms of the Academy as a place of rendezvous on the day of inauguration, Franklin himself having been one of the earliest Fellows of the Academy."

Dr. Durkee exhibited to the Academy a box of specimens of gigantic *Scarabæidæ* from the vicinity of Gaboon River, Africa; also specimens of *Platyphyllum concavum* (Katydid), of both sexes, obtained in Milton, Mass.; also *Spectrum femoratum*.

Professor J. Lovering read, in behalf of Colonel Emory, by title, a "Memoir containing the Results of Magnetic Observations not yet published; and combining the Results of all the Magnetic Observations made under my Orders in the United States and Mexican Boundary Commission. By Colonel W. H. Emory." This memoir was referred to the Committee of Publication.

Dr. Jenks read a highly interesting letter, written on July 21, 1781, by Dr. Richard Price, to President Joseph Willard, who

was then Corresponding Secretary of the Academy. Dr. Jenks having stated that there was probably other valuable correspondence among the papers left by Mr. Willard, Joseph Lovering, Daniel Treadwell, and Francis Bowen were appointed a committee to confer with the descendants of Mr. Willard in regard to the publication of such matter as might illustrate the early history of the Academy.

Dr. Jenks also stated that he had received a communication from Dr. Hamlin, offering to obtain for the Academy the famous Dighton Rock, at an expense of not far from seventy-five dollars, and urging the expediency of the measure, on the ground that the inscription upon it is fast wearing away, and that its situation is such, being covered by every tide, that it is impossible to obtain an accurate cast of it in its present position. It was voted, —

"That the whole subject of the expediency of copying or transporting the rock be referred to a committee of three, namely, Dr. W. F. Channing, Dr. A. A. Gould, and Dr. C. T. Jackson."

Professor E. Horsford referred to the statement made at a former meeting, on the authority of Mr. Daniels of Wisconsin, that the bones of a fœtal child had been found in that country transformed into pure phosphorus. He exhibited a stick of phosphorus having a rude resemblance to the thigh-bone of a child, and which had been put in his hands as evidence of the statement. It was an ordinary stick of phosphorus, and could not have resulted from spontaneous decomposition of human remains. Mr. Horsford had calculated that the body of a child weighing ten pounds could not furnish more than an ounce of phosphorus.

Dr. C. T. Jackson expressed his concurrence in the remarks of Professor Horsford.

Four hundred and thirty-first meeting.

October 14, 1856. — MONTHLY MEETING.

The PRESIDENT in the chair.

Dr. C. T. Jackson, from the committee appointed at the last preceding meeting to consider the propriety and practicability of removing Dighton Rock, read a letter from Dr. Hamlin of Maine, describing the present situation of this interesting antiquity, and giving urgent reasons for its removal, in order to the preservation of the inscription, which, it appears, is in such a position that it cannot well be photographed as it lies.

President Hitchcock joined in the recommendation, and gave some details respecting the position and nature of the rock, and the condition of the inscription, which, he argued, is likely soon to be obliterated, unless removed from its present situation.

Dr. O. W. Holmes exhibited a suite of Indian arrow-heads, or, most likely, spear-heads, found in the soil of his grounds at Pittsfield, arranged in a series so as to show all the stages of manufacture, from the natural piece of hornstone, slightly hammered, to the finished implement.

Dr. A. A. Hayes made the following communication: —

"*On the Change of Position among the Particles of Solid Metals, induced by the Action of Gentle but Continued Percussion of the Masses they form.*

"In calling the attention of the members to this subject, I will state that the chief illustration of some new points is to be found in the specimens exhibited; which show the gradation of action, dependent on time elapsing while the masses were exposed, in a distinct manner.

"The change by which malleable iron becomes converted into a highly crystalline metal, when subjected to pressure attended by a tremulous motion, as in the case of railway bars, has been often observed, and the attendant circumstances noted. My attention has been called to many cases, in which the same effects have followed

a gentle percussive action on a part of a bar, the metal becoming changed at one point only, and hence — by chemical dissection the bar being laid open — the fibrous metal could be seen united to that changed portion, which had become highly crystalline and generally brittle.

"It is well known that the crystalline condition, assumed after the iron has been laminated to the extent of rendering it uniformly fibrous, is due to motion and change of place between the molecules of the iron, without the condition of softening or fluidity. The extreme cases often present us with a polarized condition, in which the crystallized iron is as perfect indeed as would have resulted from cooling a fluid mass in a state of repose.

"Malleable iron in its fibrous arrangement may be assumed as exhibiting its particles of broken-down crystals in a state of tension, in which certain physical conditions, such as specific gravity and resistance to strain, are insured while this state continues. A return to the normal or crystalline state requires only vibratory motion, in aid of natural polarizing forces always acting, to cause molecules to unite into regular solids and pass to a condition of repose, in which the masses become brittle. It is among the triumphs of modern science that a successful effort has been made to overcome the practical disadvantages arising from this disposition in malleable iron to become brittle; and in one of its most important applications — that of railway axles — this has been effected completely. The discovery by E. M. Connell, an English engineer, that the vibrations among the particles of *hollow masses* do not result in crystalline arrangements, has led to the adoption of hollow axles, in which uniformity of thickness of metal is insured, while only two thirds of the weight of the metal used for forming a solid axle is retained.

"An interesting case of the formation of large crystals under quite new conditions, in an alloy of which zinc forms the larger part, has recently been observed by me. This alloy, when rapidly cooled, presents a crystalline arrangement much like that of steel. When cast in the form of balls, in cold metallic moulds, it shows the effect of *chilling* remarkably. The metal forming the exterior becomes solid and more dense, while that in the interior conforming to it leaves a void of a spherical form, in each ball of an inch in diameter as large as a small pea. From well-known facts, we should have expected to find this cavity bounded by crystals or crystalline facets; which does

not occur, but its inner surface always exhibits the flaws and irregularities observed when a metallic mass contracts in cooling from a fluid state. These balls were used for reducing saline bodies to powder in revolving cylinders containing several hundreds of them, and the conditions were such that the balls, impinging on each other at mere points as it were, received light blows over every part of their surfaces. It would perhaps be inferred that the diameters would have been reduced by the metal being forced into the void space as the effect of percussion. Instead of this reduction, the balls first became elongated pear-shaped, they then exhibited protuberances, and finally an elongated mammillary form, in which the diameter was one half longer than that of the original, while the whole bulk was increased from one to one and twenty-four hundredths.

"A careful examination of the surfaces showed that the uniformity of the indentations from impinging was constant, and the conclusion was, that the new forms assumed were in no wise affected by any inequality of this action.

"On breaking the specimens, the internal structure of each ball was nearly the same, *exhibiting an effort to form prismatic crystals radiating from a centre on one side of the void, while every particle seemed to have changed its place and made a new aggregation.* Where before the texture was small-granular, broad and brilliant-bladed crystals were found, with open interstices, while in the space originally void the terminal points of many crystals made it a geode in appearance.

"In offering an explanation of this extensive change among the molecules, I think we may consider the polarized state of the outer surface of the ball suddenly cooled as continuous in its action. The attraction of the interior molecules for this part is seen in the formation of a void space; and when the vibrations of impinging points induced a movement, the molecules united their dissimilar poles in the ordinary way of building up a crystalline aggregate. The natural crystal of this alloy being prismatic, room for the radiations which this form must exhibit would be found only by an enlargement of the exterior crust, which, owing to the slight degree of malleability in this case, occurred without fracture. Unequal aggregation of crystals formed would produce the concretionary and mammillary masses into which the balls were converted; and it seems probable that the taking on of this form was but one step in passing to one still more simple, in

which the natural crystalline form of the alloy would have been presented in a single crystal."

Dr. Engelmann gave additional accounts of the peculiarities, classification, and geographical distribution of the *Cactaceæ* of the United States.

President Hitchcock exhibited a model representing the shape of the masses of snow which fell at Brattleborough, Vermont, on the 24th of May last. The masses were all alike, and in the form of a cone with a concave base, of about a quarter of an inch in diameter, and of a pretty firm consistence, — about that of an ordinary snow-ball.

Four hundred and thirty-second meeting.

November 12, 1856. — QUARTERLY MEETING.

The PRESIDENT in the chair.

Professor Agassiz stated that he had recently been engaged in the study of a number of fishes of Greece, which he had received from his friend, Dr. Roeser, through the agency of Professor Felton, which led him to identify the Glanis of Aristotle.

"There are several classes of the animal kingdom, respecting the habits of which most of the information stored up in our scientific records is derived from the observation of men of little education engaged in the labors of common life. This is particularly the case with the fishes. The importance of fisheries at all times, and the value of fish as an article of food, have made it necessary for those interested to ascertain all that can be known respecting the habits of fishes, in order that they may the more successfully pursue their occupations. If we look over all the works on ichthyology written down to the present day, or any more general works in which the fishes are included, a critical reader will very soon perceive that the remarks relating to the habits of fishes are for the most part made on the authority of the fishermen. Cuvier justly says, that to his day no man knew the fishes of the Mediterranean more accurately than Rondelet, — that classic sea, surrounded from the most ancient times by civilized nations interested in fisheries, fond of fish as an article of

food, carrying the luxury so far as to have them brought alive upon their table, to enjoy the beautiful sight of the changing of their colors in the struggles of death; and yet every page of his work shows that most of his information respecting the habits of fishes was borrowed from his intercourse with fishermen. The works of Aristotle furnish frequent evidence that his own information upon this class of animals, as far as their habits were concerned, had a similar foundation. But he, as all great naturalists of all times, sifted the reports, sought for more information where it seemed needed, and related only what he knew could be depended upon, however marvellous some of his statements may seem at first sight. There are many facts of this kind related in the works of Aristotle, which have excited considerable doubt, and even led to suspicions respecting the general trustworthiness of his assertions. There are a few passages in his works which have even been questioned more directly. Such is his mention of the habits of the Glanis, in the following passages: —

" ' The fresh-water fishes spawn in the still waters of rivers and lakes among the reeds, as the Phoxinos and the Perke. The Glanis and the Perke give out their spawn in a continuous string, like the frogs; and indeed the spawn is so wound up that the fishermen reel it off, at least that of the Perke, from the reeds in lakes.

" ' The larger Glanis spawns in deep waters, some at the depth of a fathom; the smaller in shallower places, especially among the roots of willows or some other tree, and also among the reeds, or the mosses. They copulate, sometimes a very large with a very small one, and bringing the parts together which some call the navel, and through which they discharge the seed, the females the eggs, and the males the sperma. All the eggs that are mingled with the sperma become generally on the first day white and larger, and a little later the eyes of the fishes become visible. These at first, in all fishes, as also in all animals, are early conspicuous on account of their size. And those of the eggs that the sperm does not touch, as in the case of the sea-fishes, are useless and sterile. But in these fertile eggs, as the fishes grow larger, a kind of husk separates. And this is the envelope that encloses the egg and the young fish. When the sperm has mingled with the egg, the spawn becomes more viscous among the roots, or wherever it may have been deposited. And where the greatest quantity is deposited, the male guards the eggs, and the female, having spawned, departs. The growth of the Glanis

from the egg is very slow, wherefore the male keeps watch forty or fifty days, that the young may not be devoured by the fishes that happen to be in their neighborhood.' *

"'Of the river fishes, the male Glanis takes great care of its young. For the female, having brought forth, departs; but the male, where the greatest deposit of eggs has been formed, remains by them watching, rendering no other service except keeping off other fishes from destroying the young. He does this for forty or fifty days, until the young are sufficiently grown to escape from the other fishes. And he is known to the fishermen wherever he may chance to be watching his eggs; for he keeps off the fishes by rushing movements, and by making a noise and moaning. And he remains by the eggs with so much of natural affection, that the fishermen, when the eggs adhere to deep roots, bring them up to the shallowest place they can; but he does not even then leave his offspring, but if he chance to be a young fish, he is easily taken by the hook, because he snaps at all the fishes that approach him; but if he is already accustomed to this, and has swallowed hooks before, he does not even then desert his young, but breaks the hook by a very strong bite.' †

"Cuvier, alluding to these passages in the great *Histoire Naturelle des Poissons*, which he published in connection with Valenciennes, makes the following remarks respecting the fish called Glanis by Aristotle, and its habits: —

"'It cannot be doubted that our Silouros is the Γλάνις of Aristotle. Besides that it is common in Macedonia, and still bears in Turkey the name of *Glanos* or *Glano*, what the philosopher states concerning his *Glanis* agrees well enough with our Silouros, so far as we know its history; the disturbance that stormy weather causes him, the slow development of the eggs, their size, the care he takes of them, the noise he makes, &c.

"'It is possible that at a certain period the name Silouros, which Aristotle does not employ, may not have been the synonyme of Glanis. For in a passage of Ælian, where the Glanis of the Strymon [misprinted in Cuvier's work Shymon] is mentioned, the Glanis of Aristotle is compared with the Silouros. Perhaps this name belonged originally to some of the species of Egypt or Syria; but

* Aristotle, Hist. An., Lib. VI. c. xiii. §§ 2–6.

† Lib. IX. c. xxv. § 6.

what is also very certain is, that, in another passage, Ælian applies this name to our Silouros of the Danube; and Pliny makes the same application, and even employs it in translating the very passages of Aristotle.' *

"'What Aristotle relates in detail, and in two passages, of the care which the male Silourus takes of the eggs of the female, borders on the marvellous. According to him, the large Silouri deposit them in deep waters; the smaller among the roots of willows and other trees, among the reeds or even the mosses. The female, having laid them, leaves them, but the male guards and defends them; and as the eggs are long in developing, he continues this care forty or fifty days.' †

"Within the last ten years, much unexpected information has been collected by naturalists themselves, no longer borrowed from indirect observation, but ascertained while tracing their embryonic growth. Among these investigations, none has attracted so much attention as that of Coste, who observed that the Sticklebacks of Europe build a very neatly constructed nest, in which the eggs are deposited, the parents sitting upon and watching by them until the young are hatched. This fact, however, had already been noticed more than thirty years ago, and recorded in the Isis of Oken. Von Martens had made similar observations upon a species of Gobius, found in the Lagunes of Venice.. But from want of sufficiently minute illustrations, these facts hardly attracted notice, until the full and extensive accounts of Coste, accompanied with numerous drawings, not only removed all doubt respecting the care which some fishes take of their progeny, but revived extensively the interest in such investigations.

"Since I have been in the United States, my attention has been particularly directed to this subject, again and again, by the numerous reports which have reached me, that there are in this country several species of fishes which take care of their young in a similar way, belonging to the genera Catostomus, Exoglossum, Pomotis, and Pimelodus. Of Exoglossum and Catostomus I have had no opportunity thus far to observe the habits with sufficient minuteness to ascertain which of the numerous species of the latter genus takes such care of its young, and in what way this is performed; but it is reported of Exoglossum, that

* Cuvier, Histoire des Poissons, Liv. XVII. c. 1, Vol. XIV. pp. 344, 345.

† Ibid. pp. 350, 351.

they carry little stones to build heaps, among which the eggs are laid; and this species is commonly called *Stone-toters* (carriers of stone). But I have had ample opportunity to watch the Pomotis in the breeding season every spring for the last eight years. At that time it approaches in pairs the shores of the ponds in which it lives, and selects shallow, gravelly places, overgrown with *Potamogeton*, water-lilies, and other aquatic plants, in which it begins by clearing a space of about a foot in diameter, rooting out the plants, removing, with violent jerks of its tail, the larger pebbles, carrying away with its mouth the coarser gravel, and leaving a clean spot of fine sand, in which it deposits its eggs, surrounded and overshadowed by a grove of verdure as represented in the following wood-cut. In

this enclosure one of the parents remains hovering over its brood, and keeping at a distance all intruders. The office of watching over the progeny does not devolve exclusively upon either of the sexes, but the males and females keep watch alternately. The fierceness with which they dart at their enemies, and the anxiety with which they look out for every approaching danger, show that these are endowed with stronger instincts than have been known heretofore in any of their class. Their foresight goes so far as to avoid the bait attached to any hook, however near it may be brought to them, and however lively and tempting it may be. *Pomotis* do not build their nest singly; hundreds of them may be seen along the same shore, within very small distances of one another, forming, as it were, temporary settlements, two nests sometimes hard by each other, or only separated by narrow partitions of water-plants. However near to one another, the pair of one nest do not interfere with those of another,

but like good neighbors they live peacefully together, passing over each other's domain when going out for food without making any disturbance. But whenever an unmated single fish makes its appearance among the nests, he is chased away like an intruding libertine and vagabond. The development of the egg is very rapid. In less than a week the young are hatched, and the parents soon cease to take any further care of them.

"*Pimelodus catus* I have had fewer opportunities to watch. However, I have seen them in the spring, which, in the latitude they inhabit, does not fairly set in before the end of May, approach the shores of our ponds, like Pomotis, in pairs, and clear also a space among the low water-grasses, scirpus, and the like, in very shallow water, not more than a foot or so in depth, and deposit its eggs in the same manner as Pomotis, and watch as carefully and vigilantly over its progeny. Yet I have not been able to ascertain how long the period of incubation lasts. But at different times I have seen the young already hatched, still hanging about within the area of the nest, protected by their watchful parent: sometimes the male and female remaining together with them; at other times, either one or the other of the old fish keeping watch alone. I have seen larger broods of young, already three fourths of an inch, and even an inch long, remaining together like a flock, around one or the other of the parents; and sometimes both swimming slowly in the centre or by the side of what, at some distance, would appear like a black cloud rolling slowly through the water in one or another direction, but which, seen more closely, proves to be a flock of young fish. I have observed such flocking broods through the whole month of June, and noticed that in each the young were of larger and larger size in the latter part of that month, until they swim more loosely, and finally disperse half together; the parents standing nearer the flock, or even in its centre, in proportion as the fish are smaller. When watching over the eggs which are not yet hatched, or when following the young brood, the old fish seem very solicitous for the safety of their progeny, and drive away with great fierceness any approaching enemy. I have even seen one dart at a little hand-net which I was dipping in the water, to secure the young which were still hovering over their nest.

"Having thus far become familiar with the mode of reproduction of Pimelodus, the statements of Aristotle relating to the Glanis of Greece, which is another representative of the same family of Silu-

roides, were brought back to my mind with increased interest. The correctness of the facts related by the great Stagirite respecting that fish could no longer be doubted, as soon as it had been ascertained that another member of the same family has habits so nearly similar to those of the fish of Hellas. There was, moreover, a particular charm in the prospect of confirming the reports of a philosopher of classic Greece, by investigations made in a country so recently covered with the primitive forest, and roamed over by the native tribes of Indians. I availed myself with eagerness, therefore, of the opportunity afforded by Professor Felton's visit to Greece to obtain, if possible, fresh-water fishes from that country, to ascertain by direct comparison what the Glanis of Aristotle really is. Though I had no longer reason to doubt the facts reported by the ancients respecting its mode of reproduction, I was not prepared to believe that Cuvier is correct in considering the Glanis as identical with the Silurus of Central and Eastern Europe, even though the opinion expressed by Cuvier is that entertained also by Pliny, and the naturalists of the Middle Ages; * for I have been acquainted with the Silurus from my boyhood; I was brought up on the shore of a lake where it is common, where fishing is practised on an extensive scale, and where I have myself spent weeks and months in the delightful, lazy, and enticing pursuit; and yet I have never heard nor seen anything respecting that Siluroid which could apply to the Glanis of Aristotle. I wrote by Professor Felton a letter to my old friend, Dr. Roeser, first physician to their majesties, the king and queen of Greece, requesting him to spare no efforts in procuring for me fresh-water fishes from that country, in the hope of thus obtaining the means of ascertaining by actual inspection the true character of the Glanis. Some time after, I received from Dr. Roeser a very fine collection of well-preserved specimens from the Eurotas, the Ache-

* Ælian (Nat. An. XII. 14) does not confound the two: "The Lagnis (Glanis) is found in the Mæander, the Lycus, and other Asiatic rivers, and in Europe, in the Strymon; and resembles the Silurus in appearance. Of all fishes it has the most natural affection for its young. When the female has laid her eggs, she is relieved of all care of the young, like one in childbed; but the male, taking his post as the guardian of his offspring, stands by them, keeping off every assailant. He is capable even of swallowing a hook, as Aristotle relates."

Pliny (IX. 52), however, makes the mistake: "The male Silurus alone watches the eggs when laid, often even fifty days, that they may not be destroyed by others"; — thus transferring Aristotle's description of the Glanis to the Silurus of Central Europe.

lous, and the Spercheios, to which were appended labels with the local names under which they are known to the Greek fishermen at the present day. A more interesting collection than this I have seldom had an opportunity to examine. In it were half a dozen specimens labelled Γλανίδια (Glanidia), caught in the Achelous, the chief river in Acarnania, from which locality Aristotle himself had derived his information about the Glanis. The identity of the name and of the place leave no doubt that I am now in possession of the true Glanis of the Greek philosopher; that this *Glanis* is a genuine Siluroid, but not the *Silurus Glanis* of the systematic writers.* It is a distinct

* The following quotations will sustain these assertions: —

"The Cordylus swims with its feet and its tail; and it has a tail like the *Glanis*." — Aristotle, Hist. An. I. 5. 3.

"Of those that have gills, some have simple gills and some have double; but the last, nearest the body, is in all cases simple. And some have few gills, others have many, but all have an equal number on both sides. Those that have the fewest have one on each side, but that double, as the Capros; others have two on each side, one simple, the other double, as the Conger Eel and the Scarus; others have four simple ones on each side, as the Elops, the Synagris, the Murœna, and the Eel; and others still have four, but in two lines, except the last, as the Kichle, the Perke, the *Glanis*, the Cyprinos." — Ibid. II. 9. 4.

"Of those belonging to the sea, and having lungs, the dolphin has no gall-bladder; but all birds and fishes have the gall-bladder, the egg-laying, the four-footed, and, to speak generally, sometimes more, sometimes less. But some of the fishes have it on the liver, as the Galeodes, the *Glanis*, the Rhine, the Leiobatos, the Narke; and of the lung fishes, the Enchelys, the Belone, and the Zygœna." — Ibid. II. 11. 7.

"The river and lake fishes are exempt from pestilential disease, but some of them have peculiar disorders, as the *Glanis*, which, about the time of the dog-star, by reason of swimming on the surface, becomes sun-struck, and is stupefied by loud thunder; and many Glanides in shallow water perish by the bite of snakes." — Ibid. VIII. 20. 12.

These passages show, that, — 1. The anal fin of the Glanis of Aristotle has the form of the Glanidia of the Achelous. 2. The description of the gill agrees equally with those of the specimens in my possession. 3. The presence of the gall-bladder in the position described is another point of agreement. 4. The connected spawn of the Siluroid differs from the isolated eggs laid by many other fishes, as, for instance, the Salmonidæ. 5. The swimming near the surface agrees fully with what is observed among Siluroids in hot weather. So every statement of Aristotle relating to his Glanis, either agrees with the structure observed in the specimens obtained from Acarnania, or, as far as the habits are concerned, with the mode of spawning of the North American Pimelodus, with perhaps the single exception, that the account of Aristotle is more minute than any statements that could at this moment be made respecting our fishes of that family.

The passages here given contain all that Aristotle has said of the Glanis.

genus, closely allied to Silurus proper, of which I shall take an early opportunity to publish a detailed description, with figures, under the name of *Glanis Aristotelis:* and thus, though at this late day, vindicate once more the accuracy of the greatest naturalist of the ancient world.

"The great work of Cuvier and Valenciennes, *Histoire Naturelle des Poissons*, contains all that was currently known about the class of fishes up to the time of its publication. The learned authors of this extensive book, which, though unfinished, numbers not less than twenty-two volumes, have not only described all the fishes they could obtain themselves, but also sedulously collected all the information that may be gathered from earlier writers, and even referred the statements of the ancients relating to these animals to their respective species, as far as this could be done. That work is therefore as truly a model of scientific erudition, as it is a standard for all future investigations upon the class of fishes.

"These remarks are made chiefly with the view that I may not appear to disparage a scientific production which is destined to stand the test of time, because I happen to have it in my power to rectify some statements respecting the *Silurus Glanis* contained in that work.

"Strange condition of modern culture, which makes it possible for an inhabitant of the United States to contribute to the elucidation of the works of Aristotle, written more than two thousand years ago, and to vindicate the accuracy of that great naturalist by observations of a similar character made upon the inhabitants of the fresh waters of a continent, the existence of which was not even suspected by the Greek philosopher."

Professor Felton remarked, that he had some acquaintance with the fishes of Greece, but chiefly in other than their scientific relations. He rose, however, not to speak of science, but to make a few philological remarks.

"The communication of Professor Agassiz is extremely interesting in every point of view. It is a very striking fact, that the fish in question should, so many centuries after the death of Aristotle, have come from the Achelous across the Atlantic to this country, to furnish our associate with a commentary on the great philosopher, and to vindicate his accuracy as an observer against the criticism even of a Cuvier.

"There can be no doubt of the identity of this fish with that whose habits are described by Aristotle, under the name Γλάνις. The ancient names of birds, fishes, and quadrupeds, in numerous instances, are preserved among the common people, under forms modified in the same way as other classes of words are by the uneducated. The oblique cases are often used, as is common in other languages among the ignorant, for the nominative; in other instances, diminutives are formed from the roots, as exhibited in the oblique cases, and used in the sense of the original word. The name in Aristotle is written Γλάνις; the local name still preserved among the fishermen, in the same region, in the North of Greece, is Γλανίδι, formed, according to numerous analogies, from the genitive Γλάνιδος; and the plural of Γλανίδι (Γλανίδιον) is Γλανίδια, the word employed in the catalogue accompanying the specimens. Thus the fish sent from Acarnania to Athens, and from Athens to Cambridge, to find a place in Professor Agassiz's collection, though dumb, has spoken a noble eulogy upon the greatest philosopher of the ancient world.

"There is a close connection, as Cicero long ago observed, a *commune vinculum*, between all departments of learning. This instructive fish has not only corrected Cuvier, but the Greek lexicographers, who must take a lesson of him, and change their definition. Pape, who is generally very accurate, defines Γλάνις as 'eine Art Wels,' *a kind of cat-fish*, which is tolerably near the truth; and Liddell and Scott, the translators of Passow, call it *a kind of shad*. Hereafter the shad must give place to *horn-pout*, a substitution less displeasing to the lexicographer than to the epicure."

Dr. B. A. Gould acknowledged, in the name of Argelander, his election as Honorary Member, and offered as an apology in his behalf, for not directly addressing the Academy, his inability to write English with facility.

Dr. O. W. Holmes exhibited a section of a Hemlock which had recently fallen on his estate at Pittsfield. The section was made at the height of twelve feet, and by its rings showed its age to be at least three hundred and forty-six years, dating back to 1510. The section exhibited the usual inequality of growth at different periods in the varying width of its rings. Dr. Holmes made the specimen interesting, by indicating at different points the epoch of the birth and death

of some of the great lights of English literature, comparing the existence of each with the few inches of growth of the tree, exhibiting in striking contrast the shortness of man's earthly career. Some conversation ensued on the popular notion that, under certain circumstances of external condition, more than one ring might be formed in a single year.

Professor Gray regarded all such opinions as erroneous, or at least not based on any reliable observations. So far as is known, in temperate climates, all ordinary woods make one annual ring; the fact has not as yet been determined so decidedly in the case of tropical trees. Young trees grow more rapidly and unequally than old ones, and hence an inequality in the width of the rings.

Professor Agassiz said that Mr. H. J. Clark had recently noticed that in the climbing Dogwood (*Rhus Toxicodendron*) the side of the branches resting on any opposing object becomes thickened by an increased development of the rings on that side.

Professor Gray said he had observed this unequal growth in the same plant in old stems of the plant, but had not noticed it as bearing any relation to any circumstances of position. Such anomalies are common in climbing plants, particularly in those of southern and tropical climates. Mr. Clark had shown him very young stems of Rhus, in which the same irregularity existed without any reference to position. The fact is, that, after the first year, the woody layer fails to be formed on one side of the stem, and that too on the free and convex side, not on that which is flattened by pressure against the supporting object, as would have been expected. Mr. Clark has promised to investigate this anomalous growth more particularly.

Dr. B. A. Gould stated, that in Texas it had been pointed out to him, that trees grow most on the south side; and the circumstance was depended upon at times by hunters to direct their path.

Professor Gray observed that such facts are well known, as

trees habitually grow most on the side on which the most favoring influences predominate. On the sea-coast the trees naturally grow most freely on the land side.

The following gentlemen were elected Resident Fellows, viz.: —

Professor Henry W. Torrey of Cambridge, in Class III., Section 3.

Rev. N. L. Frothingham, in Class III., Section 4.

Benjamin A. Gould, in Class III., Section 2.

E. A. Sophocles, in Class III., Section 2.

Dr. C. H. F. Peters, in Class I., Section 2.

Henry James Clark, in Class II., Section 3.

Four hundred and thirty-third meeting.

December 9th, 1856. — ADJOURNED QUARTERLY MEETING.

The Academy met at the house of the President. The President in the chair.

The Corresponding Secretary read letters from the Rev. N. L. Frothingham, accepting the Fellowship; from the Imperial Academy of Sciences, Vienna, March 10th and April 15th, acknowledging the receipt of the Academy's publications; from the Zoölogical and Botanical Association, Vienna, May 10th; the Royal Society of Sciences at Upsal, November 16th, 1855; the Royal Prussian Academy of Sciences, Berlin, March 6th; the Natural History Association of the Prussian Rhine Countries and Westphalia, Bonn, January 12th; the Imperial Geological Society, Vienna, March 20th; the Imperial Academy of Sciences, Vienna, May 23d and July 16th, presenting their various publications; from the Society of Physics and Natural History, Geneva, March 11th, in acknowledgment of the receipt of the Academy's publications, and presenting its own, with a circular, offering the fifth annual botanical prize on the foundation of De Candolle.

The President read a paper on the probable cause and nature of the death of Pliny the Elder, taking the ground, in

opposition to the commonly received opinion, that he died of apoplexy, and not of suffocation.

A discussion arising upon the nature of the effluvia, ashes, &c., emitted by volcanoes, Dr. Hayes remarked, that eruptions were of a mixed character, distinguished by lava overflows, sublimations, and chloridic and aqueous exhalations in some cases, while in others the presence of atmospheric air and vapor of water in large quantity gave rise to sulphurous acid fumes, and sulphydric gases, with sulphur depositions. Regarding the account of the death of the elder Pliny as remarkably explicit in details, he thought the statement in relation to emission of sulphurous fumes at that time as in accordance with present knowledge on this subject, and yet as in no wise opposing the interesting view which has just now been presented of the cause of his death. The abundant source of sulphur fumes and sulphydric gases is the solfa-taras, which, generally in action, exhibit during eruptions their highest activity; and these existed then, and now exist, in the low grounds in the vicinity of Vesuvius, changing their places as the decompositions on which they are dependent proceed. Solfa-tara action can hardly be classed with true volcanic action, although primarily dependent on it. It is a slow combustion, taking place among the aggregates formed at the time of previous volcanic action, requiring the presence of water for continuing it. The earliest history of Vesuvius presents it as a solfa-tara consuming the lava rocks of an earlier period, and its cones of later dates have been craters of elevation, subject to degradation, which has several times occurred. Pliny, at the time of his death, was at Stabiæ, where were hot volcanic waters along the shores, marking the points of solfa-tara action. The sulphur of commerce is derived from the deposits formed by solfa-taras, and its immense quantity affords some estimate of their extent and antiquity.

Mr. Everett followed, illustrating the changes in locality of the solfa-taras, from his own observations, after an interval of a few years had elapsed. He also stated as his experience,

that the crevices of the lavas, in the vicinity of the crater of Vesuvius, emitted sulphur fumes; the napkin containing eggs, while being cooked, was coated with sulphur.

Dr. Pickering remarked, that, so far as his observations extended, sulphur vapors were abundant in lava crevices, wherever vapor was emitted. Referring to the great lava lake of the volcano of Hawaii, he said there was no perceptible smell of sulphur near its surface.

The President, Dr. Peters, and Professor Horsford also took part in the discussion.

The President expressed an interest in the question of the origin of volcanic ashes, referring to the fact of their being carried by winds and dispersed over extended areas at the time of eruptions; falling on vessels at sea far from any land.

In answer to an inquiry from the President as to the nature of volcanic ashes, Dr. Hayes replied, that they are the finely divided parts of broken down volcanic aggregates, having generally the composition of silicates of alumina, slightly contaminated by other silicates. To have a clear view of the origin of these ashes, it is necessary to consider that volcanic action, under its differing intensities, either fuses together or merely compacts assemblages of divers minerals, including sulphur compounds of metals and of earths. This action is often aqueous or hot-water action, and the rocks formed *include the elements of their own destruction*, on exposure subsequently to the air and moisture. Thus one of the most solid is the true Augitic Trachyte, which will not resist exposure to a New England atmosphere one year, without crumbling and disintegrating. Craters of elevation are composed in large part of this rock, often covered by true fused lavas in part. The latter, at the points near their source, are tolerably compact, but as they pass along the surface, they become tumefied and scoriaceous, and hence subject to decomposition. When the sulphurets have been engaged in the trachytes, decomposition commences soon after exposure to humidity, attended by the emission of vapors and acid fumes, which corrode and decom-

pose all the superincumbent mass of rock, more or less. In craters of depression, as water can more copiously fall in, this decomposition of compound aggregates proceeds with great rapidity, and to great depths. The changes resulting from the chemical action thus established are not merely mechanical; salts more or less soluble form, and are dissolved in the escaping waters, while the rocky masses are reduced to their insoluble, finely divided, proximate elements. Few of the compound silicates resist this action; thus soda felspar, which generally is found in trachytes, and in the laboratory, decomposes slowly, but rapidly yields its silicate of soda to the acid and aqueous vapors, and solfa-tara is soon reduced to a mixture of silicic acid and pipe-clay. From this brief statement of facts, it becomes apparent that every volcanic focus becomes covered to a great depth with finely divided materials, resulting from rock decomposition, and any succeeding eruption must be preceded by a removal of this matter in the way of upheaval. The narratives of the eruptions of Vesuvius, so remarkable for graphic description, show that, after periods of repose, the first efforts of reawakened vigor are expended on the materials covering the surface. One of the most instructive examples, also, is that of the eruption, so called, of the volcano Morne Ronde, on the island of St. Vincent, in 1792, the marks of which I have examined. This, as is well known, is one of the volcanic vents of the Windward West India Islands, and its resumption of activity was preceded by no preliminary efforts. The inhabitants of the island were roused from their slumbers at about 2 A. M. by a terrific convulsion, the earth swaying under their feet, while the atmosphere, suddenly displaced, was rushing in opposing currents from all directions, attended by deafening reports. By one sudden explosion, the top of the mountain, about three thousand feet high, lost several hundred feet in height, while, as afterwards appeared, a cavity of about eight hundred feet deep was formed. The larger masses of the covering material rolled down its base, while the more finely divided part

was carried upward, falling into the sea, — nearer or farther off in proportion to the size of its fragments. The finer parts rose above the current of the trade winds, and, taking the upper and opposite flow, spread over the sea and the island of Barbadoes, obscuring the light of a tropical sun, and causing the greatest consternation on land and sea. This ash I have examined from several parts of its course, and it differed in no respect from the fine parts of the trachyte, undergoing decomposition by atmospheric agents on the spot. There followed after this explosion no flow of lava, but a shower of rude balls of half-fused, tumefied trachyte, succeeded by fragments of rocks, earths, and finally mud and water. The final action took place obviously within the crater, formed more than eight hundred feet below the surface of the top of the mountain, and resulted in the production of a regular cone of sand and gravel, which remained. Twenty years after (1812) a similar explosion took place, and the point of greatest interest is, that a new centre of action appeared. A smaller crater was formed, so near the older one that the rim of the later one breaks its continuity. The action which followed the dispersion of the disintegrated covering in this case was of a kind among the most remarkable on record. A large part of the force was expended in discharging from the crater rocks broken into fragments, from the size of a cubic inch to that of grains of sand; nearly every fragment and grain being bounded by straight lines, square or rectangular, with sharp angles and edges. As the volcanic vents of the West Indies, and indeed whole islands, have been elevated from below a deep ocean which surrounds them, they offer the best examples of that secondary effect, resulting from chemical action taking place within the aggregates formed, which I could adduce.

Professor Horsford suggested that, as the volcanic ashes are silicates of alumina, it might be possible for the mixed chlorides of aluminium and silicium to be shot as a bolt from a crater, and at a distance from that point find moisture and

atmospheric oxygen to convert them into oxides and hydrochloric acid; when they would unite to form silicate of alumina.

Dr. Hayes replied, that, if such a supposition were for a moment entertained, the mixed chlorides could only form hydrochlorates under the conditions, and if the mixed metallic bases were to be oxidized in union, a crystallized silicate of alumina would result, while volcanic ashes under a microscope are either scales with rough imbrications, or feathery forms, such as we every day see in decomposing trachytes and micaceous rocks, water being present.

In reply to the President, Dr. Hayes added, that the chloridic sublimates are not true chlorides usually, but hydrated compounds which do not form solid crystals, being transported in a vesicular state by watery vapor, which, with atmospheric oxygen, is always present in the gases evolved during the most active eruptions; hence true chlorides, excepting common salt, are rarely found.

Dr. A. A. Hayes made the following communication, "On some Points of Chemical Interest, connected with the Manufacture of Ductile Iron by the new Process of H. Bessemer," and exhibited some specimens.

"In calling the attention of the Academy to a part of the process for obtaining nearly pure ductile iron from crude products of the iron-ore furnace, which has of late excited much interest among those engaged in the iron manufacture, it is not my intention to enter upon the economical or technical part of the subject at this time. It is well known that Mr. Bessemer has based his improvements on the startling novelty of making crude iron nearly pure, *without the aid of fire from carbonaceous matter*. In considering the ordinary mode of refining crude iron, the final operations being performed on crude pig, or on partially refined pig-iron, we have as one of the conditions of success the application of an intense heat, and the presence of more or less atmospheric oxygen, necessary to maintain the required degree of fluidity in the mass of iron, and to burn out the carbon and other impurities present. As the iron loses its carbon and other extraneous substances, it becomes less fusible, and

the workman, stirring the mass as it begins to lose its fluidity, gathers into rough masses the aggregated particles, which are always spherical in general form. From the masses, which are very porous and unequal, a bar of regular form is obtained by the usual means of pressing, or hammering and rolling.

"There is in this process strictly a segregation of particles of pure iron from the crude mass, which, under the agitation of stirring, unite to form rounded aggregations, and the heat of the furnace being increased, the separation of pure iron continues, until the melted impurities alone remain. The change of crude to pure iron is accompanied by the *production* in part of the impurities which remain; they are not educts. Aside from the loss of carbon in the form of carbonic oxide, the phosphorus and sulphur, — which my experiments have proved are always united to the metallic bases of the earths or alkalis, — with these bases, burn into oxidized products; while the silicium and a portion of the iron, also oxidized, form the melted slag, or cinder, as an additional foreign matter. To the loss of impurities we must also add the weight of iron burned in forming secondary products, so that, if the operations were performed on crude iron containing ninety-two per cent of pure iron, no more than eighty-two per cent of malleable iron will be obtained. By the method of Bessemer, crude iron in a melted state is exposed in a nearly closed receptacle to jets of air forced into and under the fluid, and it is alleged that such an excess of heat is produced in the process, 'that the metal continues to boil even after the blast has ceased.' The direct statement is made, that 'the air, dividing into globules, and diffusing itself among the particles of fluid iron, and thus coming in contact at numerous points with the carbon contained in the crude iron, and producing thereby a vivid combustion,' and the same action is implied in other parts of Mr. Bessemer's patent-specification.

"Now it is well known to chemists, that the combustion of the carbon of crude iron *cannot take place under the conditions.* This carbon exists in gray iron in the allotropic state of graphite, and is not combustible even alone, when exposed highly heated to a current of atmospheric air. We burn it in the laboratory by the application of oxygen in some condensed state only. The proper chemical explanation of this point is a very simple one. Iron, which is a highly combustible body at ordinary temperatures, has its attraction for oxygen enormously increased by the heat of fluidity, and in com-

bining with this element, the heat disengaged is ample for carrying the temperature of the mass still higher. A portion of oxide of iron being formed, the mechanical motion imparted by the jets of air favors the contact of the oxide with the carbon, *which then burns with the condensed oxygen of the oxide of iron.* The products of this combustion, arising from the mingling of oxide of iron and graphitic carbon and pure graphite, are two, — pure iron, and carbonic oxide; the former uniting with the mass, the latter escaping as gas, and burning in the atmosphere, or even with any oxide of iron it meets with in the mass. A moment's consideration of the operation shows that the combustion of the iron at the first stage leads to the separation of the carbon as carbonic oxide, and a reduction of the oxide formed to pure iron. Silicium, phosphorus, cyanogen, and sulphur, the bases of the alkaline earths, and interposed slags are oxidized and removed as fusible compounds in the same way, *while the pure iron assumes the crystallized state.* The combustion of the iron raises the temperature of the acting bodies far above the initial point, while the reduction of the oxide of iron formed diminishes in a corresponding degree this temperature. Were the conditions of the experiment such that the oxide formed from the iron burned was equivalent to converting the carbon into carbonic oxide only, at the moment the oxide of iron became pure iron, then no increase of temperature would be noted, and the cooling influences of the surrounding medium would cool the acting bodies below the initial temperature. Hence, it is essential that more than an equivalent of iron should be burned, and a loss of this substance must take place, so that the operation of purification by the new process is carried on by substituting *iron as fuel* for carbon consumed in the ordinary process. Assuming six pounds of carbon to exist in a sample of crude iron containing ninety-two pounds of pure iron in one hundred pounds, then *twenty-eight pounds of iron* must be burned to oxide, and the six pounds of carbon will exactly reproduce the twenty-eight pounds of iron, leaving ninety-four parts of iron deprived of carbon. But the practical result differs from this statement, inasmuch as a positive loss of at least ten pounds of iron occurs; and in explaining the increased elevation of temperature, we neglect that portion of the iron which, having been burned and again reduced, adds to the mass, and keep in view the effect of the combustion of ten pounds of iron lost in the operation at the high temperature attained. Accurately, some addition to the temperature

is made by the combustion of other bodies present besides carbonic oxide, but there are also sources of expenditure; leaving as useful effect the amount of heat generated by ten pounds of iron burned, from every one hundred pounds of melted iron taken.

"I believe this combustion, going on momentarily with the reduction of the oxide, is sufficient to afford the excess of heat required to maintain the temperature of the mass of iron above the initial temperature for the short time of thirty or forty minutes, during which the conversion takes place in a nearly closed vessel.

"The other point in this connection is the condition of the pure iron at the moment of its conversion. As this is most important to a correct conception of the practical bearing of the method, it was deemed necessary to describe briefly the ordinary mode of puddling iron, and reference is now made to that part where it is stated, that, as the iron becomes pure, it is less fusible.

"In ordinary, this less fusible part is 'gathered,' and forms 'puddle-balls'; if not thus removed, and time sufficient were allowed, the whole charge would become consolidated, and could not be removed. In the new method, the jets of air agitate or 'boil' the fluid iron, and yet this solidification does not proceed, and it has been assumed that the acting temperature is so high that the pure iron becomes fluid. No evidence has been presented to sustain this assumption, and it has been shown above, that there is no source of heat present adequate to cause such fluidity. All the specimens of a suite illustrating the manufacture, prepared under the eye of Mr. Bessemer, show that such heat of fluidity is unnecessary." (Dr. Hayes exhibited these specimens, which illustrated, step by step, the conversion of crude iron into pure iron, and the subsequent production of the interwoven particles forming wrought-iron, and the most finished specimens of laminated sheets.)

"These specimens prove that the molten mass of pure iron is not a *liquid iron*, but a semi-fluid composed of crystals of pure iron, which, in accordance with the laws of crystallization, have withdrawn from the fluid, merely wet by the fluid iron present, and rendered pultaceous by the carbonic oxide gas entangled. This physical condition of the iron is represented by particles of hail mixed with a small proportion of water, or more exactly by the mixture of crystals of sugar and concentrated sirup, as it is filled into the forms; such a mass will flow and take sharp impressions in the moulds, while its

texture on cooling is highly crystalline and porous. Although the iron in this state is as pure chemically as any bar-iron, its mechanical state does not assimilate it to malleable iron, and the ingots rarely present the compactness of cast-iron of the coarser qualities. A careful examination of the specimens suggests the conclusion, that much of the character of fluidity is also due to the presence of the engaged carbonic oxide, which, like any gas disengaging from a dough-like semi-solid, causes it to flow.

"This mechanical constitution of the pure iron removes the difficulty which every iron-master must have conceived to exist, in the descriptions of the new method heretofore published, and it will be seen that the effects produced in the old and new process are strikingly similar; while the fuel in the one case is iron, in the other the ordinary coke or coal. In removing the iron from the furnace, the puddler depends on forming a rude porous aggregate, while Mr. Bessemer, by a refined mechanical agitation, converts the whole into a semi-solid, crystalline mass, full of gas-bubbles, which flows from an inverted vessel, and takes the forms of the moulds."

Mr. Charles Jackson expressed a doubt as to the practical value of the new process, and adduced the significant fact, that it had not in the least affected the price of iron in the market, nor the value of iron-works.

Dr. Hayes rejoined, that he had presented to the Academy only the interesting chemical points, avoiding the economical bearing of the discovery. He was, however, prepared to discuss this fact, in view of its importance to the English, rather than to the American manufacturer.

Professor Gray presented, in the name of Dr. Engelmann, the following

"*Corrections and Additions to the Synopsis of the Cactaceæ of the United States.*

"On p. 279, the var. *minor* of *Cereus dasyacanthus* should be cancelled, and after *C. longisetus*, p. 280, the following added: —

"9½. C. Rœtteri, E. in B. C. R.: ovato-cylindricus, 10 – 12 costatus; areolis ovato-orbiculatis; aculeis e basi bulbosa subulatis-rubellis apice obscuris exterioribus 10 – 15, interioribus 2 – 5 robustioribus

sub-brevioribus; floribus subterminalibus magnis purpureis; bacca subglobosâ; seminibus tuberculatis.

"El Paso, southward to the Sandhills; fl. April. — Stem 5–6 inches high; spines 4–8 lines long; flower 2½–3 inches long. Similar to *C. dasyacanthus*, from which it is distinguished by the fewer ribs, fewer and stouter spines, purple flowers, smaller fruit, and larger seed. This species is intermediate between the *Pectinati* and *Decalophi*.

"After *Opuntia setispina*, p. 294: —

"O. Pes Corvi, Le Conte, Mss.: articulis parvis teretiusculis; pulvillis subconfertis setas paucas breves graciles flavidulas gerentibus plerisque armatis; aculeis binis ternisve gracilibus sæpe basi compressis tortisque; flore flavo minore.

"Sandy coast of Georgia, *Major Le Conte*, and Florida, *Dr. Chapman*. — Joints not much over an inch long, and half as thick. Spines 1–1½ inches long, straight and slender. Flower 1½ inches in diameter. Ovary only with 5 areolæ; stigmas 5. — In the shape of the joints this curious little species resembles *O. fragilis*, but in other respects it seems intermediate between *O. vulgaris* and *O. tenuispina*."

Professor Agassiz addressed the Academy on the general characters of Orders in the classification of the animal kingdom. Orders, he said, are natural groups characterized by complication of structure. There are groups, however, constituting orders, which do not come under this definition; hence he concludes that the different classes of the animal kingdom do not all admit of the same divisions. Professor Agassiz illustrated his views by the different orders of Echinoderms. In conclusion, he remarked, that orders are of different kinds, some synthetic, some prophetic, others graduated.

After nomination by the Council, —

Laurens P. Hickok, D. D., President of Union College, Schenectady, was elected an Associate Fellow in the Section of Philosophy and Jurisprudence.

Dr. George B. Wood and Dr. Isaac Hays, both of Philadelphia, were elected Associate Fellows in the Section of Medicine and Surgery.