東京帝國大學
理科大學紀要

第參拾貳册

THE
JOURNAL
OF THE
COLLEGE OF SCIENCE,
IMPERIAL UNIVERSITY OF TOKYO.

Vol. XXXII.

東京帝國大學印行
PUBLISHED BY THE UNIVERSITY.

TOKYO, JAPAN.

1911–1913.

MEIJI 44—TAISHO 2.

Publishing Committee.

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All communications relating to this Journal should be addressed to the Director of the College of Science.

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PRINTED BY THE TOKYO PRINTING CO., LTD.

JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY, TOKYO.
VOL. XXXII., ARTICLE 1.

Revisio Aceracearum Japonicarum.

by

G. Koidzumi.

(With 33 Plates)

Introduction.

In the year 1902, Dr. F. Pax published, in Engler's "Das Pflanzenreich," his excellent monograph of the Aceraceae, in which the genus Acer was divided into 13 sections, comprising 114 species in all, besides a large number of varieties and forms.

Since that publication, new species have been added to the genus from Eastern Asia, especially from the Sinico-Japanese region, augmenting the total number of known species up to 127.

In 1905, a new section of the genus was proposed by Dr. Rehder, based on certain species found in eastern continental Asia, in addition to those of Pax.

The present monograph deals with *Acer* found in Japan proper, Loochoo Islands, Formosa and Sachalin. Based on the results of careful examinations and revisions of each species, I have attempted to present a new systematic arrangement of the genus on the principle of bringing out as far as possible the phylogenetic relations of the members.

The vernacular names of every species are taken principally from the works of Prof. J. Matsumura[1] and Prof. M. Shirai.[2]

The present work was taken up at the suggestion of Prof. J. Matsumura, to whom I beg herewith to express my grateful thanks for the many acts of kindness renderd me during my studies. I am also under great obligation to Prof. M. Shirai who helped me in many matters regarding the literature. Further to Dr. Y. Shirasawa, Prof. G. Yamada, and Mr. T. Kawakami of the Formosan government, I am much indebted for the valuable material placed at my disposal.

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[1] 日本植物名彙. ed. 3. (1897).

[2] 日本機樹ノ種類. (1908).

Aceraceæ. DC.

Aceraceae, DC. Théor. Elem. Bot. (1813);—Lindl. Nat. Syst. ed. 2. (1836) p. 81; Veg. Kingd. (1847) p. 387;—Pax, in Engl. et Prantl. Nat. Pfl. Fam. III. 5. (1893) p. 263, et Pfl. Reich, 8 Heft (1902) p. 1;—Engl. Syllb. Nat. Pfl. Fam. (1904). p. 155.

Acera, Juss. Gen. Pl. (1789). 50.

Acerineae, DC. Prodr. I. (1824). p. 593:—Endl. Gen. Pl. (1836—40) p. 1055.

Sapindaceae, subord *Acerineae*, Benth. et Hook. Gen. Pl. I. (1867) p. 391.

Sapindaceae, series 8. *Acereae*, Baill. Nat. Hist. Pl. V. (1874) p. 427.

Sapindaceae, subord. *Acerinae*, Drude, in Schenk, Handb. III. B. (1887) p. 390.

Flores actinomorphi. Carpella 2. Ovaria in loculis biovulata. Fructus mericarpiis samaratis 2-compositus. Semina exarillata. Folia opposita, simplicia vel imparipinnata, exstipulata.

Acer. L.

Acer, (Tournf) L. Sp. Pl. ed. 1 (1753) p. 1054, et Gen. Pl. (1754). p. 1155;—DC. Prodr. I. (1824). p. 593;—Endl. Gen. Pl. (1836—40). p. 1056;—Benth. et Hook. Gen. Pl. I. (1867) p. 409;—Baill. Nat. Hist. Pl. V. 427;—Pax, in Engl. et Prantl. Nat. Pfl. Fam. III. 5. p. 269, Engl. Bot. Jahrb. VII. (1886). p. 177, et Engl. Pfl. Reich. (IV. 163.) 8. Heft. (1902) p. 6.

Negundo, Ludwig, Gen. Pl. ed. 3. (1760). 308;—DC. Prodr. I. 596;—Benth. et Hook. Gen. Pl. I. 409;—Endl. Gen. Pl. 1056.

Negundium, Rafin, in Desv. Journ. Bot. II. (1809). p. 170.

Eulac, Adans, Fam. II. (1763). p. 383.

Euacer, Opiz, Seznam (1852), p. 42.

Flores heterochlamydei rarissime monochlamydei, actinomorphi, cyclici rarius semicyclici, pentameri vel rarissime tetrameri, hermaphroditi vel unisexuales. Sepala 5, rarissime 4, libera vel pl. m. connata, in aestivatione imbricata vel quincunciales. Petala imbricata sepalis alterna, vel nulla. Discus varius, extra- vel intrastaminalis, annularis vel lobatus, interdum abortivus vel deficiens. Stamina 4—10, diplostemoni, saepissime 8, hypogyna vel perigyna; antheris bilocularibus, innatis, longitudinaliter dehiscentibus. Carpella 2 rarissime 3, connata (syncarpa et oligomera). Ovarium 2-lobum, 2-loculares, loculis biovulatis; stylis 2 inter lobos ovarii insertis, intus stigmatosis; ovula pendula, collateralia vel deinde superposita, integumento duplici, raphe dorsali cum micropyle supera. Fructus samarae 2, indehiscentes, demum ab axi secedentes, commissura plus minus persistente. Semina in loculis 1, exalbuminosa, testa membranacea. Embryo plerumque diplecolobeus, cotyledonibus plicatis, radicula elongata. Arbor vel frutices. Folia opposita, petiolata, exstipulata, membranacea, vel subcoriacea, simplicia vel imparipinnata. Inflorescentia racemosa, corymbosa vel paniculata; rarius bracteata; andro-polygama, andro-monoecia vel -dioecia, interdum dioecia.

Clavis diagnostica Sectionum.

I. **Intrastaminalia**: (Discus intrastaminalis. Stamina hypogyna vel in flore ♂ tantum perigyna. Flores cum foliis nascentes vel paullo tantum praecociores. Gemmae perulae interiores elongatae.)

- * Inflorescentia andro-polygama, elongato-paniculata, in ramulis foliatis terminalis. Flores pentameri. Folia palmato-lobata.......................................*Parviflora*.
- ** Inflorescentia andro-dioecia vel-monoecia. Flores pentameri rarissime tetrameri.
  - △ Inflorescentia in ramulis foliatis terminalis.
    - ○ Folia indivisa.
      - □ Folia utrinque pluri-costata; flores 5 meri. ......*Indivisa*.
      - □□ Folia utrinque multi-costata; flores 4-meri....*Carpinifolia*.
    - ○○ Folia pl. m. palmato-lobata.
      - □ Inflorescentia corymbosa..............................*Glabra*.
      - □□ Inflorescentia racemosa.
        - ◎ Antherae ellipticae, laevae. Ovaria puberulento-tomentella. Folia 3— (sub 5) lobata; lobis inaequaliter serrata.......................*Macrantha*.
        - ◎◎ Antherae ovatae, apice apiculatae, leviter scabrae. Ovaria glabra. Folia 5-lobata; lobis utrinque lobulato-inscisis. ....*Palmatoidea*.
  - △△ Inflorescentia in ramulis aphyllis terminalis....*Lithocarpa*.
- *** Flores pentameri, dioeci. Inflorescentia ♀ in ramulis foliatis, ♂ in aphyllis terminalis. Folia palmato-lobata...*Arguta*.

II. **Extrastaminalia**: (Discus extrastaminalis, rarius valde abortivus vel nullus.)

A. Discus valde abortivus vel deficiens. Flores longe ante folia nascentes. Gemmae perulae interiores non elongatae. (*Adiscantha.*)

* Folia simplicia. Flores andro-dioeci. Sepala non connata. Discus dentiformis. Stamina 5—8 .... *Rubra.*

* * Folia ternata vel pinnatim 5-foliolata. Flores dioeci. Sepala connata. Stamina 4—6. Discus nullus. Corolla deficiens. .... *Negundo.*

B. Discus bene evolutus. Flores cum foliis nascentes vel paullo tantum praecociores. Gemmae perulae interiores elongatae.

* Flores ♂ perigyni. Folia lobata.

○ Inflorescentia andro-polygama.

△ Foliorum lobi obtusiusculi, saepe integri. Stamina disco crasso prope ejus marginem interiorem inserta. Fructus loculi duri.............. *Campestria.*

△△ Foliorum lobi grosse sinuato-dentati. Stamina disco medio inserta. Fructus loculi planiusculi .... *Platanoidea.*

○○ Flores dioeci. Sepala florum ♂ cum petalis coalita. .... *Diabolica.*

○○○ Inflorescentia andro-dioecia vel-monoecia. Corolla nulla. Sepala connata. .... *Saccharina.*

* * Flores omnes hypogyni. Folia lobata, ternata aut indivisa.

○ Flores dioeci, tetrameri, minuti, elongato-racemosa. Folia ternata................................ *Cissifolia.*

○○ Inflorescentia andro-polygama. Folia lobata vel integra.

△ Folia pl. m. palmato-lobata.

◎ Inflorescentia paniculata, vel racemoso-paniculata. Folia 3—5 lobata........... *Spicata.*

◎◎ Inflorescentia corymbosa. Folia 5-pluri lobata................................ *Palmata.*

△△ Folia integra.............................. *Integrifolia.*

○○○ Inflorescentia andro-dioecia vel monoecia. Folia ternatisecta. Flores umbellati............ *Trifoliata.*

Index sectionum generis.

I. *Intrastaminalia*, Pax, 1885.
  1. Glabra, Pax, 1885.
  2. Parviflora, m.
  3. Indivisa, Pax, 1885.
  4. Carpinifolia, m.
  5. Macrantha, Pax, 1885.
  6. Palmatoidea, m.
  7. Lithocarpa, Pax, 1885.
  8. Arguta, Rehder, 1905.

II. *Extrastaminalia*, Pax, 1885.
  9. Negundo, Pax, 1885.
  10. Cissifolia, m.
  11. Rubra, Pax, 1885.
  12. Saccharina, Pax, 1885.
  13. Spicata, Pax, 1885.
  14. Palmata, Pax, 1885.
  15. Integrifolia, Pax, 1885.
  16. Trifoliata, Pax, 1885.
  17. Campestria, Pax, 1885.
  18. Platanoidea, Pax, 1885.
  19. Diabolica, m.

Index specierum, varietatum formarumque Aceracearum Japonicarum.

I. *Intrastaminalia*, Pax.

Sect. 1, **Parviflora**, Koidz.

1. Acer parviflorum, Fr. et Sav. .... *Tetsu-kaede.*

Sect. 2, **Indivisa**, Pax.

2. Acer distylum, S. et Z. .... *Maruba-kaede.*
3. Acer crataegifolium, S. et Z. .... *Ko-uri-kaede.*

var. Veitchii, Nichols.......................*Fuiri-kourikaede.*
4. Acer insulare, Mak...............................*Shima-urikaede.*
5. Acer Kawakamii, Koidz. sp. nov. ....*Onaga-kaede.*
6. Acer ovatifolium, Koidz. sp. nov..............*Koba-onagakaede.*
7. Acer morrisonensis, Hay.......................*Takasago-urikaede.*

Sect. 3. **Carpinifolia**, Koidz.

8. Acer carpinifolium, S. et Z. ....*Yamashiba-kaede.*

Sect. 4. **Macrantha**, Pax.

9. Acer rufinerve, S. et Z. ....*Urihada-kaede.*
forma, albo-limbatum, Hook. fil..............*Fuiri-urihada.*
10. Acer capillipes, Max...............................*Hosoe-urihada.*
var. fujisanense, Koidz. var. nov....*Hiroba-ashiboso-urinoki.*
11. Acer rubescens, Hay...........................*Takasago-urihada.*

Sect. 5. **Palmatoidea**, Koidz.

12. Acer micranthum, S. et Z. ....*Ko-minekaede.*
13. Acer Tschonoski, Max. ....*Mine-kaede.*

Sect. 6. **Arguta**, Rehder.

14. Acer argutum, Max ....*Asanoha-kaede.*

II. *Extrastaminalia*, Pax.

Sect. 7. **Cissifolia**, Koidz.

15. Acer cissifolium, Koch. ....*Mitsude-kaede.*

Sect. 8. **Rubra**, Pax.

16. Acer rubrum, L...*Hana-kaede.*

Sect. 9. **Spicata**, Pax.

17. Acer trifidum, Hook. et Arn ....*Tō-kaede.*
forma integrifolium, (Mak) m. ....*Maruba-tōkaede.*
var. ningpoense, Hance...........................*Tō-kaede.*

var. formosanum, Hay. ....*Takasago-tōkaede.*

18. Acer ginnala, Max. ....*Karakogi-kaede.*

var. yezoense, Koidz. var. nov. ....*Yezo-karakogikaede.*

19. Acer spicatum, Lam.

var. ukurunduense, Max ....*Ogarabana, Hozaki-kaede.*

20. Acer Oliverianum, Pax.

var. Nakaharae, Hay. var. nov..............*Shima-momiji.*

svar. formosanum, Koidz. svar. nov.................. ....*Itomaki-shimamomiji.*

svar. trilobatum, Koidz. svar nov..................... ....*Mitsude-shimamomiji.*

Sect. 10. **Palmata**, Pax.

21. Acer Sieboldianum, Miq.

α. typicum, Max. ....*Itayameigetsu, Kibana-uchiwakaede.*

svar. albiflorum, m. ....*Shirobana-itayameigetsu.*

svar. tortuosum, m.

svar. microphyllum, m........................*Hime-uchiwakaede.*

svar. Momijigasane, m............................*Momiji-gasane.*

svar. Sodenouchi, m......................................*Sodenouchi.*

β. tsusimense, m................................*Koba-itayameigetsu.*

svar. Kasatoriyama, m. ....*Kasatoriyama.*

svar. laxifolium, m. ....*Hina-itayameigetsu.*

svar. Ayaigasa, m. ....*Ayaigasa.*

22. Acer Shirasawanum, Koidz. sp. nov......... *Oh-itayameigetsu.*

var. tenuifolium, m. ....*Hina-uchiwakaede.*

svar. Murasame, m.............................*Murasame.*

23. Acer japonicum, Thg.

α. typicum, Gr. v. Schw..*Hauchiwa-kaede, Akabana-uchiwakaede.*

forma angustilobum, m.

forma macrophyllum, m.

forma tenuilobum, m.

forma semiovatum, m.

forma ascendens, m.

forma crassifolium, m.

β. aureum, Gr. v. Schw.
γ. Parsonii, Veitch.
δ. Heyhachii, Matsum. ....*Mai-kujaku.*
ε. microphyllum, m. ....*Yezo-meigetsu-kaede.*
ζ. circumlobatum, m. ....*Oh-meigetsu.*
η. villosum, m.
θ. Kasado, m. ....*Kasado.*
ι. Kokonoye, m. ....*Kokonoe.*
κ. Sayosigure, m. ....*Sayoshigure.*
λ. Matsuyoi, m. ....*Matsuyoi.*
24. Acer palmatum, Thunb. ....*Kaede, Momiji.*
ssp. α. genuinum, m.
a. spectabile, m. ....*Iroha-momiji.*
forma Chisiwo, m. ....*Chishio.*
forma Komonnisiki, m. ....*Komon-nishiki.*
svar. crispum, m. ....*Okushimo.*
svar. Higasayama, m ....*Higasa-yama.*
b. amabile, m ....*Iroha-momiji.*
forma Akajinisiki, m. ....*Akaji-nishiki.*
forma Tsuchigumo, m. ....*Tsuchigumo.*
forma Hanaizuminisiki, m....*Hanaizuminishiki.*
forma Oridonisiki, m. ....*Orido-nishiki.*
svar. Kagiri, m ....*Kagiri.*
ssp. β. septenlobum, (Thg.) m. ....*Takao-momiji.*
var. latilobatum, m. ....*Hiroha-momiji.*
var. speciosum, m. ....*Nomura-kaede.*
var. palmatipartitum m.
forma Senri, m. ....*Senri.*
forma Ichigioin, m. ....*Ichigyoin.*
forma Akitsuta, m. ....*Akitsuta.*
forma Tsukubane, m. ....*Tsukubane.*
forma Ohsakazuki, m. ....*Oh-sakazuki.*
svar. Tanabata, m. ....*Tanabata.*
svar. linearilobum, m ....*Shimenouchi.*
forma lineare, (Gr. v. Schw.) m.
forma atro-lineare, (Gr. v. Schw.) m.

- *ssp.* γ. Matsumurae, m. .... *Yama-momiji.*
  - a. spontaneum, m.
    - *forma* angustilobum, m.
    - *forma* circumlobatum, m.
    - *forma* acutum, m.
    - *forma* rectangulare, m.
    - *forma* obtusum, m.
    - *svar.* elegans, m.
    - *svar.* formosanum, m. .... *Takasago-momiji.*
  - b. hortense, m.
    - *svar.* palmatilobum, m.
      - *forma* Sigitatsu, m. .... *Shigitatsu.*
      - *forma* Nisikikasane, m. .... *Nishikigasane.*
      - *forma* Asanoha, m. .... *Asanoha.*
    - *svar.* palmatipartitum, m.
      - *forma* Monnisiki, m. .... *Monnishiki.*
      - *forma* Akitsusima, m. .... *Akitsushima.*
      - *forma* Tokonatsu, m. .... *Tokonatsu.*
      - *forma* Yugure, m. .... *Yūgure.*
      - *forma* Nokibata, m. .... *Nokibata.*
      - *forma* Kihachijo, m. .... *Kihachijō.*
      - *forma* Kageorinisiki, m. .... *Kageorinishiki.*
      - *forma* Siguresome, m. .... *Shigurezome.*
      - *forma* Takinogawa, m. .... *Takinogawa.*
      - *forma* Kurabuyama, m. .... *Kurabuyama.*
      - *forma* Awoba, m .... *Aoba.*
      - *forma* Karukaya, m. .... *Karukaya.*
      - *forma* Murasakitaka, m. .... *Murasakitaka.*
      - *forma* Asaji, m. .... *Asaji.*
      - *forma* Akegarasu, m. .... *Akegarasu.*
      - *forma* Murehibari, m. .... *Murehibari.*
    - *svar.* heterolobum, m.
      - *forma* Wabibito, m. .... *Wabibito.*
      - *forma* Sensunagasi, m. .... *Sensunagashi.*
      - *forma* Hibari, m.
    - *svar.* dissectum, (Thg.) m.

1. multifidum, m.
forma Awosidare, m. ....*Aoshidare.*
forma Tamukeyama, m. ......*Chirimen-momiji.*
2. palmatisectum, m.
forma Matsukaze, m. ....*Matsukaze.*
forma Ohsiusidare, m. ....*Ohshyushidare.*
svar. sessilifolium, m..............................*Hagoromo-kaede.*

Sect. 11. **Integrifolia**, Pax.

25. Acer oblongum, Wall. ....*Kusunoha-kaede.*

Sect. 12. **Trifoliata**, Pax.

26. Acer nikoense, Max...................*Chōjanoki*, *Ohmitsude-kaede.*

Sect. 13. **Platanoidea**, Pax.

27. Acer Miyabei, Max. ....*Kurobi-itaya.*
28. Acer pictum, Thunb.
α. typicum, Gr. v. Schw.
svar. eupictum, Pax....................................*Itaya-kaede.*
svar. mono, (Max.) Pax. ....*Itaya-kaede.*
svar. Savatieri, Pax. ....*Itomaki-itaya.*
forma septenlobum, m.
forma novemlobum, m.
svar. Mayri (G. v. Schw.) m. ....*Itaya-kaede.*
svar. Futagoyama, m.
β. Paxii, Gr. v. Schw. ....*Oni-itaya.*
γ. dissectum, Wesmael.............................. .*Asahi-kaede.*
svar. subtrifidum, Mak...........................*Yaguruma-kaede.*
δ. glaucum, m...*Urajiro-itaya.*
svar. latilobum, m..........................*Urajiro-itomaki-itaya.*

Sect. 14. **Diabolica**, Koidz.

29. Acer diabolicum, Bl. ....*Kaji-kaede*, *Oni-momiji.*

Descriptiones Specierum Aceris Japoniae.

I. Intrastaminalia, Pax.

Instrastaminalia, Pax, in Engl. Bot. Jahrb. VI. (1885) p. 327. (*Perigyna*, Pax, l. c. pro parte.)

Sect. 1. *Parviflora*. m.

Inflorescentia andro-polygama, elongato-paniculata. Flores pentameri. Stamina 8, in flore ♂ perigyni; antheris scabris. Discus intrastaminalis. Stylus bipartitus. Folia membranacea, palmatilobata. Species unica.

1. **Acer parviflorum,** Fr. et Sav. (Tab. I.)

Fr. et Sav. En. Pl. Jap. II. (1879) p. 321;—Max. Mel. Biol. X. (1880) 595;—Pax, in Engl. Bot. Jahrb. VII. (1886) p. 247, et Engl. Pfl. Reich, 8 Heft (IV. 163), (1902) p. 49;—C. K. Schn. Ill. Handb. Laubh. II. (1907) p. 236;—Leveil. Bull. Soc. Bot. Fr. VI. (1906) p. 592.

A. pennsylvanicum, var. *parviflorum*, Wesmael, in Bull. Soc. Bot. Belgique XXIX. (1890) 62.

Nom. jap. *Tetsu-kaede* (草木名寄), *Tetsu-no-ki* (ibid.)

Arbusculus vel arbor; ramulis novellis, foliis inflorescentibusque rufo-pubescentibus, cito glabriusculis. Folia membranacea, adulta ad axillas costarum tantum rufo-barbarta, aequilonga (6—20 cm.) ac lata; ambitu quadrangulata, sed in foliis trilobatis ovata; basi cordata, 5-lobata; lobis triangulari-ovatis breve acuminatis, duplicato-serratis; extimis valde abbreviatis; petiolis elongatis basi parum dilatatis. Inflorecentia spicato-paniculata; floribus andro-polygamis, foliis coaetaneis; pedicellis ebracteolatis, minute puberulentibus. Calyx extus ciliolatus; limbis 5, ovatis obtusis. Petala 5, alba v. lutescentia, oblonga obtusa, quam sepala breviora. Stamina 8; filamentis subulatis glabris; antheris scabris. Discus crenatus, intrastaminalis. Ovarium puberulento-tomentosum; stylis ad basin bipartitis; stigmatibus revolutis. Samarae loculi rufo-tomentelli; alis angulo obtuso divergentibus.

Obs. Julio—Augusto fl., Augusto—Octobri fr.

Hab. in sylvis montuosis insulae Hondō et Sikoku; Hondō: Kurikomayama (Rikuzen), Ōtōge, Gassan, Hagurosan, Iidesan, Azumasan (Uzen), Simizutōge (Simotsuke), Myōkōsan, Kurobeyama (Yechigo), Togakusiyama (Sinano), Fujisan (Suruga), Sikok: Tsurugiyama (Awa).

Distr. endemica.

Sect. 2. *Indivisa*, Pax.

Indivisa, Pax, in Engl. Bot. Jahrb, VI (1885) 327. VII. (1886) 210.

Inflorescentia racemosa. Flores andro-dioeci vel-monoeci. Sepala petalisque 5. Stamina 8, hypogyna, in flore ♂ perigyna. Petala rarius eroso-serrata. Discus intrastaminalis. Stylus profunde bilobatus. Folia membranacea, indivisa, saepe subtrilobata immixta, utrinque pauci—pluri costata.

Species ad 6, Hondoensis, Sikokuensis, Kiusiuensis, et Formosae incolae.

Clavis specierum dichotoma.

1. Folia elliptica, glabra, crenata; samarae loculi ferrugineo-tomentosa.......................................*A. distylum*, S. et Z.
   Folia ovata acuminata; samarae glabrae. 2
2. Folia nunquam trilobata. 3
   Folia saepe triloba immixta..................................4
3. Folia crenulata nunquam dentato-lobulata.....*A. ovatifolium*, m.
   Folia serrata, saepe inciso-serrata; serraturis subito acutis patentibusque; petalis eroso-serratis. ....*A. Kawakamii*, m.
4. Folia inciso-serrata; serraturis inaequalibus, plerumque incurvatisque; petalis eroso-serratis........*A. insulare*, Makino.
   Petala integra; foliis serraturis patentibus........................5
5. Florum pedicellis glabris; folia ab initio glabra, subtus glaucescentes, saepius distincte trilobata; alae samarae horizontaliter patentes. ....*A. crataegifolium*, S. et Z.
   Florum pedicellis puberulentibus; folia juniora ad venas puberula, leviter trilobata............*A. morrisonense*, Hayata.

2. **Acer distylum**, S. et Z. (Tab. II.)

Siebold, et Zuccarini, Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2 (1846) 154;—Miq. Prol. Fl. Jap. (1866). 21;—Walp. Ann. I (1846) 960;—Fr. et Sav. En. Pl. Jap. I. (1875) 89;—Max. Mél. Biol. X (1880) 595;—Pax, in Engl. Bot. Jahrb. VII (1886) 216, et Engl. Pfl. Reich. 8 Heft (1902) 34;—Leveil. in Bull. Soc. Bot. Fran. VI (1906) 590;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 217.

Nom. Jap. *Hitotsuba-kaede* (nom. vulg.) *Maruba-kaede*, *Itago-kaede*, *Chidori-no-ki*. (天保三年 飯沼欲齋著 草木圖説 1832.)

Arbor; ramulis juvenilibus ferrugineo-tomentosis; gemmae perulis chartaceis, ovato-lanceolatis, extus ferrugineo-pubescentibus praeditae. Folia membranacea, juniora petiolisque ferrugineo-tomentosa, mox glabra, ovato-elliptica, crenata, apice subito breve acuminata, basi cordata. Inflorescentia foliis coaetanea, subcomplicato-racemosa, ferrugineo-tomentosa: floribus androdioeciis. Calyx 5-fidus, laciniis utrinque puberulento-tomentosis, oblongis, apice rotundatis. Petala 5, alba vel lutescentia, oblonga basi parum angustata, apice rotundata, sepalis aequilonga. Discus bene annulato-evolutus, intrastaminalis. Stamina plerumque 8, in flore ♂ leviter exerta, antheris laevibus. Ovarium dense puberulento-tomentosum, stylis ad basin bipartitis, laciniis subulatis. Samarae loculi ovato-oblongi, ferrugineo-tomentosi; alis angulo obtuse divergentibus.

Obs. Maio—Junio fl., Augusto—Septembri fr.

Hab. in sylvis insulae Nippon: Hayachine, Sengantōge (Rikuchiu), Kurikomayama (Rikuzen), Azumasan (Uzen), Aidzu (Iwashiro), Nikkō (Shimotsuke), Togakushiyama (Shinano), Chichibu (Musashi), Ohyama (Sagami), Ibukiyama (Ohmi).

Distr. endemica.

3. **Acer crataegifolium**, S. et Z. (Tab. III.)

Sieb. et Zucc. Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1846), p. 155, et Fl. Jap. II. (1870), 84. t. 147;—Miq, Prol. Fl. Jap. (1866), 21;—Fr. et Sav. En. Pl. Jap. I. (1875), 89;—Max. Mél. Biol. X. (1880), 596;—Pax, Engl. Bot. Jahrb. VII. (1886), p. 248, et Engl. Pfl. Reich. 8 Heft (1902). p. 36;—Leveil. et Vnt. Bull. Soc. Bot. Fr. VI. (1906), p. 590;—C. K. Schn. Ill. Handb. Laubh. II. (1907), 216.

A. crataegifolium, 2. *typicum*, Graf. v. Schw. in Gartenfl. (1893) 455;—Pax. Pfl. Reich. l c. 36.

A, *cucullobracteatum*, Leveil. et Vnt. l c. 59, Nom. Jap. *Shirahashinoki* (享保十二年. 江村如圭著. 聚芳帯圖左編. 1727);—*Hana-kaede* (寳永五年. 貝原益軒著, 大和本草. 1708;—*Yama-kaede* (大和木經);—*Hon-uri* (信州馬籠);—*Shira-kaede* (天保八年. 畔田翠山著. 紀南六郡志. 1837);—*Ao-uri* (Indigenis nikkoensis et chichibuensis vocatur);—*Me-urinoki*, *Uri-kaede*, *Ko-urikaede* (J. Matsumura, Shokubutsu-Meii, no. 30).

Arbor; ramulis novis ferrugineo-pubescentibus, mox glabris. Gemmae perulae anguste vel spathulato-oblongae, parce pilosae. Folia membranacea, glabra; nascentia praesertim ad axillas nervorum ferrugineo-tomentosa; subtus glauca vel glaucescentia, ovata acuminata, basi cordata, inciso-serrata saepius leviter trilobata, utrinque pauci(4—6)—costata; acuminibus acutis vel obtusiusculis; petiolis gracilibus. Inflorescentia racemosa, foliis coaetanea; pedicellis glabris; floribus luteis, andro-dioeciis. Calyx 5-fidus, extus glaber; laciniis oblongis apice rotundatis. Petala 5 oblonga sepalis parum longiora. Stamina 8, inclusa; antheris rotundatis laevibus. Discus carnosus, intrastaminalis. Ovaria glabra; stylis profounde bilobatis, laciniis subulatis revolutis. Samara glabra, loculis reticulato-nervosis, roseo-coloratis, pulcherrimis; alis horizontaliter patentibus, 6—8 mm. latis. Maio—Junio fl., Augusto fr.

Hab. in Hondo: Hayachine (Rikuchiu), Aidzu (Iwashiro), Nikko (Shimotsuke), Akagisan (Kōdzuke), Chichibu, Tamagawa (Musashi), Norikurasan, Ontakesan (Shinano), Komono (Ise), Kōyasan (Kii), Prov. Swō, Tottori (Inaba), Prov. Yamato. Kiusiu: Hikosan (Buzen).

var. **Veitchii**, Nichols. in Gard. Chron. (1881), II. 75;—Pax, Engl. pfl. Reich. l. c. 37.

Nom. Jap. *Fueri-kourikaede* (nom. nov.)

Folia juvenilia roseo- demum albo-marmorata, inprimis secus marginem.

Hab. culta.

Distr. sp. endemica.

4. **Acer insulare**, Makino. (Tab. IV.)

T. Makino, in Bot. Mag. Tokyo, XXIV. (1910) 293.

A. rufinerve, ENGL. Bot. Jahrb. VI. 59;—MATSUM. et ITO, Tent. Fl. Lutch. I. 120;—FORB. et HEMSL. Jour. Lin. Soc. XXIII. 142 (non S. et Z.)

A. caudatum, MATSUM. Bot. Mag. Tokyo, XII. (1898) 63;—MATSUM. et ITO, l. c. 120 (*non* WALL.)

Arbor ramis glabris, cortice lutescenti-viride. Folia membranacea, adulta glabra, juniora subtus secus costas et in axillis nervorum ferrugineo-pubescentia, ovata ovali-ovata, utrinque 5—7 costata, basi cordata vel subcordata, apice longe acuminata, margine inaequaliter, vel interdum subinciso-serrata; serraturis plerumque incumbentibus; 7—14 cm. longa, 4—14 cm. lata; petiolis mox glabris 2,5—9 cm. longis. Inflorescentia elongato-racemosa, circ. 8 cm. longa, parce ferrugineo-pubescentes; pedicellis filiformibus 3—8 cm. longis; floribus foliis coaetaneis, circ. 10 mm. in diametro. Calyx extus parce puberulens; sepalis 5, lineari-oblongis, obtusis vel acutiusculis, circ. 3 mm. longis. Petala 5, cuneato-oblanceolata, obtusa vel acutiuscula, eroso-serrata, 4,5—5,5 mm. longa. Discus crenatus, intrastaminalis. Stamina 8, filamentis subulatis, antheris ellipticis. Ovaria puberulento-tomentosa; stylis profunde bilobatis, laciniis revolutis. Fructus glaber, circ 24 mm. longa; alae angulo obtuso vel obtusissimo divergentes.

NOM. JAP. *Shima-urikaede* (T. MAKINO.)

HAB. Kiusiu: Prov. Ohsumi, insul. Yakushima, insul. Amami-Ohshima.

5. **Acer Kawakamii**, KOIDZ. (Tab. V.)

KOIDZ. in Bot. Mag. Tokyō, XXV. no. 290 (Mart. 1911) p. 102.

A. caudatum, MATSUM. et HAY. En. Pl. Formos. (1905) 96 (*non* WALL.)

A. caudatifolium, HAYAT. in Jour. Coll. Sci. Tokyō, XXX. 1. (Jun. 1911) p. 65.

Arbor; ramulis ab initio glabris; gemmae acutae pauci-perulatae. Folia membranacea, glabra, juniora subtus in nervis parce et ad axillas costarum copiose rufo-puberula, ovata vel ovato-oblonga, caudato-acuminata, basi aperte cordata, subaequaliter serrata, sublobulata immixta; serraturis patentibus; basi 5-nervata ceterum 4—6 penninervia, 6—10 cm. longa, 3—4.5 cm. lata; petiolis gracilibus limbo brevioribus, 3—5 cm. longis. Racemus sat multiflorus, glaber vel parce pube rufescenti tectus; floribus andro-dioeciis, foliis coaetaneis. Sepala 5, obovata obtusa. Petala 5, subspathulata, quam sepala longiora, circ. 3—3.5 mm. longa, eroso-serrata. Discus intrastaminalis. Ovarium glabrum; stylis quam stigmata revoluta brevioribus. Samarae cum loculis 20—22 mm. longae; alis angulo obtuso divergentibus.

NOM. JAP. *Onaga-kaede* (M. SHIRAI)

HAB. in sylvis temperatis Formosae: Arisan, Hakkutaisan.

DISTR. endemica.

Nota, species arcte affinis *A. laxifloro*, PAX, ab hoc diversa petalis spathulatis eroso-serratis; foliis non crenulatis.

6. **Acer ovatifolium**, sp. nov. (Tab. VI.)

Arbor; cortice ramulorum laevi, luteo-viride. Folia membranacea, adulta utrinque glabra, ovata rarius ovato-oblonga, caudato-acuminata, basi rotundata vel aperte cordata, margine minute crenulato-serrulata v. crenulata, interdum sublobulata immixta, basi 5-nervata ceterum 5—6 penninervia; petiolis glabris 1.5—2.0 cm. longis. Inflorescentia andro-dioecia, multiflora, racemosa, dense ferrugineo-tomentella. Flores.............. Fructus glaber, circ. 1.5 cm. longus, alae angulo recto vel obtuso divergentes; pedicellis brevibus 4—5 mm. longis.

NOM. JAP. *Koba-onaga-kaede* (nom. nov.)

HAB. in sylvis temperatis Formosae: Akō (Yokusensha).

Nota. Species ab *A. Hookeri*, MIQ. quocum junxit, distinctissima ist foliis minoribus 4.5—6.5 cm. longis, 2—3 cm. latis, minute crenulatisque.

7. **Acer morrisonense**, HAYATA, sp. nov. (Tab. VII.)

Arbor; ramis glabris nigro-viridescentibus; ramulis juvenilibus parce rufo-puberulis. Gemmae ovatae perulis paucis praeditae. Folia membranacea, cito glabra, juniora utrinque praesertim subtus secus nervos rufo-puberula, leviter triloba vel trilobatisve, rarius indivisa immixta, basi aperte cordata, apice longe acuminata, subduplicato-serrulata, utrinque 5—6-costata, 6—11 cm. longa, 3—7 cm. lata; lobis lateralibus multo minoribus obtusis; petiolis gracilibus 3—4 cm. longis. Flores andro-dioeci, in racemum pendulum parce puberulum, ramulo bifoliato insidentem dispositi; pedicellis capilliformibus ad 8 mm. longis. Sepala 5 ovata, obtusa, virescentia. Petala 5 sepalis aequilonga, rotundato-ovata, flavescentia. Stamina 8, antheris laevibus; filamentis subulatis glabris. Discus lobatus intrastaminalis. Fructus.........

Nom. Jap. *Takasago-urikaede.* (nom. nov.)

Hab. Formosa: in monte Morrison.

Distr. endemica.

Nota. Species affine videtur *A. crataegifolio*, S. et Z., sed ab hoc et a reliquis speciebus *Indivisorum* foliis saepius leviter trilobis, utrinque viridibus, subtus tenuissime reticulatis manifeste distincta.

Sect. 3. *Carpinifolia*, m.

Inflorescentia racemosa, ♂ saepe umbellata vel subcorymbosa. Flores tetrameri, andro-dioeci. Sepala 4. Petala 4. Stamina 5—6, hypogyna. Discus intrastaminalis. Stylus ad basin partitus, laciniis subulato-curvatis. Folia membranacea, utrinque multicostata.

Species unica Japonensis.

8. **Acer carpinifolium**, S. et Z. (Tab. VIII.)

Siebold et Zuccarini, Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1846) 154, et Fl. Jap. II. (1870) 81, t. 142;—Fr. et Sav. En. Pl. Jap. I. (1875) 89;—Miq. Prol. Fl. Jap. (1866) 21;—Max. Mél. Biol. X. (1880) 595;—Pax, in Engl. Bot. Jahrb. VII. (1886) 217, et Engl. Pfl. Reich. 8 Heft (1902) 34;—Leveil. Bull. Soc. Bot. Fr. VI (1906) 589;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 215.

Nom. Jap. *Yamashiba-kaede*, *Chidorinoki*, *Shirashide* (大和木程); *Shiro-shide* (天保七年. 畔田翠嶽著. 金岳草木志. 1836);—*Taniasa* (天保三年. (飯沼慾齋著. 草木圖說. 1833);—*Arahago*, *Tsubanoki* (indigenis Chichibuensis vocatur).

Arbor; ramulis novellis glabris vel sparce villosis, cortice ramorum cinereo-fusescente. Gemmae perulae intimae membranaceae oblanceolatae acuminatae versus basin valde angustatae. Folia membranacea, supra mox glabra, subtus praesertim ad venas adpresse pubescentia, oblonga, acuminata, basi rotundata saepe leviter cordata vel subauriculata, utrinque argute incisoserrata, parallele multi-costulata; petiolis brevibus glabris. Inflorescentia foliis coaetanea, laxe puberula. Flores andro-dioeci, albi vel lutescentes, ♂ longe racemosi; ♀ umbellati, corymboso-cymosi, vel racemosi; pedicellis capilliformibus tenuissimis. Calyx extus ciliatus; sepalis 4 oblongis apice rotundatis. Petala 4, oblonga apice obtusa, saepissime ciliolata, sepalis aequilonga, in floribus ♂ caduca. Stamina 5—6 inclusa; antheris laevibus. Discus lobatus intrastaminalis. Ovarium margine pilosum, ceterum glaberrimum; stylis brevissimis subnullis; stigmatibus elongatis subulatis. Samara glabra, loculis planis ovatis; alis angulo obtuso divergentibus; pedicellis elongato-capilliformibus, fere saemper nutantibus.

Hab. Hondō: Nambu (Rikuchiu), Aizu (Iwashiro), Nikko (Shimotsuke), Chichibu, Ohdake (Musashi), Ohyama, Hakone (Sagami), Usuitōge, Ontake, Toriitōge, Hōfukujitōge, Togakushiyama, (Shinano), Amagisan, (Idzu) Prov. Kii, Prov. Nagato. Sikok: Prov. Tosa; Prov. Awa. Kiusiu: Kudshusan.

Distr. endemica.

Nota. Folia ad 16.5 cm. longa, 8.5 cm. lata; samara ad 3 cm. longa, 1.3 cm. lata.

Sect. 4. *Macrantha*, Pax.

Macrantha, Pax, in Engl. Bot. Jahrb. VI. (1885) 328, et VII. (1886) 244.

Inflorescentia racemosa. Flores andro-dioeci vel monoeci, pentameri. Stamina 8 hypogyna, in flore ♂ perigyna. Discus intrastaminalis. Antherae laevae, ellipticae. Ovaria pl. m. puberulento-tomentosa; stylis profunde bilobatis. Folia membranacea, 3—5-palmatilobata, inaequaliter serrata.

Clavis specierum.

1. Folia trilobata, rarius simul sub pentaloba immixta............2
   Folia quinquelobata...3
2. Folia ambitu obovata, subtus ad venas inflorescentiaque rufo-ferruginea. Flores mediocres, pedicellis brevibus. Fructus alae 16—20 mm. longae, 10 (7—10) mm. latae. ....
   ....*A. rufinerve*, S. et Z.
   Felia ambitu ovata glabra. Flores minuti, pedicellis gracile elongatis, circ. 10 mm. longis. Fructus alae circ 5 mm. latae, 10 mm. longae. ....*A. capillipes*, MAX.
3. Folia glabra, 5-nervata, ceterum 6—11-penninervia; lobis acuminatis. Fructus pedicelli capilliformes 10—12 mm. longi. ....*A. capillipes*, var. *fujisanense*, m.
   Folia juniora subtus rufo-hirta, 5-nervata, ceterum 4—5 penninervia; lobis caudato-acuminatissimis. Fructus pedicelli 7—10 mm. longi; alis majoribus ....
   ....*A. rubescens*, HAYATA.

9. **Acer rufinerve**, S. et Z. (Tab. IX).

SIEBOLD et ZUCCARINI, Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1845) 155, et Fl. Jap. II. (1870) 85, t. 143 ;—MIQ. Prol. Fl. Jap. (1866) 20 ;—KOCH in Ann. Mus. Lugd. Bat I. (1863—64) 251 ;—WALP. Ann. I. 961 ;—MAX. Mél. Biol. X. (1880) 595 ;—PAX, in ENGL. Bot. Jahrb. VII. (1886) 247, et ENGL. Pfl. Reich. 8 Heft (1902) 69 ;—FR. et SAV. En. Pl. Jap. I. (1875) 89 ;—LEVEIL. Bull. Soc. Bot. Fr. VI. (1906). 593 ;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 237.

A. pennsylvanicum, var. *rufinerve*, WESML. in Bull. Soc. Bot. Belgique, XXIX. (2890) 62.

A. rufinerve, forma *normale*, GR. v. SCHW. in Gartfl. (1893) 454.

NOM. JAP. *Urihada-kaede* (藥物籤);—*Iizuku*, *Konjinoki* (文政七年. 岩崎常正著. 日光山草木圖. 1825);—*Kōmori-kaede*, *Ohba-urinoki* (文政八年. 水谷助六著. 物品識名拾遺.) 1826;—*Ao-kaede*, *Oh-minekaede* (天保八年. 畔田翠山著. 紀南六郡志. 1837);—*Urikko* (北越產物寫眞);—*Ao-momiji* (享和元年. 小野蘭山著. 常野採藥記. 1801); *Uri-i* (nom. indig. Chichibuensis); *Oh-urikaede* (J. MATSUMURA, Shokubutsu-Meii, no. 45); *Urinoki* (indig. Provinciae Settsu vocatur).

Arbor vel arbusculus, ramis laevibus, cortice luteo-viridescente nigricanto-striato; ramulis novellis glabris; gemmae perulae spathulato-oblongae extus rufo-tomentosae. Folia membranacea, subtus secus nervos, mox ad venarum axillas tantum rufo-barbarta, ambitu obovata, basi leviter cordata vel rotundata, triloba, vel quinquelobata si lobis basalibus adsunt minimis, inciso-vel subduplicato-serratis; petiolis demum glabris. Racemi foliis coaetanei rufo-pubescentes; floribus sulphureis glabris, androdioeciis; pedicellis ebracteatis, flore minoribus circ. 3—5 mm. longis. Sepala 5 spathulato-oblonga, apice rotundata. Petala 5, obovato-oblonga apice emarginata vel rotundata, sepalis aequilonga. Stamina 3, inclusa, antheris laevibus. Discus intrastaminalis, margine crenato, intus glaber. Ovaria puberulento-tomentella; stylis bifidis, laciniis subulatis intus longe stigmatosis. Alae samarae 5 m.m. latae, 10 m.m. longae, subparallelae vel angulo acuto interdum fere recto divergentes, loculis rufo-tomentellis multo longiores. Maio fl., Augusto fr. mat..

HAB. Hando: Nanshōzan, Himekamiyama, Iwatesan, Goyōzan (Rikuchiu), Chōkaizan (Ugo), Azumasan, Gassan, Asahidake, Ichinenhō, Iidesan (Uzen), Aizu (Iwashiro), Nikko, Shimidzutōge (Shimotsuke), Hakone (Sagami), Amagisan (Idzu), Fujisan (Suruga), Hakusan (Kaga), Tateyama (Yettchiu), Kasugasan (Yamato), Prov. Nagato.—Shikok: Prov. Awa, Tosa, Sanuki.—Kiusiu: Iwatake (Buzen).

DISTR. endemica.

Nota. Affine *Acer pennsylvanico*, et *A. tegmentoso*, sed a priori pedicellis florum rufo-pubescentibus; fructus loculis quam ala multo-brevioribus, fructus pedicellis haud ultra 5 mm. longis; ab altero foliis fructibusque non glabris differt.

forma **albo-limbatum**, HOOK. fil. in Bot. Mag. (1869), t. 5793;—PAX, ENGL. Pfl. Reich. 8 Heft (1902) 69.

A. rufinerve, f. *marginatum*, et *marmoratum*, PAX, in ENGL. Bot. Jahrb. VII. (1886) 247.

Folia albo-pulverulento-marginata vel -maculata glabriuscula; racemis glabris vel rarius parce puberulis, pedicellis inferioribus longioribus circ. 10 mm. longis; fructibus glabris alis angulo obtuso divergentibus.

NOM. JAP. *Fuiri-urihadakaede* (nom. nov.)
Hatsuyuki-kaede (hort. nom.)

HAB. culta.

10. **Acer capillipes**, MAX. (Tab. X.)

C. J. MAXIMOWICZ, in M. l. Biol. VI. (1867) 367, et X. (1880) 593;—FR. et SAV. En. Pl. Jap. I. (1875) 88:—PAX, in ENGL. Bot. Jahrb. VII. (1886) 246, et Pfl. Reich. 8 Heft (1902) 67;—LEVEIL. in Bull. Soc. Bot Franc. VI. (1806) 589;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 238;—MAKINO, in Bot. Mag. Tokyo XXIV (1910) p. 292.

A. pennsylvanicum, var. *capillipes*, WESMAEL in Bull. Soc. Bot. Belgique, XXIX. (1890) 62.

NOM. JAP. *Oh-karabana* (文政七年. 岩崎常正著. 日光山草木圖. 1825);—*Hosoe-kaede* (R. YATABE 日本植物編. vol. I. (1900) p. 411.);—*Ashiboso-urinoki* (M. SHIRAI 日本機樹ノ種類 1908.);—*Hosoe-urihada* (nom. nov.)

Arbor glaber 10 metralis. Ramuli cortice laeve, luteo-viridiscente nigricanto-striato. Folia membranacea ambitu ovata, trilobata rarius subquinquelobata, basi rotundata, lobis lateralibus valde minoribus, omnibus acuminatis subduplicato-serratis serraturis ovatis mucronatis; petiolis quam limbo brevioribus basi parum incrassatis. Flores andro-dioeci, foliis coaetanei, minuti, in racemum multiflorum pendentem, elongatum, pedunculo 3—5 cm. longo insidentem dispositi; pedicellis capilliformibus circ. 10 mm. longis. Sepala oblonga obtusa virescentia. Petala oblonga sepalis aequilonga lutescentia. Stamina 8 antheris laevibus. Discus intrastaminalis, margine crenato. Ovaria parce puberula, stylis bifidis, stigmatibus subulatis exertis. Samara cum loculis 13-14 mm. longa, ad 4—5 mm. lata; alis angulo obtuso divergentibus; pedicellis 10-12 mm. longis.

HAB. in sylvis Hondō: Nikkō, Ontakesan, Fujisan.

DISTR. endemica.

var. **fujisanense**, m.

Folia ambitu subquadrangulata, distincte quinquelobata lobis extimis multo minoribus.

NOM. JAP. *Hiroha-ashiboso-urinoki.*

HAB. Fujiyama.

11. **Acer rubescens**, HAYATA, sp. nov. (Tab. XI.)

Arbor, rami purpureo-viridi glabri; gemmae magnae ovoideae pauci-perulatae. Folia membranacea, elongato-petiolata, juniora ad basin costarum subtus rufo-barbarta, mox glabra, ambitu rotundato vel subquadrangulato-ovata, quinquelobata, basi cordata pentanervia, ceterum 4—5 penninervia, 6—9 cm. longa 4—7 cm. lata; lobis inaequaliter serratis caudato-acuminatis: petiolis gracile elongatis, laminae aequantibus vel paulo brevioribus. Inflorescentia in ramulis 2 foliatis terminalis, fructifera glabra elongato-racemosa. Flores ut videtur andro-dioeci, graciliter pedicellati. Fructus in racemum pendulum circiter ad 8 cm. longum dispositi. Samarae plerumque 1,3 cm. longae (raro ad 1,7 cm. longae), loculis ovoideis 3(—5) mm. longis, convexis, parce venosis; alis horizontalibus vel angulo obtusissimo divergentibus, medio 4—5 mm. latis, basi contractis; pedicellis capilliformibus 7—10 mm. longis.

NOM. JAP. *Takasago-urihadakaede* (nom. nov.)

HAB. in sylvis temperatis Formosae: in monte Morrison (ad 7000—7500 ft. alt.), Hokkutaisan, Arisan, Kanmutsusha.

DISTR. endemica.

Not. Species affinis *Acer capillipes*, var. *fujisanensi*, KOIDZ., distinguitur foliis junioribus parce hirtis, utrinque 5—6 penninervis, lobis caudato-acuminatissimis; fructibus pedicellis brevioribus.

Sect. 5. *Palmatoidea*, m.

Inflorescentia racemosa. Flores andro-dioeci vel monoeci. Sepala petalisque quinque. Stamina 8 hypogyna, in fl. ♂ perigyna; antheris leviter scabris, ovoideis apiculatis. Ovaria glabra; stylis apice bilobatis. Discus intrastaminalis. Folia membranacea profunde 5-lobata, lobis incisis vel lobulatis. Species ad 3 Japoniae et Sinensis.

Clavis specierum dichotoma.

* Racemus 15—22-floratus, floribus minutis, sepalis suborbiculatis, petalis ellipticis: fructus minor 13—20 mm. longus, (3—) 4—6 mm. latus..................*A. micranthum*, S. et Z.

** Racemus 6—10-floratus, floribus mediocribus, sepala petalisque anguste spathulata; fructus major 20—25 mm. longus, 6—12 mm. latus. ....*A. Tschonoskii*, Max.

12. **Acer micranthum**, S. et Z. (Tab. XII.)

Siebold et Zuccarini, Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1845) 155, et Fl. Jap. II. (1870) 80, t. 141 ;—Miq. Prol. Fl. Jap. (1866) 21 ;—Fr. et Sav. En. Pl. Jap. I. (1875) 89 ;—Max. Mél. Biol. X. (1880) 598 ;—Pax, Engl. Bot. Jahrb. VII. (1886), 248, et Engl. Pfl. Reich. 8 Heft (1902) 70 ;—C. K. Schn. Ill. Handb. Laubh. II. (1902) 239 ;—Leveil. in Bull. Soc. Bot. Fr. VI. (1906)., 591.

A. Tschonoskii, Komaro. (*non* Max.) Fl. Man. II. 735 (vidi specim) ;—Nakai, Fl. Korea. I. 134.

Nom. Jap. *Ko-mine-kaede* (J. Matsumura, Shokubutsu-Meii, no. 35.)

Arbuscula, ramis glabris viridescentibus; gemmae tegmentis interioribus obovato-oblongis vel late spathulatis apice rotundatis, utrinque glabris, marginibus ciliolatis praeditae. Folia membranacea glabra vel subtus in axillis costarum rarius secus nervos rufo-barbulata, palmato-quinquelobata, basi cordata; lobis extimis abbreviatis ceterum lanceolato-ellipticis vel ovato-lanceolatis, caudato-acuminatis argute serratis, omnibus utrinque incisis; petiolis gracilibus quam lamina brevioribus. Racemus glaber circiter 15—22 florus; floribus minutis pallide roseis, foliis coaetaneis, androdioeciis. Sepala minuta ovata vel rotundata, quam petala 2—3-plo breviora. Petala obovata vel obovato-elliptica 1,5—3,0 mm. longa. Stamina 8 in sinubus disci inserta, exerta; antheris vix scabris apiculatis. Discus crenatus intrastaminalis. Ovaria glabra, stylis apice bilobatis. Samara glabra 13—20 mm. longa (3—) 4—6 mm. lata; alis cum loculis horizontaliter vel obtusissime patentibus.

Hab. in sylva. Hondo: Sengantōge, Himekamiyama, Omyōjin (Rikuchiu), Gassan, Adzumasan (Uzen), Aidzu, Bandaisan (Iwashiro), Nikko (Shimotsuke), Mitsuminesan (Musashi), Hakone (Sagami), Amagisan (Idzu), Obara (Yettchiū), Tateyama (Kaga), Kiso (Shinano), Shikok: Tsurugisan (Awa), Yahazuyama, Nanogawamura (Tosa);—Kiusiu: Hikosan (Buzen), Hōmanzan.

Distr. Korea, Manshuria.

Not. Affine *A. Maximowiczii*, Pax, et *Acer Tschonoskii*, Max.

sed a priori foliis lobis inter se fere aequantibus; ab altero floribus minutis; foliis lobis caudato-acuminatissimis; fructibus minoribus, alis horizontaliter patentibus differt.

13. **Acer Tschonoskii**, MAX. (Tab. XIII.)

C. J. MAXIMOWICZ, in Mél. Biol. XII. (1886) 432;—PAX, in ENGL. Pfl. Reich. 8 Heft (1902) 70;

A. pellucidobracteatum, LEVEIL. et VNT. in Bull. Soc. Bot. Fr. VI. (1906), 592.

NOM. JAP. *Mine-kaede*, *Hime-ogarabana* (J. MATSUMURA, Shokubutsu-Meii, no. 49);—*Hakusan-momiji* (北越卉牒).

Arbusculus dumosus, ramuli viridescentes glabri, gemmae tegmentis interioribus ut in praecedente. Folia membranacea supra glabra subtus ad nervos, vel rarius adulta tantum in axillis costarum rufo-barbarta, palmato quinquelobata, basi cordata; lobis ovalibus subito breve acuminatis, argute serratis utrinque sublobulato-incisis; petiolis gracilibus quam lamina brevioribus. Flores andro-monoeci, 5-meri, in racemum circiter 6—10 (—13) florum erectum, pedunculo 2—3 cm. longo insidentem dispositi; pedicelli glabri; sepala 5 lineari-spathulata, obtusa; petala 5, sepalis conformia, pallide rosea, sed parum superantia, 4—4,5 mm. longa; stamina 8 petalis subaequilonga; discus leviter crenatus intrastaminalis; ovaria glabra stylo stigmatibus revolutis vix longiore. Samara loculis horizontalibus; alis in angulo obtuso divergentibus; 20—25 mm. longae, 6—12 mm. latae.

HAB. in subalpinis Japoniae mediae et borealis. Yezo: Raidentōge, Makkarinupuri, Prov Tokachi, Yunosawa.—Hontō: Iwakisan Hakkōdasan (Mutsu), Iwateyama, Goyōzon, Hayachine (Rikuchiū), Kurikomayama (Rikuzen), Chōkaisan (Ugo), Gassan, Asahidake, Zaōsan, Iidesan, Azumasan (Uzen), Komagatake, Myokōzan, Niōzan (Yechigo), Osenodaira, Nikko (Shimotsuke), Togakushiyama, Ōnogawa, Ariakeyama, Norikurayama, Ontake (Shinano), Tateyama (Yettchiū), Hakusan (Kaga).

DISTR. endemica.

Nota. Affine *Acer Maximowiczii*, PAX, et *Acer micrantho*, S. et Z., sed a priori foliis lobis inter se fere subaequalibus; ab altero floribus majoribus, petalis sepalisque lineari-spathulatis 4—4,5 mm.

longis, in racemum 6—10 florum dispositis; foliis subtus plerumque secus venas rufo-barbartis, subito breve acuminatis; alis samarae obtuse divergentibus, latioribusque; fructibus majoribus 20—25 mm. longis. 6—12 mm. latis, differt.

Sect. 6. *Arguta*, Rehder.

Rehder, in Sargent, Trees and Shr. I. (1905) 181;—C. K. Schn. Ill. Handb. II. 2. (1909) 244.

Inflorescentia mascula secus ramulos elongotos e gemmis lateralibus corymboso-fasciculata; foemina semper in ramulo bifoliato terminalis, racemosa. Flores dioeci, tetrameri (sep. 4, pet. 4, stam. 4, carpel. 2). Discus intrastaminalis 4—lobatus. Stamina hypogyna. Stylus profunde bilobatus. Folia membranacea palmatilobata.

14. **Acer argutum**, Max. (Tab. XIV.)

C. J. Maximowicz, in Mél. Biol. VI. (1867) 368, et X. (1880) 594;—Fr. et Sav. En. Pl. Jap. I. (1875) 91;—Pax, in Engl. Bot. Jahrb. VII. (1886) 252, et Pfl Reich. 8 Heft (1902) 72;—Leveil. in Bull. Soc. Bot. Fr. VI. (1906) 589;—C. K. Schn. Ill. Handb. Laubh. II. (1909) 244.

A diabolicum, subsp. *argutum*, Wesmael, in Bull Soc Bot. Belgique, XXIX. (1890) 63

Nom. Jap. *Asanoha-kaede*, *Miyama-momiji* (J. Matsumura, Shokubutsu-Meii, no. 26).

Arbor ramulis novellis incano-puberulis; gemmae tegmentis interioribus oblongis vel ellipticis apice plerumque obtusis utrinque puberulis. Folia membranacea juvenilia subtus incano-pubescentia supra glabriuscula vel ad venas parce puberula, adulta tantum subtus secus costas pilosiuscula, circumscriptione orbicularia, quinquelobata basi aperte cordata, lobis ovatis acuminatis utrinque arguteinciso-serratis; petiolis gracilibus quam lamina brevioribus superne parce pilosiusculis. Inflorescentia primum corymbosa tum racemosa; floribus lutescentibus vel albis dioeciis foliis coaetaneis; pedicellis glabris gracile elongatis; bracteolis minutis. Calyx glaber, sepalis 4 anguste oblongis vel oblongolanceolatis obtusis. Petala 4 sepalis breviora. Stamina 4 (in fl. ♀ abortivi) exerta, filamentis antherisque glabris in faciebus exterioribus disci insertis. Discus carnosus 4-lobatus, in flore

♀ rudimentarius ad dentes reductus. Ovaria glabra, stylis ad basin fere bipartitis. Fructus glaber in racemum pendentem dispositi, loculis alisque horizontaliter patentibus; pedicellis gracile elongatis.

Hab. Hondo: Nikko, Ashio (Shimotsuke), Chichibu (Musashi), Ariakeyama, Togakushiyama, Kiso (Shinano), Taira-no-yu (Hida)..—Shikok: Tsurugisan (Awa).

Distr. endemica.

II. **Extrastaminalia**, Pax.

Extrastaminalia, Pax, in Engl. Bot. Jahrb. VI (1885), 326.
Adiscantha, Pax, l. c. 327.
Perigyna, Pax, l. c. 327 (pro parte)

Sect. 7. *Cissifolia*, m.

Inflorescentia elongato-racemosa. Flores dioeci minuti. Sepala petalisque 4. Stamina 4 (—5) hypogyna. Stylus profunde bilobatus. Discus extrastaminalis. Folia membranacea ternata, foliolis petiolulatis. Species unica.

15. **Acer cissifolium** (S. et Z.) Koch. (Tab. XV.)

C. Koch, in Ann. Mus. Lugd-Batav. I. (1864) 252;—Fr. et Sav. En. Pl. Jap. I. (1875) 90:—Max. Mél, Biol. X. (1880) 610;—Pax, in Engl. Bot. Jahrb. VII. (1886) 204. et Pfl. Reich. 8 Heft (1902) 29;—Leveil. in Bull. Soc. Bot. Fr. VI. (1906) 589:—C. K. Schn. Ill. Handb. Laubh. II. (1907) 210.

Negundo cissifolium, Sieb. et Zucc. Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1846) 159;—Miq. Prol. Fl. Jap. (1866) 22 (?)

Negundo (?) *nikoense*, Miq. Prol. Fl. Jap. 22. (1866).

Negundo nikoense, Miq. Archiv. Neel. t. II. (1857).

Nom. Jap. *Mitsude-kaede* (文政五年. 喜多村直子温著. 日光採品錄. 1822);—*Mitsude-momiji*, *Ammakko-kaede* (文政八年. 水谷助六著. 物品識名拾遺. 1825):—*Amakogi* (會津物產圖帳);—*Amakuki* (二本松物產圖帳).

Arbor innovatione pubescente; gemmae perulis interioribus oblongis apice rotundatis dense rufo-tomentosis. Folia membranacea trifoliolata, nascentia supra dense subtus ad costas petiolisque pubescentia, adulta utrinque glabra, aut supra pilosa et tunc subtus in axillis venarum tomentella; petiolis communis elongato-gracilibus mox glaberrimis; foliolis petiolulatis ellipticis vel oblongis saepe ovato vel obovato-oblongis interdum versus basin cuneatis aut subrhombeo-oblongis, apice in acumen longum acutum integerrimum productis, sursus pauci grosse dentato-serratis rarius incisis vel integerrimis, serraturis cuspidatis. Inflorescentia longe racemosa, pedunculis pedicellisque pubescentibus, floribus minutis lutescentibus dioeciis. Calyx 4-fidus extus puberulus, laciniis ovatis vel lanceolato-ovatis acutiusculis. Petala 4, anguste spathulata quam sepala duplo longiora. Discus extrastaminalis lobatus. Stamina 4 (—5), filamentis exertis anguste fusiformibus. Ovaria glabra, stylis brevissimis, stigmatibus recurvatis. Fructus glaber, alis angulo acuto divergentibus.

HAB. Yezo: Niikapp (Hidaka).—Hondo: Hirosaki (Mutsu), Hiraidzumi, Kukaitōge, Tsunatoriyama, Kadoma (Rikuchiū), Aidzu, Iidesan (Iwashiro), Nikko (Shimotsuke), Hakone (Sagami), Ontake, Norikuradake (Shinano), Shimokura (Bittchiu).—Sikok: Nanogawa (Tosa), Tsurugisan (Awa).

DISTR. endemica.

Sect. 8. *Rubra*, PAX.

F. PAX, in ENGL. Bot. Jahrb. VI (1885) 326, et VII. (1886) 179.

Inflorescentiae secus ramulos fasciculatae. Flores androdioeci longe folia ante nascentes. Sepala petalisque 5. Stamina 5—8 hypogyna. Discus valde abortivus. Stylus profunde bilobatus. Folia membranacea palmatilobata. Gemmae perulae interiores non elongatae. Species unica.

16. **Acer rubrum**, L. (Tab. XVI.)

LINN. Sp. Pl. ed. 1. (1753), 1055;—DC. Prodr. I. (1824) 595;—ROBINSON, in GRAY, Syn. Fl. I. (1897) 437;—PAX, in ENGL. Bot. Jahrb. VII. (1886) 181, et Pfl. Reich. 8 Heft (1902) 37;—T. NUTTAL, in North Am. Fl. (1855) II. 34;—MAKINO, in Bot. Mag. Tokyo,' XVI. (1902) 93.

A. pycnanthum, C. KOCH, in MIQ. Ann. Mus. Lugd. Batav. I. (1863–64) 250;—S. et Z. Fl. Jap. II. (1870) 86, t. 143, fig. I. et 1—4;—MIQ. Prol. Fl. Jap. (1865) 21 (p. p.);—FR. et SAV. En. Pl. Jap. I. (1875), II. (1879) 322;—MAX. Mél. Biol. X. (1880) 591;—PAX, in ENGL. Bot. Jahrb. VII. (1886) 254.

A. semiorbiculatum, PAX, l. c. (1886) 181.

Nom. Jap. *Hananoki* (文化六年. 水谷助六著. 物品識名. 1890):—*Hana-kaede* (J. Matsumura, Shokubutsu-Meii, no. 44):—*Megusuri-noki* (伊藤圭介著. 日本產物志. 近江郡. fol. 28. fig.)

Arbor magna, cortice ramulorum glaucescente; gemmae perulae coriaceae ovatae vel ovato-rotundatae obtusae intus tomentosae; innovationibus foliis junioribusque rufo-pubescentibus mox glabris. Folia chartacea, subtus intense glauca, trinervia vel subpentanervia, trilobata, indivisa immixta, basi rotundata vel leviter cordata interdum rotundato-obtusa, obtusiter acuminata, duplicato-inciso-serrata, serraturis obtusis, circ. 3—7 cm. lata 5—9 cm. longa; petiolis gracilibus ad 6 cm. longis. Flores andro-dioeci, rubri, secus ramos fasciculato-umbellati, foliis praecociores; pedicellis glabris filiformibus; perulis rubris vel coccineis. Sepala lanceolata acuta, petalis spathulatis obtusis subaequantia. Stamina 8, antheris rubris oblongis. Discus abortivus. Stigmata 2 ovario glabro inserta elongata undique papillosa. Fructus glaber, alis rectis medio latissimis in angulo acuto divergentibus.

Hab. Hondo. Prov. Mino et Ohmi.

Distr. in America boreali atlantica, a Canada ad Floridam.

Sect. 9. *Spicata*, Pax.

F. Pax, in Engl. Bot. Jahrb. VI. (1885) 326, et VII. (1886) 182.

Inflorescentia paniculata vel racemosa, interdum corymboso-paniculata. Flores andro-polygami. Sepala peatalisque 5. Stamina 8 hypogyna. Discus carnosus extrastaminalis. Folia simplica 3 vel 5—7 lobata, membranacea raro coriacea.

Claris specieram dichotoma.

1. Antherae scabrae: folia 5-lobata ....
..................................*A. spicatum*, var. *ukurunduense*, Max.
Antherae laevae. ....2.
2. Folia palmato-5-lobata argute serrulata.....*A. Oliverianum*, Pax.
Folia trilobata. ....3.

3\. Folia adulta integerrima..................*A. trifidum*. Hk. et Arn.
Folia irregulariter serrata. ....*A. Ginnala*, Max.
Folia aequaliter argute serrulata. ....
.........*A. Oliverianum*, var. *Nakaharae*, svar. *trilobatum*, m.

17. **Acer trifidum**, Hk. et Arn. (Tab. XVII.)

Hooker et Arnot, in Bot. Beech. Voy. (1841) 174 (*nec* thg);—Sieb. et Zucc. Fl. Jap. Fam. Nat in Abh. Akad. Münch. IV. 2. (1846) 157;—Walp. Ann. I. 961;—C. Koch. in Miq. Ann. Mus. Lugd. Batav. I. (1863—64) 251;—Miq. Prol. Fl. Jap. (1865) 19;—Fr. et Sav. En. Pl. Jap. I (1875) 87, II. (1879) 186;—Forb. et Hemsl. Jour. Linn. Soc. XXIII. (1886—88) 142;—Pax in Engl. Bot. Jahrb. VII. (1886) 186, et Pfl. Reich. 8 Heft (1902) 10;—Max. Mél. Biol. X. (1880) 603; —Mak. Bot. Mag. Tokyo, XV. 112;—Leveil. Bull. Soc. Bot. Fr. VI (1906) 593;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 197

A. Buergerianum, Miq. Prol. Fl. Jap. (1866) 20;—Fr. et Sav. En. Pl. Jap. I. (1875) 88.

A. palmatum, var. *trilobum*, C. Koch, in Miq. Ann. Mus. Lugd. Batav. I. (1864) 251.

A. trinerve, Dippel, Laubh. II. 428 (1892);—Pax, in Engl. Pfl. Reich, 8 Heft (1902) 12;—Mak. Bot. Mag. Tokyo, XIV. p. 136.

Nom. Jap. *Tōkaede* (nom. vulg.);—*Kakumino* (文政十二年. 伊藤圭介著. 泰西木草名疏 1829);—*Hanakazura* (文政八年. 水谷助六著. 物品識名拾遺. 1825).

Arbor magna, ramis glabris, innovationibus tomentosis. Folia nascentia pannosa, demum glabra, membranacea vel tenuiter chartacea, supra nitida subtus pallide viridia vel glaucescentia, trinervia trilobata, indivisa immixta, basi cuneata vel rotundata, lobis plerumque aequilongis plus minus acutis integerrimis rarius pauci-serratis; petiolis glabris laminae aequantibus vel brevioribus. Flores andro-polygami lutescentes foliis coaetanei pentameri, in paniculam compositam dispositi; pedicello tomentoso. Sepala ovata acuta glabra. Petala sepalis longiora lineari-lanceolata. Discus extrastaminalis pl.m. carnosus. Stamina 8 inclusa; antheris innatis laevibus. Ovarium bilobum pilosum; stigmata filiformia circinato-revoluta. Samarae glabrae ad 2 cm. longae; alis parallelis erectis 5—8 mm. latis, saepissime sese invicem obtegentibus.

Hab. Formosa.

Distr. in China australi.

Not. Species valde affinis *Acer Paxii*, Franch. distinguitur foliis membranaceis, fructus alis parallele erectis.

var. **ningpoense**, Hance, in Jor. Bot. XI. (1873) 163;—Pax, in Engl. Bot. Jahrb. VII. (1886) 187;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 198.

A. Paxii, var. *ningpoense*, Pax, in Engl. Pfl. Reich. 8 Heft (1902) 11.

A. Buergerianum, var. *ningpoense*, Rehder, in Sargent Trees and Shr. I. (1905) 179.

Differt a typo praecipue fructus alis angulo circiter 55° divergentibus.

Nom. Jap. Tōkaede.

Hab. in hortis culta.

forma **integrifolium**, m.

A. trifidum, var. *integrifolium*, Makino, in Bot. Mag. Tokyo, XV. 112;—Leveil. Bull. Soc. Bot. Fran. VI. (1906) 593.

Folia subrhombeo-oblonga integerrima, rarius biloba triloba immixta, basi rotundata vel obtusa, apice plerumque obtusiter acuminata; fructus alis erecto-patentibus.

Nom. Jap. *Maruba-tōkaede*.

Hab. in hortis culta.

var. **formosanum**, Hayata, Leveil. in Bull. Soc. Bot. Fran. VI. (1906) 593;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 198.

A. trifidum, var. ? Hayata, in Matsum. et Hayata, En. Pl. Formos. (1905) 97.

Folia basi cordata, leviter trilobata lobis obtusissimis. Alae samarae horizontaliter patentes.

Nom. Jap. *Takasago-tōkaede*.

Hab. Formosa.

18. **Acer Ginnala**, Max. (Tab. XVIII.)

C. J. Maximowicz in Mél. Biol. II. (1857) 415;—Rupr. ibid. 522;—Pax, in Engl. Bot. Jahrb. VII. (1886) 185, et Pfl. Reich. 8 Heft (1902) 12;—Freyn, Oester. Bot. Zeitsch. (1902) 17;—Komaro. Fl. Mansh. II. 719;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 196;—Nakai, Fl. Korea. I. (1909) 134.

A. tataricum, var. *Ginnala*, Max. Prim. Fl. Amur. (1859) 67, Mél. Biol. X (1880) 604, et Fl. Mongol. 133;—Regel, Tent. Fl. Uss. no. 106;—Forb. et Hemsl. Jour. Linn. Soc. XXIII. 142;—Palib. Consp. Fl. Kor. I. 59;—Korsh. in Act. Hort. Petr. XII. 318;—Schmidt, Fl. Amur. no. 79;—Regel, in Gart. fl. (1877) 308;—Leveil. Bull. Soc. Bot. Fr. VI. (1906) 593.

A. tataricum, *b. laciniatum*, Regel, in Bull. Ph. Math. Akad. Petrop. XV. p. 218.

A. tataricum, Fr. et Sav. En. pl. Jap. I. (1875) 89, II. (1879) 323;—Leveil. l.c. 593.

A. tataricum, var. *acuminatum*, Franch. Pl. David. I. 76.

A. tataricum, var. *aidzuense*, Franch. in Bull. Soc. Bot. Fr. XXVI. (1880) 84;—Pax, in Engl. l. c. VII. 185 (1886).

A. tataricum, *a. euginnala*, Pax, in Engl. l. c. VII. 185, et Pfl. Reich. 8 Heft (1902) 12.

Nom. Jap. *Karakogi-kaede*, *Kanokogi* (天保三年. 飯沼慾齋著. 草木圖說. 1832);—*Mochinesso* (文政八年. 水谷助六著. 物品識名拾遺. 1825);—*Yachiitaya*, *Nanaye-itaya* (北海道樹木志料);—*Hanakaede* (J. Matsumura, Shokubutsu-Meii, no. 33.)

Arbor, ramuli cortice griseo- vel fusco-brunneo; ramulis juvenilibus leviter pilosis. Folia juvenilia utrinque ad nervos plus minus dense molliter pilosa; adulta membranacea supra glabra subtus ad venas pilosa, ovato-oblonga vel ovata, acuta vel acuminata, basi leviter cordata vel rotundata interdum subtruncata, trilobata rarius indivisa vel subquinquelobata, inciso-serrata vel irregulariter subduplicato-serrata interdum crenato-serrata, versus basin integerrima; lobis lateralibus multo minoribus; petiolis gracile elongatis supra sulcatis. Panicula dense pubescens; floribus andro-polygamis. Calyx glabriusculus 5-fidus, sepalis ovatis obtusis. Petala alba oblanceolata quam sepala longiora. Stamina 8 antheris laevibus. Discus bene evolutus extrastaminalis. Ovarium dense visllosum, stylis bilobatis. Samara glabriuscula, loculis reticulato-venosis, alis ad 18 mm. longis apice rotundatis angulo acuto divergentibus rarius sese invisem obtegentibus.

Hab. in sylvis montuosis per totam Japoniam. Yezo: Shibetsu (Nemuro), Sapporo (Ishikari), Prov. Iburi;—Honto: Nambu (Rikuchiu) Yonezawa (Uzen), Aidzu (Iwashiro), Nikko (Shimotsuke) Togakushi, Ontake (Shinano), Ohnogōri (Hida);—Kishu: Hikosan (Buzen).

Distr. Asia orientali (Mongolia, China, Manshuria, Korea, Amuria).

var. **yezoense**, m.

Alae samarae parallelae sese invisem obtegentes ceterum ut in typicum.

Nom. Jap. *Yezo-karakogi-kaede*.

Hab. Yezo: Prov. Ishikari.

19. **Acer spicatum**, Lam.

var. **ukurunduense**, Max. (Tab. XIX.)

Acer spicatum, Lam. Encycl. Method. II. (1736) 381;—DC. Prodr. I (1824) 593;—Pax, in Engl.

Bot. Jahrb. VII. (1866) 188, et Pfl. reich. 8 Heft (1902) 16;—Robinson, in Gray, Synopt. Fl. Nor. Am. I. (1897) 435;—K. Koch, in Dendrolog. I. (1869) 522;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 199.

Acer spicatum, Lam. var. *ukurunduense*, Maxim. Prim. Fl. Amur. (1859) 65; et Mél. Biol. X. (1880) 504;—Fr. et Sav. Pl. Jap. I. (1875) 88;—Leveil. Bull. Soc. Bot. Fr. VI. (1906) 593:—Pax, l. c. VII. 183, et Pfl. reich. l.c. 16;—Fr. Schmidt, Reis. Amur. Sachal. p.p. 35, 119;—Korsch. in Act. Hort. Petr. XII. 317;—Koidz. Pl. Sachal. Nakah. (1910) 89.

A. ukurunduense, Trautv. et Mey. Fl. Ochot. no. 78;—Rupr. Mél. Biol. II. 520;—Komaro. Fl. Mansh. II. 722;—Nakai, Fl. Korea. I. 134;—C. K. Schn. Ill, Handb. Laubh. II. 199.

A. dedyle, Max., Rupr. in Mél. Biol. II. 520.

A. spicatum, var. *ussuriense*, Bud. (ex Komaro.)

A. caudatum, var. *ukurunduense*, Rehder (ex. C. K. Schneider).

A. lasiocarpum, Leveil. et Vnt. in Bull. Soc. Bot. Fr. VI. (1906). 591.

Nom. Jap. *Ogarabana*, *Arahana* (文政七年. 岩崎常正著. 日光山草木圖. 1825;—*Hozaki-kaede* (北海道樹木志料);—*Arahaga* (享和元年. 小野蘭山著. 常野採薬記. 1801);—*Yama-asagara* (鹿兒島草木譜).

Arbuscula ramis viridibus vel fuscis, juvenilibus pilosis. Folia membranacea supra glabra juniora subtus piloso-tomentosa, adulta praesertim ad costas pubescentia pallidiora vel subcanescentia, rarissime utrinque perfecte glabra, amibtu rotundata vel ovalia (5—) 7 (—9)-nervia, 5—7-lobata, basi cordata vel aperte cordata interdum cordato-rotundata; lobis acuminatis inciso-dentatis vel irregulariter subduplicato-dentata, dentibus mucronatis vel aristatis; petiolis elongatis mox glabriusculis. Racemus multiflorus molliter pilosus; floribus andro-polygamis viridi-flavescentibus. Sepala (4—) 5 ovata vel ovato-lanceolata acuta extus minute pilosa. Petala oblanceolata vel subspathulata quam sepala longiora caduca fugacea. Discus lobatus extrastaminalis. Stamina 8, filamentis antherisque minutissime scabriusculis. Ovaria villoso-tomentosa, stylis profunde bilobatis laciniis revolutis intus stigmatosis. Fructus minute pilosus, alae angulo obtuso divergentes.

Hab. in subalpinis Japoniae mediae et septemtrionalis. Sachalin: Tretya-padj; Kuriel; Yezo: Teinesan, Sapporodake, Jōzankei, Moiwayama (Ishikari). Makkarinupuri (Shiribeshi). Konbumori (Hidaka). Titose (Iburi),— Hondo: Iwaki-san, Hakkōdasan (Mutsu). Iwatesan, Hayachine (Rikuchiū), Chokaizan (Ugo), Asahidake, Gassan, Zaōsan, Azumasan, Iidesan (Uzen). Bandai-san, Aizu, Hiuchigatake (Iwashiro). Nikko (Shimotsuke). Togakushiyama, Hakubasan. Yatsugatake, Komagatake, Ariakeyama (Shinano); Hakusan (Kaga); Tairanoyu (Hida); Myōkōsan (Yechigo).

Distr. var. China, Manshuria, Korea, Amuria.

Distr. sp. America boreali, Asia orientali.

Not. A typo differt foliis 5—7 lobatis, inciso grandi-dentatis.

20. **Acer Oliverianum**, Pax.

F. Pax in Hooker Icon. Pl. XIX (1889) sub. t. 1897, et Engl. Pfl. Reich 8 Heft (1902) 21;—C. K. Schn. Ill. Handb. Laubh. II. (1907). 206.

var. **Nakaharae**, Hayata. (Tab. XX.)

A. *serrulatum*, Hayata. in sched. (Surculus sterilis!)

Arbor, ramuli glabri purpureo-brunnei vel olivaceo-virides. Folia membranacea quinquenervia, juniora subtus praesertim ad nervorum basin parce molliter pilosa, adulta glabra palmato-quinquelobata, basi aperte cordata raro truncata, argute serrata, serraturis incumbentibus, lobis triangularibus vel ovato-lanceolatis acuminatissimis; petiolis gracilibus quam lamina paullo brevioribus. Panicula corymbosa multiflora glabra, floribus albis foliis coaetaneis andro-polygamis. Sepala 5 ovata obtusa extus puberula. Petala 5 quam sepala paullo longiora rotundato-obovata apice undulata. Stamina 8 antheris laevibus. Ovarium pilosum mox glabrum, stylis gracilibus 2—2½ m.m. longis, stigmatibus revolutis brevioribus. Samara glabra loculis ovoideis alis angulo obtuso divergentibus.

Nom. Jap. *Shima-momiji* (T. Kawakami).

Hab. Formosa: in sylvis temperatis, Taitō, Kierun, Nanō. Sintek.

Distr. Sp. China australi.

Not. Differt a typo alis samarae obtuse divergentibus.

subvar. **formosanum**, m. (fig. 1.)

Folia ambitu subquadrangulata basi cordata, lobis 5 late triangularibus subito acuminatisque.

Nom. Jap. *Itomaki-shimamomiji*.

HAB. Formosa: Chōsōkei.

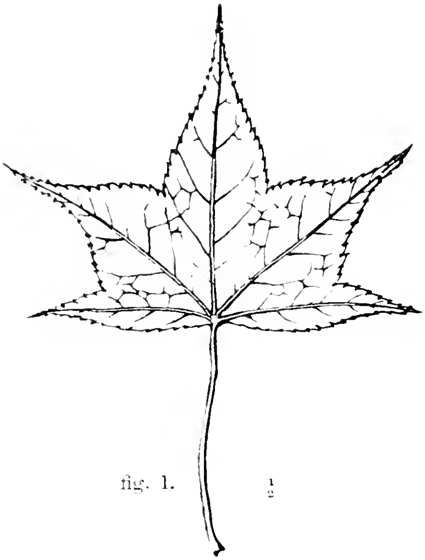


fig. 1. ½

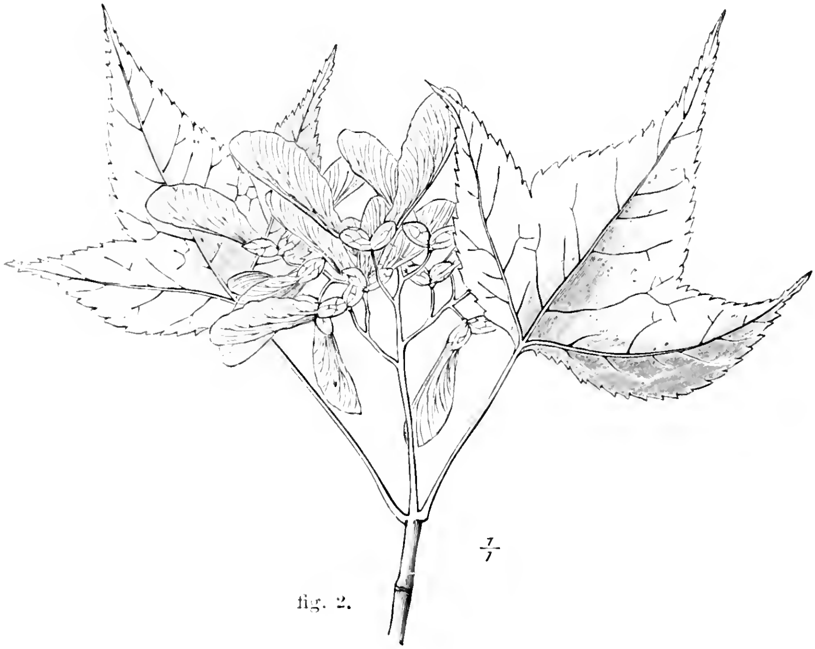
svar. β, **trilobatum,** m. (fig. 2.)

Acer Tutscheri, var. *Shimadae*, HAYATA. in Sched..

Folia glabra, trilobata rarius tetraloba intermixta, lobis ovatis longe acuminatis regulariter serratis, serraturis leviter incumbentibus; petiolis glabris cum lamina usque 15 cm. longis. Alae samarae obtusissime divergentes. Folia basi rotundata, lobis intermediis saepe longioribus.

NOM. JAP., *Mitsude-shima-momiji*.

HAB., Formosa: Hakkutaizan, Sintek.



$\frac{1}{1}$

fig. 2.

Sect. 10. *Palmata*, PAX.

PAX, in ENGL. Bot. Jahrb. VI. (1885) 326, VII. (1886) 198.

Inflorescentia corymboso-paniculata vel corymbosa, bracteata vel nulla. Flores andro-polygami. Sepala petalisque 5. Stamina 8 hypogyna. Discus extrastaminalis. Stylus apice bilobatus. Folia membranacea simplicia (5—) 7—pluri palmatilobata.

Species 4.

Clavis specierum.

* Antherae scabrae. Folia plerumque 9-lobata subtus secus venas petiolisque pubescentia. Inflorescentia bracteolata, floribus ochro-leucis. Ovaria villosa. Alae samarae horizontaliter patentes........................*A. Sieboldianum*, MIQ.

** Antherae laevae, inflorescentia ebracteolata.

- △ Folia plerumque 11-lobata, secus costas pedicellisque in juventate tomentosis. Flores purpurei. Ovaria villoso-tomentosa. Alae samarae in angulo obtuso divergentes..............................*A. japonicum*, THG.
- △△ Folia plerumque 11-lobata, petiolisque ab initio glabriuscula. Flores ochro-leuci. Ovaria pubescentia. Alae samarae obtusissime divergentes...*A. Shirasawanum*, m.
- △△△ Folia plerumque 7-lobata, nascentia subtus secus costas parce hirta vel glabra. Flores plerumque purpurei. Ovaria glabra. Alae samarae obtuse divergentes...*A. palmatum*, THG.

21. **Acer Sieboldianum**, MIQ. (Tab. XXI.)

MIQUEL, Prol. Fl. Jap. (1865) 19;—FR. et SAV. En. Pl. Jap. I. (1875) 87;—MAX. Mél. Biol. X. (1880) 603, XII. (1888) 433;—PAX, in ENGL. Pfl. Reich. 8 Heft (1902) 25, et Bot. Jahrb. VII. (1886) 200;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 209.

A. japonicum, var. *Sieboldianum*, FR. et SAV. En. Pl. Jap. II. (1879) 317;—LÉVEIL. Bull. Soc. Bot. Fr. VI. (1906) 591.

A. Sieboldianum, *a. typica*, MAX. Mél. Biol. XII. (1888) 433;—PAX in ENGL. Pfl. Reich. 8 Heft (1902) 25.

Arbor rami glabri, cortice badio-brunneo vel purpurascente, ramuli juveniles cinereo-tomentosi. Folia membranacea juniora supra sparce puberula subtus presertim in nervis petiolisque cinereo-tomentosa, adulta supra glabra subtus secus costas petiolisque pubescentia, in axillis venarum villoso-barbarta, ambitu rotundata vel rotundato-ovalia, 5—8 cm. longa, 6—9 cm. lata, 9 lobata rarius 7—11 loba immixta, basi aperte cordata interdum subtruncata; lobis ovatis acutis vel breve acuminatis argute serratis vel irregulariter subduplicato-serratis; petiolis limbo brevioribus vel aequantibus dense pubescentibus, basi gemmas occultantibus. Flores andropolygami pentameri ochracei, in corymbum pluriflorum pendentem, pedunculo dense niveo-velutino 1—3 cm. longo insidentem dispositi; bracteolis linearibus vel lineari-lanceolatis. Sepala ovata vel lanceolata acuta utrinque dense minute puberula. Petala ovata vel rotundato-ovata obtusa, calycis lobis breviora, margine plicato. Discus extrastaminalis pauci-lobatus. Stamina 8 sub anthesin exerta; antheris scabris. Ovarium dense villosum stylis apice bilobatis. Samara pubescens deinde subglabra, alae oblongae horizontaliter patentes ad 13 m.m. longae 5 m.m. latae.

Hab. in sylvis montuosis Hondōensis, Sikokuensis et Kiusiuensis.

Distr. Korea, Manshuria.

α. **typicum**, Max. in Mél. Biol. XII. (1888) 433;—Pax. in Engl. Pfl. Reich 8 Heft. (1902) 25.

Nom. Jap. *Itayameigetsu* (J. Matsumura, Shokubutsu-Meii. no. 46); *Kibana-uchiwa-kaede* (R. Yatabe, Nippon-Shokubutsuhen. I. p. 417.)

Folia 9-lobata, rarius 7-loba immixta, basi aperte cordata, 5—7 (—8) cm. lata; floribus flavescentibus.

Hab. Hondō: Zaōsan. Nikkōsan Komono, Ontake, Wadatōge. Shikok: Tsurugisan, Nanogawamura, Yahazuyama. Kiushiu: Hōmanzan, Inutake, Hikosan, Amami-ohshima (Prov. Ohsumi).

subvar. **albiflorum**, m.

Floribus albis, ceterum ut in typicum.

Nom. Jap. *Shirobana-itayameigetsu.*

Hab. Hondō: Yonezawa, Nikkō.

subvar. **tortuosum,** (Max.)

A. Sieboldianum, γ. tortuosum, Max. Mél. Biol. XII. (1838) 433;—Pax Pfl. Reich. l. c. 25.

Habitus tortuoso-ramosissimus; foliis lobis 9 plerumque brevissime acutis vel obtusis.

Nom. Jap.

Hab. culta.

subvar. **microphyllum,** (Max.)

A. Sieboldianum. β. microphyllum, Max. l. c;—Pax l. c. 25.

Folia minora, 5—6 cm. longa.

Nom. Jap. *Hime-uchiwa-kaede.*

Hab. culta.

subvar. **Momijigasane,** m.

Foliis lobis anguste oblongis, versus basin subito constrictis.

Nom. Jap. *Momiji-gasane* (紅葉重) (伊藤伊兵衛, 廣益地錦抄)

Hab. culta.

subvar. **Sodenouchi,** m.

Folia minora semper 9 lobata.

Nom. Jap. *Sode-no-uchi* (袖ノ内) (寶永七年, 伊藤伊兵衛, 增補地錦抄. 1710)

Hab. culta.

β. **tsusimense,** m.

Folia 7-lobata basi aperte cordata vel subtruncata; lobis oblongis inciso-serratis, sinubus profundioribus.

Nom. Jap. *Koba-itayameigetsu.*

Hab. Kiushiu: Insl. Tsushima.

subvar. **Kasatoriyama,** m.

Folia 7-lobata, basi cordata, lobis ellipticis acutis.

Nom. Jap. *Kasatoriyama* (笠取山) (寶永七年. 伊藤伊兵衛. 增補地錦抄. 1710)

Hab. culta.

subvar. **laxifolium**, m.

Folia ambitu rotundata, 7-lobata, basi profunde cordata, lobis inciso-serratis.

Nom. Jap. *Hina-itayameigetsu.*

Hab. culta.

subvar. **Ayaigasa**, m.

Folia minora 7-lobata.

Nom. Jap. *Ayaigasa* (綾藺笠) (伊藤伊兵衛. 廣益地錦抄)

Hab. culta.

22. **Acer Shirasawanum.** sp. nov. (Tab. XXII.)

Arbor glaber, rami cortice cinerascente. Folia membranacea, juniora supra vel utrinque secus nervos et in axillis venarum parce pilosa, adulta supra semper glabra subtus pilis persistentibus, ambitu rotundata vel rotundato-subreniformia, basi cordata, palmato-11-lobata, lobis acuminatis duplicato-serratis; petiolis elongatis ab initio vel mox glabris. Inflorescentia umbellato-corymbosa, glabra vel parce puberula ebracteolata pedunculata; floribus albis vel ochro-leucis andro-polygamis (vel andro-dioecis interdum andro-monoecis ?). Sepala 5 ovata acuta extus raro puberula, atropurpurea vel purpurea. Petala 5 ovata apice rotundata quam sepala breviora. Discus carnosus extrastaminalis. Stamina 8 exerta, antheris laevibus. Ovaria villosa stylis glabris stigmatibus leviter revolutis. Samarae glabrae loculis horizontalibus, alis obovato-oblongis leviter arcuato-ascendentibus.

Nom. Jap. *Oh-itayameigetsu.*

Hab. Hondo: Nikkō, Usuitōge, Hakoneyama.

Distr. endemica.

Not. Affine *Acer Sieboldiano*, Miq. et *Acer palmato*, Thg. sed a priori foliis 11-lobatis petiolisque glabris; antheris laevibus;

inflorescentibus glabris ebracteolatis; sepalis extus purpurascentibus; ab altero foliis 11-lobatis lobis duplicato-serratis, subtus ad nervos et in axillis venarum parce pilosis; alis samarae obtusissime divergentibus; ovariis villosis; petalis albis differt.

Var. **tenuifolium,** m. (Tab. XXIII.)

Folia tenuiora basi profunde cordata, ambitu rotundata, 9 rarius 11 circumlobata, lobis incisis; samaris ad apicem ramulorum solitariis.

NOM. JAP. *Hina-uchiwakaede.*

HAB. Hondō: Nikko, Fujiyama, Ontake.

subvar. **Murasame,** m.

Folia rotundata usque 5 cm. longa 11-circumlobata basi profunde cordata, lobis incisis acuminatis subtus secus costas adpresse pilosis.

NOM. JAP. *Murasame* (村雨)

HAB. in hortis culta.

23. **Acer japonicum,** THUNB. (Tab. XXIV.—XXV.)

THUNBERG. Fl. Jap. (1784) 16. et Icon Fl. Jap. dec. 2. t. 19 (1794) :—SIEB. et ZUCC. Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2 (1846) 156. et Fl. Jap. II. (1870) 82. t. 144 :– MIQ. Prol. Fl. Jap. (1867) 18 ;—FR. et SAV. Eu. Pl. Jap. I. (1875) 87 ;—MAX. Mel. Biol. X (1880) 605 :—PAX, in ENGL. Bot. Jahrb. VII. (1886) 199, et Pfl. Reich, 8 Heft (1902) 24 :—DC. Prodr. I. (1824) 595 :—C.K. SCHN. Ill. Handb. Laubh. I. (1907) 208 ;—LEVEIL. Bull. Soc. Bot. Fr. VI. (1906) 591 :—A. GRAY in PERRY Exped. Jap. 309;—C. KOCH in MIQ. Ann. Mus. Lugd. Batav. I. 251 :—NAKAI, Fl. Korea. I. p. 135.

Arbor rami cortice atro-purpurascente vel rufo-fuscescente, ramulis novellis glabriusculis. Gemmae perulae caducae, exteriores coriaceae rotundatae, interiores omnes dense villosae oblanceolatae vel lineari-spathulatae apice rotundatae vel obtusae. Folia membranacea juvenilia utrinque dense villosa, cito supra glabra subtus in axillis venarum tantum barbarta, ambitu rotundata, 11-lobata rarius 7—13 lobata, basi profunde cordata: lobis ovato-ellipticis acuminatis inciso-serratis; petiolis limbo multo brevioribus glabrescentibus basi plerumque dilatatis, junioribus pl. m. villosis. Flores andro-polygami pentameri purpurei spectabiles, in corymbum laxiflorum pendentem dispositi; pedunculis pedicellisque glabris vel villoso-tomentellis ebracteolatis. Sepala purpurea, late elliptica obtusa, ampla 5—7 mm. longa, demum reflexa. Petala ovato-orbiculata obtusa vel rotundata, alba vel purpurascentia, sepalis fere duplo breviora. Discus carnosus extrastaminalis. Stamina 8 sub anthesin exerta, filamentis antherisque laevibus. Ovarium dense villosum stylis elongatis apice bilobatis. Samara pubescens, alae angulo obtuso divergentes.

Hab. in sylvis montuosis Yezoensis et Hondoensis.

Distr. Korea. (Manshuria?)

α. **typicum**, Gr. v. Schw. in Gartn. fl. (1893) XLII. p. 703;—Pax in Pfl. Reich l.c. 24 (1902).

Folia aequilonga ac lata, lobis ovato-ellipticis acuminatis vel caudato-acuminatis; alae samarae angulo obtuso divergentes.

Nom. Jap. *Ha-uchiwa-kaede* (J. Matsumura, Shokubutsu-Meii, no. 34); *Akabana-uchiwa-kaede* (R. Yatabe. 日本植物編. 第一卷. p. 417); *Ogurayama*, *Jūnihitoye*, *Meigetsu-kaede* (伊藤伊兵衛氏. 增補地錦抄. no. 4).

Hab. Yezo: Moiwadake, Teinesan, Sapporo, Jōzankei (Ishikari); Makkarinupuri (Shiribeshi); Shikifu (Iburi). Hondō: Tokiwano, Iwakiyama, Hakkōdasan (Mutsu); Iwateyama, Hayachine, Nanshōzan (Rikuchiū); Kurikomayama (Rikuzen); Chōkaizan (Ugo); Gassan, Asahidake, Zaōsan, Adzumasan, Iidesan (Uzen); Bandaisan, Aidzu (Iwashiro); Nikkōsan (Shimotsuke) Harunasan (Kōtsuke); Togakushiyama, Kiso, Ōnogawa, Norikuradake, Ontake, Yatsugatake (Shinano); Prov. Hida.

forma **angustilobum**, m.

Foliis lobis angustioribus oblongo-lanceolatis acuminatis.

forma **macrophyllum**, m.

A. japonicum, var. *macrophyllum*, Gr. v. Schw. l.c. 709. (1893)

Folia valde ampla 14 cm. longa ac lata, lobis caudato-acuminatis.

forma **tenuilobum**, m.

Folia 8—10 cm. longa, 11—13 cm. lata, lobis ovatis breve acuminatis, infimis sese invisem obtegentibus; alae samarae semiovatae.

forma **semiovatum**, m.

Folia subtus secus costas petiolisque dense villosa, basi profunde cordata, lobis ovatis acuminatis; alae samarae semi-obovatae.

forma **ascendens**, m.

Alae samarae arcuato-ascendentes.

forma **crassifolium**, m.

Folia crassiora subchartacea, subtus petiolis ramulisque plus minus canescentia.

β. **aureum**, Gr. v. Schw. l.c. 709;—Pax l.c. 24.

Folia aureo-tincta.
Nom. Jap.
Hab. culta.

γ. **Parsonii**, Veitch. ex Gr. v. Schw. l.c. 709;—Pax l.c. 25.

Folia profunde inciso-lobata.
Nom. Jap.
Hab. culta.

δ. **Heyhachii**, Matsum., Makino in Bot. Mag. Tokyo (1904) 115. (Tab. XXV.)

Acer circumlobatum, Max var. *Heyhachii*, Mak. ibid. XXIV. (1910) 74.

Folia 11—13 palmatipartita, lobis ambitu oblanceolatis longe acuminatis, sursum utrinque profunde lobulatis, deorsum integerrimis versus basin cuneato-attenuatis.
Nom. Jap. *Mai-kujaku*.
Hab. culta.

ξ. **microphyllum**, m. (Tab. XXV.)

Folia minora 7½—8½ cm. lata. 11—13 lobata, lobis ovatis acutis inciso-serratis.

Nom. Jap. *Yezo-meigetsukaede*.

Hab. Yezo.

η. **circumlobatum**, (Max.) m. (Tab. XXV.)

Acer circumlobatum, Max. Mél. Biol. VI. (1867) p. 368, et X. (1880) 608 ;—Fr. et Sav. En. Pl. Jap. I. (1875) 88 ;—Pax Engl. Bot. Jahrb. VII. (1886) 199, et Pfl. Reich. l.c. 25 ;—Leveil. Bull. Soc. Bot. Fr. VI. (1906) 589.

A. circumlobatum, α. *insulare*, Pax l. c. p p. 25. 200.

Folia chartacea, in venarum axillis albo villosa, nec rufo-barbarta, 11-lobata, lobis basalibus sese invisem saepe obtegentibus. Alae samarae horizontaliter patentes.

Nom. Jap. *Oh-meigetsu* (J. Matsumura, l. c. no. 28)

Hab. Nikko, Shinano.

ζ. **villosum**, m.

Folia 9-lobata 11-loba intermixta, supra parce subtus praesertim secus costas et in axillis venarum villoso-tomentosa; petiolis villoso-tomentellis.

Nom. Jap.

Hab. Yezo, Nikkō.

forma **macrophyllum**, m.

Folia ampla 14 cm. longa ac lata.

Nom. Jap.

Hab. Nikkō.

θ. **Kasado**, m.

Acer japonicum, α. *typicum*, forma *Kasado*, m. Mss.

Folia tenuiora 8 cm. longa ac lata. 13-lobata. lobis acuminatis inciso-serratis serraturis argutissimis.

Nom. Jap. *Kasado* (笠戸).

Hab. culta.

ν. **Kokonoe**, m.

A. japonicum, α. forma, *Kokonoe*, m. Mss.

Folia 11-lobata, lobis ovatis acutis.

NOM. JAP. *Kokonoe* (九重) (伊藤伊兵衛氏. 增補地錦抄. 第四卷).
HAB. culta.

χ. **Sayosigure**, m.

A. japonicum, α. forma, *Sayosigure*, m. Mss.

Folia minora 9-circumlobata.

NOM. JAP. *Sayoshigure* (小夜時雨) (伊藤伊兵衛氏. 廣益地錦抄).
HAB. in hortis culta.

λ. **Matsuyoi**, m.

A. japonicum, α. forma, *Matsuyoi*, m. Mss.

Folia minora 9-lobata.

NOM. JAP. *Matsuyoi* (待宵) (伊藤伊兵衛氏. 附錄地錦抄).
HAB. culta.

24. **Acer palmatum**, THUNB. (Tab. XXVI—XXVIII.)

THUNBERG, Fl. Jap. (1784) 161;—DC. Prodr. I. (1824) 595;—K. KOCH, in MIQ. Ann. Mus. Lugd. Batav. I. (1863—64) 251, et Dendrol. I. (1869) 524;—MIQ. Prol. Fl. Jap. (1866—67) 20;—SIEB. et ZUCC. Fl. Jap. II. (1870) 83;—FR. et SAV. En. Pl. Jap. I. (1875) 88;—MAX. Mél. Biol. X. (1880) 607;—PAX in ENGL. Bot. Jahrb. VII. (1886) 201, et Pfl. Reich 8 Heft (1902) 25;—LÉVEIL. Bull. Soc. Bot. Fran. VI. (1906) 591;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 207;—DIELS, Fl. Centralchin. in ENGL. Bot. Jahrb. XXIX. p. 448.

Acer polymorphum, S. et Z. Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1846) 158.

Arbor rami glabri cortice cinerascenti-viride vel fusco-purpurascente, ramulis novellis glabis vel puberulis. Gemmae perulae interiores spathulatae ferrugineo-tomentosae. Folia maxime variabilia, juvenilia dense molliter pilosa, adulta glabra, membranacea, palmato-plurilobata, basi aperte cordata, lobis acuminatis vel caudato-cuspidatis, serratis vel inciso-serratis; petiolis gracile elongatis Inflorescentia umbellato-corymbosa vel-paniculata, pedicellis filiformibus glaberrimis; floribus coaetaneis andro-polygamis. Sepala 5 ovato-oblonga rotundata vel obtusa intense purpurea extus saepe parce ciliolata. Petala 5 sepalis aequilonga oblonga obtusa aut rotundata basi parum angustata lutescentia vel ochroleuca. Stamina 8 exerta, antheris laevibus. Ovaria glabra rarius parce ciliolata stylis bilobatis, stigmatibus revolutis. Samara glabra alis angulo vario divergentibus.

NOM. JAP. *Kaede* (寶永五年. 貝原益軒著. 大和本草. 1708);—*Kaedenoki*, *Kaerudenoki* (源順著,和名抄) *Momiji* (本草啓蒙);—*Iwatobeni* (北海道樹本志料).

HAB. per totam japoniam spontanea.

DISTR. Hupeh (China centrali). (Korea?)

Subsp. α. **genuinum**, (S. et Z.) m. (Tab. XXVI.—XXVIII.)

A. palmatum, var. *palmatum*, KOCH. Dendrol. I. (1869) 525.

A. palmatum, var. *genuinum*, S et Z. Fl Jap. II. (1870) 84 (p.p.) (excl. *A. septenlobum*, THG) t. 145 (excl. fig. 9.)

A. palmatum, var *Thunbergi*, PAX, svar. *eupalmatum*, GR v. SCHW. Gartn. fl. (1893) 652;—PAX in ENGL Pfl. Reich 8 Heft (1902) 25.

A. palmatum, var. *Thunbergi*, PAX in ENGL. Bot. Jahrb. VII. (1886) 212 (p. p.)

Gemmae perulae intimae circ. 15 mm. longae, glabrae vel ciliolatae. Folia 5—7 palmatilobata basi cordata usque 4,5 cm. longa ac lata; lobis lanceolato-oblongis acuminatissimis serrulatis aut inciso-serratis. Flores pedicellis capilliformibus. Samarae minores alis circ. 1—1,2 cm. longis in angulo obtuso, rarius acuto v. obtusissimo divergentibus.

a. **spectabile**, m. (Tab. XXVIII.)

A. palmatum, THG. Fl. Jap. 161, et Icon. Fl. Jap. (1800) t 44.

A. palmatum, var. *genuinum*, S. et Z. Fl. Jap. II. 84 (p. p.) t 145 (p. p.)

Folia aequaliter argute serrulata.

NOM. JAP. *Irohamomiji*.

HAB. Hondō: Yugashima (Idzu).

forma **Chisio**, m.

Folia 5—7 lobata serrata, nascentia intense et etiam in aestate vix roseo-colorata.

NOM. JAP. *Chishio* (千染), *Mōsen* (毛氈).

HAB. in hortis culta.

forma **Komonnisiki**, m.

Folia in variis modis aureo-maculata.

Nom. Jap. *Komon-nishiki* (小紋錦).

Hab. in hortis culta.

subvar. **crispum**, (Andre) m.

A. palmatum, α *Thunbergi*, svar. *eupalmatum*, f. *crispum* Andre, in Illustr. Hortic. XVIII. (1870) 241. t. 43;—Pax l.c. p. 26.

Folia profunde palmatifida; laciniis anguste lanceolatis, margine leviter involuto.

Nom. Jap. *Okushimo* (置霜).

Hab. in hortis culta.

subvar. **Hikasayama**, m.

Folia palmatifida, lobis oblongo-lanceolatis eroso-serratis, secus costas et margines viridia ceterum albo-maculata.

Nom. Jap. *Hikasayama* (日笠山).

Hab. in hortis culta.

b. **amabilie**, m. (Tab. XXVI.)

A. palmatum, var. *Thunbergi*, Pax, svar. *eupalmatum*, Gr. v. Schw. l.c. (p. p.)

Folia inciso-serrata.

Nom. Jap. *Iroha-momiji*.

Hab. Hondō: Nikkō, Chichibu, Kasugasan, Takiyama (Swō); Sikok: Kotohirayama; Kiushiu: Mitake (Tsushima).

forma **Akajinisiki**, m.

Folia enascentia rosea, inciso-serrata, lobis anguste oblongis acuminatis.

Nom. Jap. *Akaji-nishiki* (赤地錦).

Hab. culta.

forma **Tsuchigumo**, m.

Foliis lobis apice circinatis pulverulentibus.

Nom. Jap. *Tsuchigumo* (歌仙百錦集).
Hab. culta.

forma **Hanaidzuminisiki,** m.

Folia inciso-serrata, albo-maculata.
Nom. Jap. *Hana-idzumi-nishiki* (花泉錦).
Hab. in hortis culta.

forma **Oridonisiki,** m.

Folia inciso-serrata aureo-guttata.
Nom. Jap. *Orido-no-nishiki* (織戸錦).
Hab. in hortis culta.

subvar. **Kagiri,** m.

Folia leviter contorta argute serrata roseo-marginata aut maculata saepe viridia immixta.
Nom. Jap. *Kagiri.*
Hab. culta.

Subsp. **septenlobum,** (Thg) m. (Tab. XXVI.—XXVII.)

A. palmatum, β. septenlobum, (Thg.) Koch. in Ann. Mus. Lugd. Batav. I. (1864) 251, et Dendrol. I. (1869) 525.

A. septenlobum, Thg. Fl. Jap. (1784) 161;—DC. Prodr. I. (1824) 595.

A. meikots, Sieb. in Jaahrb. Maatsch. Tuinb. (1844) t. 2. fig. 5.

A. palmatum, var. *septenlobum,* Miq. Prol. Fl. Jap. (1867) 20.

A. palmatum, var. *palmatifidum,* S. et Z. Fl. Jap. II. (1870) 84. (p. p.)

A. palmatum, var. *Thunbergi,* svar. *subseptenlobum* Gr. v. Schw. Gart. Fl. (1893). 673;—Pax Pfl. Reich. l.c. 26. (p. p.)

A. palmatum, var. *Thunbergi,* svar. *septenlobum,* (Koch) C. K. Schn. l.c. (1907) 207.

Gemmae perulae intimae anguste spathulatae, ad 3 cm. longae tomentosae. Folia nascentia dense pilosa, adulta glabra usque 6,5 cm. longa palmato-7-lobata, basi cordata; lobis elliptico- vel oblongo-lanceolatis caudato-acuminatis vel subito cuspidatis, regulariter serratis. Inflorescentia corymboso-paniculata. Alae samarae 2—2,4 cm. longae in angulo obtusissimo, vel subhorizontaliter divergentes.

Nom. Jap. *Takawo-momiji*, *Oh-momiji*.

Hab. Hondō: Morioka, Tokizawayama, Omyojin, Ubayashiki, Kadoma, Sengantōge (Rikuchiu); Azumasan (Uzen), Wakamatsu (Iwashiro); Shiwobara, Nikkō (Shimotsuke); Chichibu (Musashi); Fujiyama (Suruga).

var. **latilobatum**, m. (Tal. XXVI).

Foliis lobis ovatis vel late triangulatis subito acuminatis. Alae samarae horizontales.

Nom. Jap. *Hiroha-momiji*.

Hab. Shiwobara (Shimotsuke), Ontake (Kiso Provinciae Shinano); Kasugami, Nanogawa (Tosa).

var. **speciosum**, m.

Folis lobis ovato-lanceolatis acuminatis utrinque purpurascentibus, coloribus autumnalibus aureo-brunnescentibus.

Nom. Jap. *Nomura-kaede*, *Musashino* (武藏野).

Hab. in hortis culta, sed saepe spontanea.

var. **palmatipartitum**, m.

Folia palmato-7-partita lobis anguste oblongis acuminatis vel subito acuminatis versus basin cuneato-augustatis vel constrictis.

forma **Senri**, m.

Folia nascentia intense rosea deinde purpureo-rosea, in aestate viridescentes.

Nom. Jap. *Senri* (千里), *Chisato*.

Hab. in hortis culta.

forma **Ichigyoin**, m.

Folia nascentia lutescentia, auctumna profunde purpurea.

Nom. Jap. *Ichigyō-in*. (一行院).

Hab. culta.

forma **Akitsuta.** m.

Foliis lobis basi subito valde angustatis.

Nom. Jap. *Akitsuta.*

Hab. in hortis culta.

forma **Tsukubane,** m.

Foliis lobis anguste lanceolatis.

Nom. Jap. *Tsukubane* (筑波峰).

Hab. culta.

forma **Ohsakazuki,** m.

Foliis lobis lanceolato-oblongis.

Nom. Jap. *Ohsakazuki* (大盃).

Hab. culta

subvar. **Tanabata,** m.

Foliis lobis lanceolato-linearibus utrinque attenuatis serratis vel integerrimis.

Nom. Jap. *Tanabata* (七夕).

Hab. culta.

subvar. **linearilobum,** (Miq) m.

A. palmatum, var. *linearilobum*, Miq. in Archiv. Neerlandeis II. (1867) 469 ;—Max. Mél. Biol. X. (1880) 608 ;—Pax in Engl. Bot. Jahrb. VII. (1886) 202.

A. palmatum, f. *linearilobum*, S. et Z. Fl. Jap. II. (1870) 84, t. 146.

A. palmatum, γ. *linearilobum*, S. et Z., Pax in Engl. Pfl. Reich. l.c. 27 ;—C. K. Schn. l.c. 207.

Nom. Jap. *Shimenouchi* (占の内).

Hab. in hortis culta.

Folia palmatisecta vel sectisve, laciniis linearibus acutis integris aut remote obscuriter serratis.

forma **lineare,** m. (Gr. v. Schw.) l.c. 682 ;—Pax l.c. 27.

Folia viridia.

forma **atro-lineare.** m. (Gr. v. Schw.) l.c. 682 ; Pax. l.c. 27.

Folia atro-purpurea.

Subsp. γ. **Matsumurae,** m. (Tab. XXVIII.)

A. palmatum, f. *palmatifidum*, S. et Z. Fl. Jap. II. (1870) 84, (pro parte ?)
A. palmatum, var. *Thunbergii*, svar. *subseptenlobum*, Gr. v. Schw. l.c. 678;—Pax, Pfl. Reich. l.c. 26 (pro parte).

Folia 7—9-lobata ad 7—8 cm. longa; lobis ellipticis ovatis vel oblongis, caudato-acuminatis incisis vel inciso-serratis rarius inaequaliter subduplicato-serratis. Inflorescentia corymboso-paniculata. Alae samarae angulo acuto, obtuso v. obtusissimo divergentes, circ. 17—25 mm. longae.

Nom. Jap. *Yama-momiji* (J. Matsumura, Shokubutsu-Meii, no. 40.)

Hab. Yezo, Hondo, Shikok, Kiushiu, Formosa.

Distr. China centrali ?.

α. **spontaneum,** m.

forma **angustilobum,** m.

Foliis lobis anguste oblongis.

Nom. Jap.

Hab. in Yezo.

forma **circumlobatum,** m.

Folia 9 (—7) circumlobata basi profunde cordata, lobis basalibus conniventibus.

Nom. Jap.

Hab. Matsumine, Yudonosan (Uzen); Shimidzutōge (Shimotsuke).

forma **acutum,** m.

Alae samarae angulo acuto divergentes.

forma **rectangulare,** m.

Alae samarae in angulo fere recto divergentes.

forma **obtusum,** m.

Alae samarae angulo obtuso v. obtusissimo patentes.

subvar. **elegans**, m.

Alae samarae latiores, circ. 2 cm. longae 1 cm. latae apice rotundatae.

Nom. Jap.

Hab. in monte Gassan et Ohtōge.

subvar. **formosanum**, m.

A. duplicato-serratum, Hayata, in sched.

Folia 7-lobata lobis lineari-oblongis acutis inciso-serratis.

Nom. Jap. *Takasago-momiji*.

Hab. Formosa.

b. **hortense**, m.

subvar. **palmatilobum**, m.

forma **Sigitatsu**, m.

Folia 7—9-lobata incisa, secus costas utrinque aureo-maculata.

Nom. Jap. *Shigitatsu*.

Hab. in hortis culta.

forma **Nisikigasane**, m.

Folia aureo-guttata.

Nom. Jap. *Nishikigasane* (錦重).

Hab. culta.

forma **Asanoha**, m.

Folia 9-circumlobata lobis ovatis acuminatis inciso-serratis.

Nom. Jap. *Asa-no-ha*.

Hab. in hortis culta.

subvar. **palmatipartitum**, m.

Folia palmatipartita inciso-serrata v. lobulata, lobis omnibus fere aequiformibus.

forma **Monnisiki**, m.

Foliis lobis 5—7, profunde incisis vel pinnatifidisve, versus basin cuneato-angustatis.

Nom. Jap. *Mon-nishiki* (紋錦).
Hab. in hortis culta.

forma **Akitsusima**, m.

Foliis lobis 7—9, anguste oblongis incisis acuminatis.
Nom. Jap. *Akitsushima*.

forma **Tokonatsu**, m.

Foliis lobis 7, oblongis breve acuminatis incisis.
Nom. Jap. *Tokonatsu*.

forma **Yugure**, m.

Foliis lobis 7 oblongis breve acuminatis incisis, basalibus conniventibus.
Nom. Jap. *Yūgure*.

forma **Nokibata**, m.

Folia nascentia intense, in aestate pallide rosea.
Nom. Jap. *Nokibata* (軒端).
Hab. culta.

forma **Kihatsijō**, m.

Folia nascentia viridia, incisa, autumnales aurea deinde roseo-colorata.
Nom. Jap. *Ki-hachijō* (黄八丈).
Hab. culta.

forma **Kageorinisiki**, m.

Folia brunneo-aurantiaca mox atro-bruunea, incisa.
Nom. Jap. *Kageorinishiki* (鹿毛織錦).
Hab. in hortis culta.

forma **Siguresome**, m.

Foliis lobis 7 oblongis acuminatis incisis basi paullo angustatis.

Nom. Jap. *Shigurezome* (時雨染).
Hab. in hortis culta.

forma **Takinogawa**, m.

Folia 7-lobata basi truncata, lobis anguste oblongis caudato-acuminatis versus basin cuneato-angustatis.
Nom. Jap. *Taki-no-gawa* (瀧ノ川).

forma **Kurabuyama**, m.

Folia basi subtruncata, lobis 7 oblongis acuminatis versus basin angustatis.
Nom. Jap. *Kurabuyama*.

forma **Aoba**, m.

Folia palmatipartita incisa, intense viridia.
Nom. Jap. *Aoba* (青葉).
Hab. culta.

forma **Karukaya**, m.

Foliis lobis lineari-lanceolatis versus basin cuneatis caudato-acuminatis argutissime inciso-serratis; samarae alis loculisque horizontaliter patentibus.
Nom. Jap. *Karukaya* (刈茅).
Hab. in hortis culta.

forma **Murasakitaka**, m.

Folia subchartacea 5-6-7-lobata, purpurascentia; lobis incisis.
Nom. Jap. *Murasakitaka*.
Hab. in hortis culta.

forma **Asaji**, m.

Folia 7-lobata, lobis incisis subtus secus nervos parce adpresse pilosis.
Nom. Jap. *Asaji* (淺路).
Hab. culta.

forma **Akegarasu**, m.

Foliis lobis 7 oblongis incisis acuminatis.
Nom. Jap. *Ake-garasu*.

forma **Murehibari**.

Foliis lobis 5, oblongis acutis, suberoso-incisis.
Nom. Jap. *Mure-hibari*.

subvar. **heterolobum**, m.

Folia palmatipartita; laciniis valde polymorphis, in eodem folio una oblonga acuminata inaequaliter serrata, alteris lanceolato-linearibus incisis; ceteris pinnatifidis vel incisis.

forma **Wabibito**, m.

Folia margine roseo-guttata.
Nom. Jap. *Wabibito* (侘人).
Hab. culta.

forma **Sensunagasi**, m.

Foliis lobis brunneo vel roseo-marginatis.
Nom. Jap. *Sensu-nagashi* (扇子流).

forma **Hibari**, m.

Folia viridia, lobis angustioribus.
Nom. Jap. *Hibari* (雲雀).

subvar. **dissectum**, (Thg.) m.

A. dissectum, Thg. Fl. Jap. (1784) 16, et Icon. Pl. Jap. t. 45.
A. palmatum, var. *multifidum*, Koch. in Ann. Mus. Lugd. Batav. I. (1863—64) 251.
A. decompositum, Miq. in Catal. Hort. Amsteld. 275, (1866).
A. palmatum, var. *dissectum*, f. *rubrifolium*, Miq. Prol. Fl. Jap. (1867) 20.
A. palmatum, var. *dissectum*, (Thg.) Koch, Dendrol. I (1869). 224 :—Pax, l.c. 27 (1902).
A. palmatum, f. *dissectum*, S. et Z. Fl. Jap. II. (1870) 84.
A. palmatum, f. *decompositum*, S. et Z. l.c. 84.
A. palmatum, var. *dissectum*, (Thg.) Max. Mél. Biol. X. (1880) 608.

Folia 5-7-9-, rarius 11-secta, lobi anguste lanceolati pinnatifidi, inciso-serrati.

1. **multifidum,** m.

A. dissectum, Thg. l.c.

Folia palmatisecta lobis pinnatipartitis acuminatis, laciniis lineari-lanceolatis argute serratis.

forma **Aosidare,** m.

Folia viridia.
Nom. Jap. *Aoshidare* (青枝垂).

forma **Tamukeyama,** m.

Folia purpurea.
Nom. Jap. *Tamukeyama* (手向山). *Chirimen-kaede.*
Hab. in hortis frequens.

2. **palmatisectum,** m.

Folia palmatisecta, laciniis anguste oblongis utrinque acuminatis incisis.

forma, **Matsukaze,** m.

Folia purpurascentia.
Nom. Jap. *Matsukaze* (待風).
Hab. culta.

forma, **Ohsiusidare,** m.

Folia purpurascentia; ramis pendulis.
Nom. Jap. *Ohshiushidare* (奥州枝垂).

subvar. **sessilifolium,** (S. et Z.) Max. in Mél. Biol. X. (1880) 608;—Pax, l. c. 28.

A. sessilifolium, S. et Z. Fl. Jap. Fam. Nat. in Abh. Akad. München. (1846) 158.
Negundo sessilifolium, Miq. Prol. Fl. Jap. (1866) 21.

Petiolis brevissimis; foliis ternatis vel quinatis; foliolis ambitu lanceolato-oblongis acuminatis utrinque pinnatifidis vel partitis interdum pinnatisectis; limbis inaequaliter vel subduplicato-serratis.

NOM. JAP. *Hagoromo-kaede* (羽衣槭), *Kakuremino*.

HAB. in hortis culta.

Sect. 11. *Integrifolia*, PAX.

F. PAX, in ENGL. Bot. Jahrb. VII. (1886) 207, VI. (1885) 327.

Inflorescentia paniculata. Flores andro-polygami pentameri. Stamina 8 hypogyna, in flore ♂ perigyna. Discus extrastaminalis. Folia coriacea simplicia integra vel integerrima. Species unica.

25. **Acer oblongum**, WALL. (Tab. XXIX.)

WALL. in DC. Prodr. I. (1824) 593;—BENTH. Fl. Hongkon. 47;—HIERN in HOOK. Fl. Br. Ind. I. 693;—MAX. Mél. Biol. X. (1880) 599;—PAX in ENGL. Bot. Jahr. VII. (1886) 208, et Pfl. Reich. 8 Heft (1902) 31;—FORBES et HEMSL. in Jour. Linn. Soc. XXIII. 141;—ITO et MATSUM. Tent. Fl. Lutch. I. p. 120;—MATSUM. et HAYAT. En. Pl. Formos. 86;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 214;—DIELS in ENGL. Bot. Jahrb. XXIX. 499.

A. laurifolium, D. DON, Prodr. Fl. Nepal. (1825) 249.
A. buzimbala, BUCH. HAM. ex PAX. l. c.
A. Itoanum, HAYATA, in sched.
A. oblongum, var. *Itoanum*, HAYATA, in sched.
? *A. albo-purpurescens*, HAYATA, in sched. (Ramul. fragm. cum 4 fol.).

Arbor ramis vetustioribus cinerascentibus rugulosis; ramulis hornotinis brunnescentibus lenticellis minutis conspicue tectis. Folia coriacea utrinque laevia minute reticulato-venosa, oblonga rarius ovata vel ovato-elliptica interdum obovato-oblonga, obtuse acuminata, integra, basi saepissime rotundata trinervata, subtus glauca vel glaucescentia, 25-55 mm. lata 5-11 cm. longa; petiolis gracile elongatis. Inflorescentia dense corymboso-paniculata. Flores minuti andro-polygami; pedicellis dense rufo-puberulis; sepala oblonga apice rotundata 1-1,5 mm. longa extus dense rufo-puberula; petala oblongo-linearia 2—2,5 mm. longa alba v. lutescentia; stamina 8 exerta, antheris scabriusculis; discus extrastaminalis; ovarium puberulento-tomentosum, stylis profunde bilobatis. Samara glabra loculis plerumque horizontalibus, alis 1-1.5 cm. longa 4-10 mm. lata, angulo acuto vel obtuso divergentibus interdum subhorizontaliter patentibus.

NOM. JAP. *Kusu-no-ha-kaede.*

HAB. Liukiu et Formosa.

DISTR. China australi, Hongkong, Himalaya.

Sect. 12. *Trifoliata*, PAX.

F. PAX. in ENGL. Bot. Jahrb. VI. (1885) 323, VII. (1886) 203;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 193.

Inflorescentia umbellata. Flores andro-monoeci vel dioeci, pentameri. Stamina 10 (8—12) hypogyna. Discus extrastaminalis. Stylus apice bilobatus. Folia membranacea trifoliolata. Species unica.

26. **Acer nikoense**, MAXIM. (Tab. XXX.)

C. J. MAXIMOWICZ, in Mél. Biol. VI. (1867) 370;—FR. et SAV. En. Pl. Jap. I. (1875) 90;—PAX, in ENGL. Bot. Jahrb. VII. (1886) 205, et Pfl. Reich. 8 Heft (1902) 29;—LEVEIL. in Bull. Soc. Bot. Fr. VI. (1906) 591;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 211. (non. MIQ.).

A. Maximowiczianum, MIQ. in Arch. Neerlan. II. (1867) 472, 476 (*nec* PAX.)

NOM. JAP. *Chōja-no-ki*, *Meguro* (北越卉蝶; 日光山草木圖); *Kochō-no-ki*; *Seminoki*, *Ohmitsude-kaede* (nov.)

Arbor ramis validis cortice cinerascente; ramulis annotinis, foliis subtus, petiolis pedicellisque canescento-tomentosis. Folia ternata membranacea supra sparce pilosa subtus secus costas praesertim petiolisque hirsuto-tomentosa; petiolis erecto-patentibus; foliolis mediis oblongis petiolulatis, lateralibus oblique oblongis subsessilibus, omnibus integerrimis obtusis, rarius obscuriter vel inaequaliter remote obtuse dentatis. Inflorescentia triflora, floribus andro-dioeciis albis coaetaneis; bracteolis linearibus caducis. Sepala 5 glabra v. extus parce puberula, obovata v. ovata basi vix unguiculata. Petala obovata basi angustata sepalum aequilonga. Stamina circ. 10-12 exerta, antheris laevibus. Discus crenatus extrastaminalis. Ovarium puberulento-tomentosum stigmatibus revolutis. Samara 3.5-5 cm. longa, loculis pubescento-tomentosis; alis circiter 13-14 mm. latis anguloobtuso divergentibus.

Hab. Hondō: Azumasan (Uzen); Aidzu (Iwashiro); Nikko; Togakushiyama; Prov. Kozuke; Ōyama (Sagami); Chichibu (Musashi). Shikok: Prov. Awa; Kiushiu: Prov. Hizen, Higo.

Distr. China centralis: Hupeh (sec. C.K. Schneider).

Sect. 13. *Platanoidea*, Pax.

F. Pax in Engl. Bot. Jahrb. VI. (1885) 327, VII. (1886) 233;—C. K. Schn. Ill. Handb. Laubh II. (1907) 193.

Inflorescentia corymboso-paniculata. Flores andro-polygami pentameri. Stamina 8 hypogyna in flore ♂ perigyna. Discus extrastaminalis. Stylus profunde bilobatus. Folia membranacea palmatilobata, lobis integerrimis grosse sinuato-dentatis. Species 2.

Clavis specierum.

* Foliis lobis lobulatis obtuse acuminatis; samarae loculi tomentosi..*A. Miyabei*, Max.

Foliis lobis integris acuminatis; samara glabra..*A. pictum*, Thunb.

27. **Acer Miyabei**, Max. (Tab. XXXI.)

C. J. Maximowicz, Mél, Biol. XII. (1888) 725;—Pax in Engl. Pfl. Reich, 8 Heft (1902) 53;—Makino, Tokyo Bot. Mag. (1904) 114;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 229;—Leveil. in Bull. Soc. Bot. Fr. VI. (1905) 591.

A. Hayatae, Leveil. et Vnt. in Bull. Soc. Bot. Fr. VI. (1905) 590.

Arbor ramulis novellis glabris vel puberulis. Gemmae perulae interiores oblongae apice rotundatae vel obtusae extus pubescento-tomentosae, exteriores ovatae coriaceae. Folia membranacea nascentia utrinque densius adulta subtus ad venas parce pubescentia, quinquenervia, 5-fida, elongato-petiolata, basi cordata; lobis obtusiter acuminatis utrinque paucilobulolatis. Inflorescentia paniculata; floribus foliis coaetaneis fulvo-sulphureis; pedicellis pilosis. Sepala 5 oblonga apice rotundata extus pilosa. Petala 5 pilosa anguste spathulata sepalis aequilonga. Stamina 8 in flore ♂ parum exerta, antheris rotundatis glabris. Discus carnosus 8-crenulatus extrastaminalis. Ovaria dense puberula stylis ultra medium bilobatis. Samarae loculi semiorbiculati fulvescenti-velutini; alae oblongae horizontaliter patentes.

NOM. JAP. *Kurobi-itaya* (K. MIYABE).

HAB. Yezo: Prov. Ishikari, Iburi, Hidaka; Hondō: Kurobegōri, Hayachine, Imoda, Shige, Kadoma (Rikuchiu).

DISTR. endemica.

28. **Acer pictum**, THUNB. (Tab. XXXII.)

THUNBERG, Fl. Jap. (1784), 161, et Icon. Fl. Jap. dec. V. t. 1 :—SIEB. et ZUCC. Fl. Jap. Fam. Nat. in Abh. Akad. Münch. IV. 2. (1846) 156 ;—A. GRAY in PERRY, Exped. Jap. 310 ;—C. KOCH, in MIQ. Ann. Mus. Lugd. Batav. I. 251 :—MIQ. Prol. Fl. Jap. (1866) 19 ;—FR. et SAV. En. Pl. Jap. I. (1875) 87, et II. (1879) 318 :—MAX. Mél. Biol. X. (1880) 594 ;—PAX. Engl. Bot. Jahr. VII. (1886) 235, et. Pfl. Reich. 8 Heft. (1902) 47 :—LEVEIL. Bull. Soc. Bot. Fr. VI. ENGL. (1906) 592 ;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 225 ;—C. KOCH, Dendrol. I. p. 531 :—FORB. et HEMSL. Jour. Linn. Soc. XXIII. 141 ;—MIYABE, Fl. Kuril. 223 ;—NAKAI, Fl. Korea. I. p. 133 ;—PALIB. Consp. Fl. Korea. III. p. 46 :—FRANCH. Pl. David. 77 ;—DIELS in ENGL. Bot. Jahrb. XXIX. 499 ;—SARGENT, Forest Fl. Jap. 28 ;—KOIDZ. Pl. Sachal. (1910) 89.

A. truncatum, FR. et SAV. En. Fl. Jap. I. (1875) 87, et I. (1879) 320 (*non* BGE.)

A. Mono, MAX. in Bull, Phys. Math. Akad. Petrop. XV. 126, et Prim. Fl. Amur. 68 :—REGEL, Fl. Uss. 35 ;—SCHMIDT, Fl. Sachal. 119 :—KOMARO. Fl. Mansh. II. 73.

A. pictum, var. *mono*, KORSH. in Act. Hort. Petrop. XII. 318.

A. laetum, var. *parviflorum*, REGEL in Bull. Phy. Math. Akad. Petrop. XII. 219.

A. ambiguum, DIPPEL (*nec.* HEER) Laubh. II. 457, fig. 218 ;—PAX in ENGL. Pfl. Reich. 8 Heft. (1902) 47. (serculus sterilis !)

A. pictum, var. *ambiguum*, PAX, in ENGL. Bot. Jahrb. XVI, 401 ;—C. K. SCHN. Ill. Handb. Laubh. II. (1907) 225.

A. pictum, var. *Paxi*, GR. v. SCHW. in Gart. Fl. (1893) 458

A. Dippeli, GR. v. SCHW. in Gart. Fl. XLII. (1893) 460.

A. Mayri, GR. v. SCHW. in Mittl. D. D. G. (1901) 58 ;—MAYR, Fremdl. Wald u. Parkb. fig. 150.

NOM. JAP. *Tokiwa-kaede*, *Tsuta-momiji*, *Shiraki-kaede* (文化六年. 水谷助六氏. 物品識名. 1809.); *Itagi*, *Yorokko-kaede* (文化七年. 水谷豐文氏. 木曾採藥記. 1810); *Itaya-kaede* (皇方物産誌): *Oh-kaede* (貝原篤信氏. 大和本草); *Oh-tsuta-momiji*, *Kibune-momiji*, *Itagi-kaede* (J. MATSUMURA, Shokubutsu-Meii. no. 42); *Sarukaede*, *Ao-kaede*, *Iwane-kaede* (草木名寄.), *Itaya*; *Tokiwa*.

Arbor magnus ramis ramulisque ab initio glabris. Gemmae perulae interiores oblanceolato-oblongae apice obtuse rotundatae extus ferrugineo-velutinae aut pubescentes. Folia maxime variabilia (Fig. 3—6.) membranacea deinde subchartacea elongato-petiolata, subtus plus minus hirta, ambitu rotundata semirotundata vel orbiculato-reniformia, (3—) 5 (—9) lobata, basi subtruncata cordata aut rotundata; lobis triangulari-ovatis integris subcaudato acuminatis vel acutis; petiolis gracile elongatis. Flores andropolygami sulphurei, foliis coaetanei, in paniculam glabram plurifloram dispositi; pedicellis ebracteolatis. Calyx glaber sepalis 5 late oblongis apice rotundatis. Petala 5 anguste oblonga sepalis aequilonga. Stamina 8 disci medio inserta; antheris rotundatis

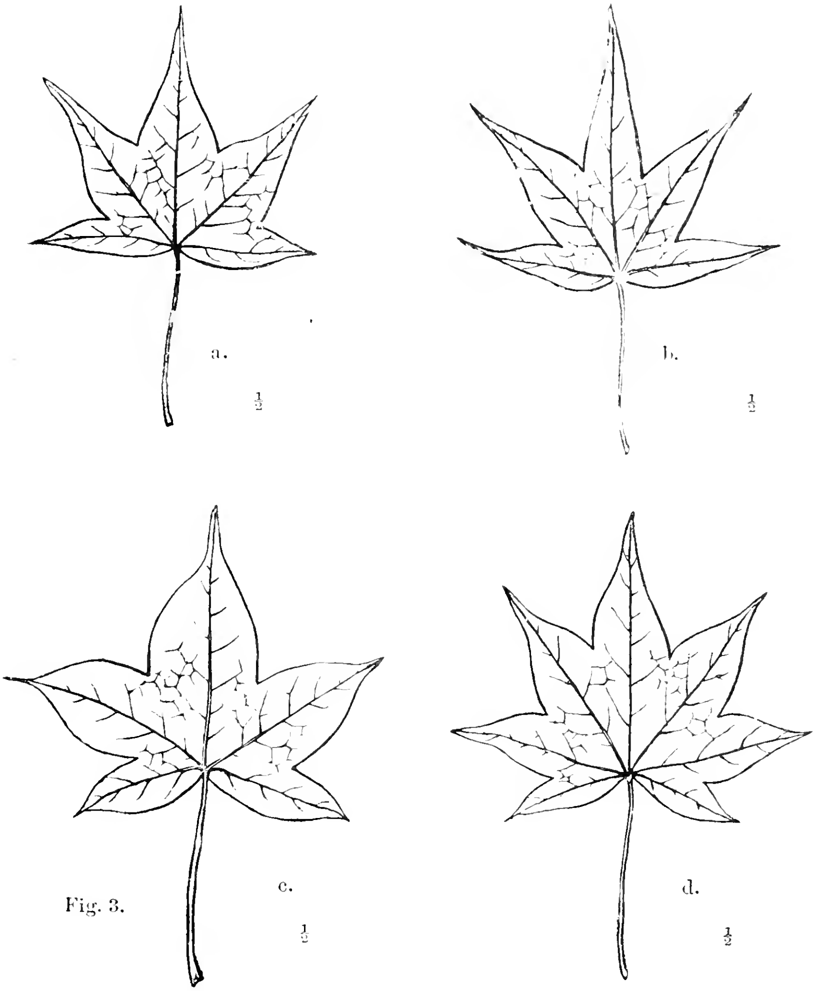


Fig. 3.

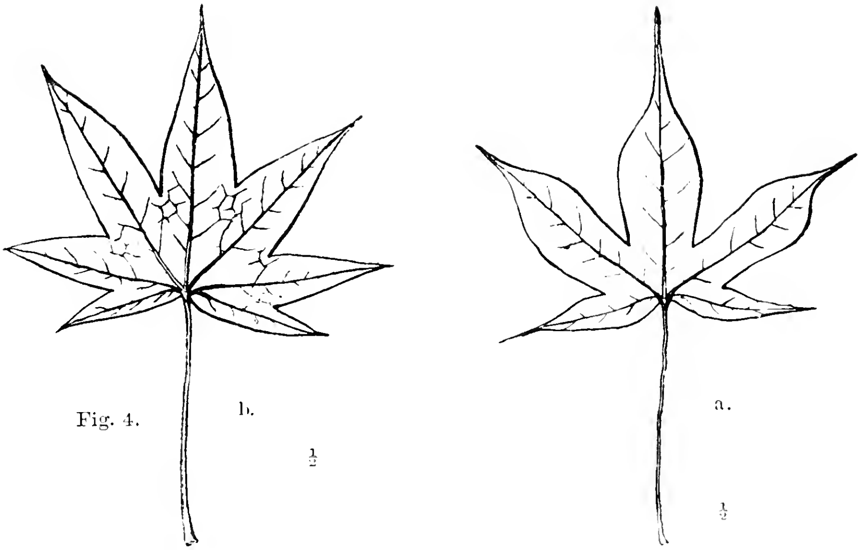


Fig. 4.

laevibus. Discus carnosus extrastaminalis margine crenato. Ovaria glabra stylis profunde bilobatis, laciniis revolutis intus stigmatosis. Samara glabra, alis loculis circiter duplo longioribus in variis angulis divergentibus.

NOM. VULG. *Itaya-Kaede.*

HAB. Saghalin, Kuril, Yezo, Hondō, Shikok et Kiushiu.

DISTR. Korea, China, Manshuria, et Amur.

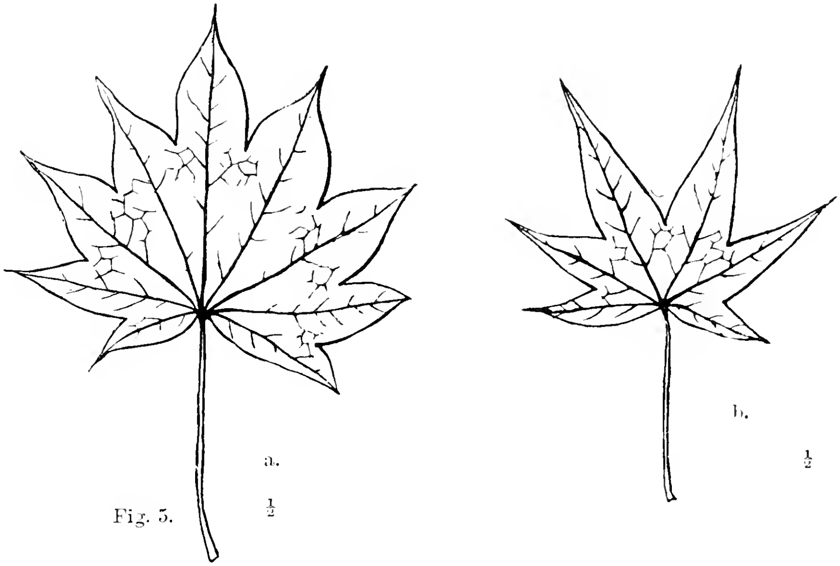


Fig. 5.

α. **typicum**, Gr. v. Schw., in Gartn. Fl. XLII. (1893) 458;—Pax, in Engl. Pfl. Reich 8 Heft. (1902) 47.

Folia glabra vel subtus secus nervos plus minus pubescentia et in axillis costarum tomentosa, 5 (—9)-lobata, basi subtruncata, vel aperte cordata; lobis ovatis vel ovato-lanceolatis longe acuminatis. Planta juvenilis, serculi steriles et innovatio novus foliis valde abnormalibus (fig. 6.) plerumque basi profunde cordatis lobis basalibus parallelis.

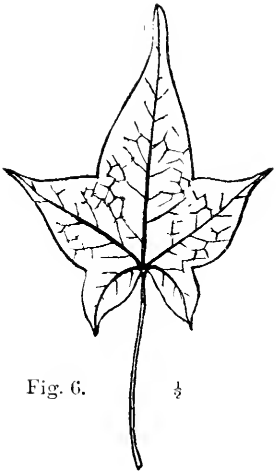


Fig. 6.

Subvar. 1. **eupictum**, Pax, l. c. 47.

A. pictum, var. *eupictum*, Pax, Bot. Jahrb. VII. 236.

Folia plerumque 5-lobata triloba immixta; alae samarae angulo acuto divergentes.

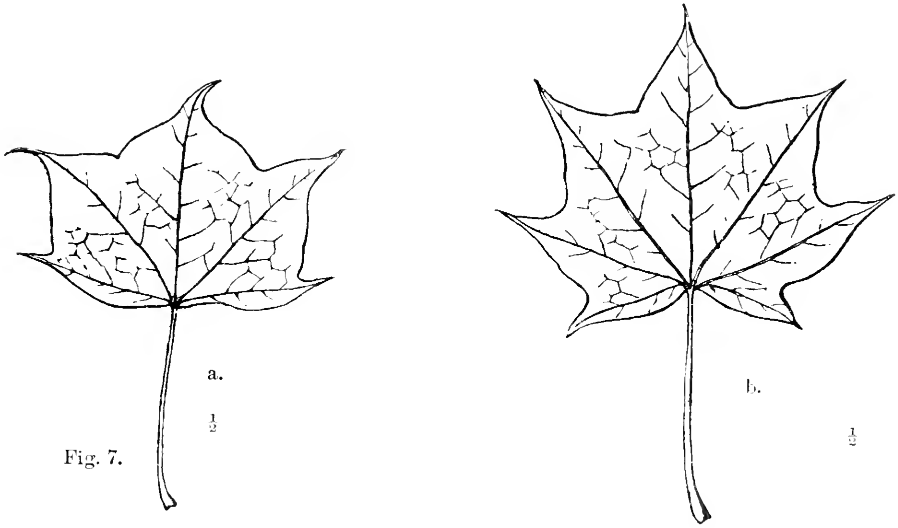


Fig. 7.

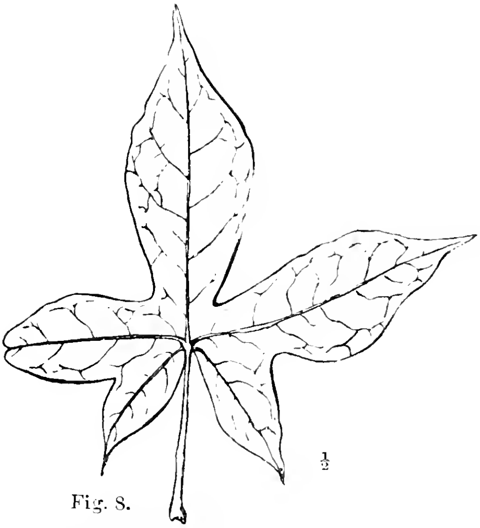


Fig. 8.

Nom. Jap. *Itayakaede.*

Hab. Yezo: Sapporo, Konuma (Oshima). Hondō: Adzumasan, Nikkosan, Togakushiyama, Chichibu, Kiso, prov. Hida. Shikok. Tosa.

Subvar. 2. **Mono**, (Max.)

Pax, in Engl. Pfl. Reich. 8 Heft. (1902) 47;—Nakai, l.c. 133.

A. Mono, Max. Prim. Fl. Amur. 68.

A. pictum, var. γ. *Mono*, Max. Mél. Biol. X. 600.

A. laetum, var. *parviflorum*, Regel, in Bull. Akad. St. Petersbg. XV. (1857) 219;—C. K. Schn. l. c. 225.

Folia 5-lobata. Samarae alae angulo fere recto divergentes.

Nom. Jap. *Itayakaede.*

Hab. Yezo: Rishiri, Shiribesi; Hondo: Iwatesan, Nikko, Chichibu, Hakusan.

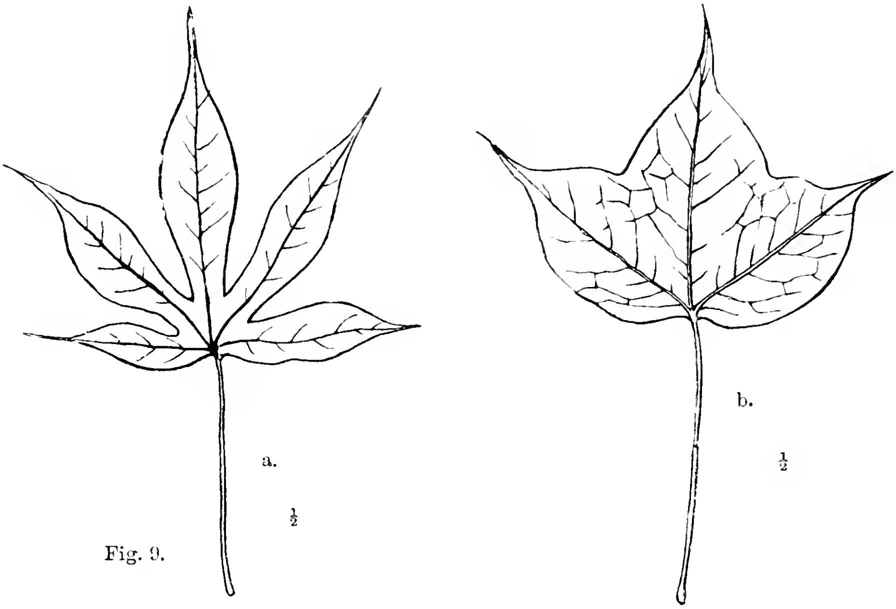


Fig. 9.

Subvar. 3. **Savatieri,** Pax, in Engl. Bot. Jahrb. VII. 236, et Pfl. Reich. l.c. 47;—Nakai, l.c. 133 (fig. 7.)

Folia plerumque 7-lobata pentaloba immixta, basi profunde cordata; lobis late triangularibus subito acuminatis. Alae samarae subhorizontaliter vel angulo subobtuso divergentes.

Nom. Jap. *Itomaki-itaya.*

Hab. Yezo: Jōzankei; Hondō: Chichibu, Hakusan, Nikkōsan, Azumasan, Iwateyama, Togakushiyama, Hakkodasan, Sengantōge.

forma **septenlobum,** m.

forma **novemlobum,** m. (fig. 5, a.)

Subvar. 4. **Mayri,** (Gr. v. Schw.) m.

Acer Mayri, Gr. v. Schw. in Mitt. D. D. G. l. c; Pax, l.c.

Folia plerumque 5-lobata 7 loba immixta. Alae Samarae rectae paralleles saepe versus apicem conniventes.

Nom. Jap. *Itayakaede.*

Hab. Yezo: Sapporo, Konuma, Jōzankei; Hondō: Hakkōdasan; Sawanouchi, Sengantōge (Rikuchiu); Azumasan; Matsumine (Shōnai); Ikaho; Nikko; Togakushiyama, Ontake. Sikok: Tsurugisan; Nanogawa (Tosa).

Subvar. 5. **Futagoyama,** m. (fig. 8.)

Nom. Jap. *Futagoyama* (双子山).

Hab. in hortis culta.

var. β. **Paxii,** Gr. v. Schw. l. c. 458;—Pax, l.c. 47.

Folia 5-lobata subtus pubescentia.

Nom. Jap. *Oni-itaya.*

Hab. Iidesan (Uzen).

Distr. Korea.

var. γ, **dissectum,** Wesmael, in Bull. Soc. Bot. Belgique (1890) 56;—Pax, l.c. 47. (Fig. 9, a.)

A. pictum, var. *angustilobum,* Makino, Bot. Mag. Tokyo VI. 51. (nomen nudum)

Folia glabra subtus in axillis costarum tomentella, palmato 5—7 partita; laciniis lanceolatis vel anguste oblongis acuminatis.

NOM. JAP. *Asahi-kaede.*

HAB. Hondō: Goyōzan, (Rikuchiu); Awone (Rikuzen); Fukushima (Iwashiro); Nikkōsan, prov. Kōzuke; Hakone, Ohyama, Yugashima; Chichibu; Amagisan. Sikok: Tsurugisan.

Subvar. **subtrifidum,** MAKINO. Bot. Mag. Tokyo (1904) 114.

Folia fere semper tripartita.

NOM. JAP. *Yaguruma-kaede.*

HAB. Takaoyama (Musashi).

var. δ. **glaucum,** m.

Gemmae perula extus puberula. Folia minora circ. 7 cm. longa ac lata, palmato 5-fida, subtus glauca in basin costarum vix pilosa; lobis lanceolato-ovatis acuminatis. Samara glabra minor 16—20 m.m. longa, alis subhorizontaliter patentibus 10—12 m.m. longis 7—8 mm. latis.

NOM. JAP. *Urajiro-itaya.* (nov.)

HAB. Mogariyama (Uzen).

subvar. **latilobum,** m.

Folia minor 4—5 cm. longa ac lata, ambitu quadrangulata 5-lobata 3-loba (fig. 9. b.) immixta, basi truncata rarius rotundata, lobis deltoideis subito acuminatis. Samara ut in praecedente.

NOM. JAP. *Urajiro-itomaki-itaya.* (nov.)

HAB. Azumayama (Uzen).

Sect. 14. *Diabolica,* m.

Inflorescentia corymbosa. Flores dioeci. Sepala fl. ♂ 5 inter se connata, in fl. ♀ libera. Petala fl. ♂ 1—5 cum sepalis connata, in fl. ♀ libera. Stamina 8—9 perigyna. Stylus profunde bilobatus. Discus extrastaminalis. Folia membranacea simplicia palmatilobata. Species unica in Hondō incola.

29. **Acer diabolicum**, Blume. (Tab. XXXIII.)

C. Koch, in Miq. Ann. Mus. Lugd. Batav. I. (1863—64) 251;—Miq. Prol. Fl. Jap. (1865—66) 20;—Fr. et Sav. En. Pl. Jap. I. (1875) 87, II. (1879) 320;—Max. Mel. Biol. X. (1880) 593;—Pax, in Engl. Bot. Jahrb. VII. (1886) 251;—Leveil. Bull. Soc. Bot. Fr. VI. (1903) 590;—Pax in Engl. Pfl. Reich. 8 Heft (1902) 71;—C. K. Schn. Ill. Handb. Laubh. II. (1907) 241.

A. purpurascens, Fr. et Sav. l.c. II. 320;—Max. Mel. Biol. X. (1880) 593;—Pax, l. c. 251, et 71;—Leveil. l. c. 592.

A. diabolicum, var. *purpurascens*, Rehder in Sarg. Tree. Shr. I. (1905) 134;—C. K. Schn. l.c. 242.

Nom. Jap. *Oni-momiji* (文政八年.水谷助六氏.物品識名拾遺. 1825); *Kiriha-kaede* (阿濃產誌); *Kaji-kaede* (J. Matsumura, Shokubutsu-Meii, no. 43).

Arbor 10—20 metralis, ramuli novelli pubescentes. Gemmae perulae interiores lanceolatae, intimae longe spathulatae ferrugineo-tomentosae. Folia membranacea demum subchartacea, juvenilia supra pubescentia subtus villoso-tomentosa ad margines ciliata, adulta tantum subtus ad venas pubescentia, circumscriptione suborbicularia, basi cordata, quinque-lobata; lobis ellipticis grosse obtuse pauci-dentatis, apice obtuse productis, infimis multo minoribus; petiolis quam lamina brevioribus nunc glabris nunc versus apicem adpresse pilosulis. Umbella 5—10-flora, floribus coaetaneis mediocribus purpurascentibus; pedicellis adpresse pilosis inferne bracteolatis in anthesi nutantibus. Calyx campanulatus sepalis 5 ellipticis apice rotundatis in flore ♂ connatis. Petala 5 albo-rosea sepalis aequilonga, in flore ♂ cum sepalis adnata. Discus crenatus extrastaminalis. Stamina 8 filamentis antherisque laevibus in anthesi exerta. Ovaria tomentosa stylis ad basin bipartitis. Samara cum loculis circ. 3—3,5 cm. longa; loculis in faciebus cristatis, adpresse ferrugineo-tomentosis, extus distincte carinatis; alis saepe parallelis vel fere angulo recto divergentibus.

Hab. Hondō: Nikkōsan; Ikaho; Chichibu; Mitake (Musashi); Usuitōge; Hakone; prov. Owari. Shikok: Tsurugisan; Nanogawamura (Tosa). Kiusiu: Inutake (Buzen).

Distr. endemica.

(*Finis*).

Distributio geographicalis specierum in Arcipelago Japonico.

Loc. / Spec.	Saghalin.	Kuril.	Yezo	Hondo bor.	Hondo med.	Hondo aust.	Sikoku.	Kiusiu	Liukiu.	Formosa.
A. parviflorum				×	×	×	×	×		
A. distylum				×	×	×				
A. crataegifolium				×	×	×	×	×		
A. insulare								×	×	
A. Kawakamii										×
A. ovatifolium										×
A. morrisonense										×
A. carpinifolium				×	×	×	×	×		
A. rufinerve				×	×	×	×	×		
A. capillipes				×	×					
A. rubescens										×
A. micranthum				×	×	×	×	×		
A. Tschonoskii			×	×	×		×			
A. argutum				×	×					
A. cissifolium			×	×	×	×	×	×		
A. rubrum					×					
A. trifidum										×
A. Ginnala			×	×	×	×	×	×		
A. spicatum	×	×	×	×	×					
A. Oliverianum										×
A. Sieboldianum				×	×	×	×	×		
A. Shirasawanum				×	×					
A. japonicum			×	×	×	×	×	×		
A. palmatum			×	×	×	×	×	×		×
A. oblongum									×	×
A. nikoense				×	×	×	×	×		
A. Miyabei			×	×						
A. pictum	×		×	×	×	×	×	×		
A. diabolicum				×	×	×	×	×		

INDEX.

sectionum, specierum et synonymorum.

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G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE I.

EXPLICATIO TABULAE I.

Acer parviflorum, Fr. et Sav.

1. Ramulus fructifer (mag. nat.).
2. Flos ♂ (aug.).
3. Stamen (valde aug.).
4. Flos hermaphroditus (aug.).
5. Verticalis ejus sectio (aug.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

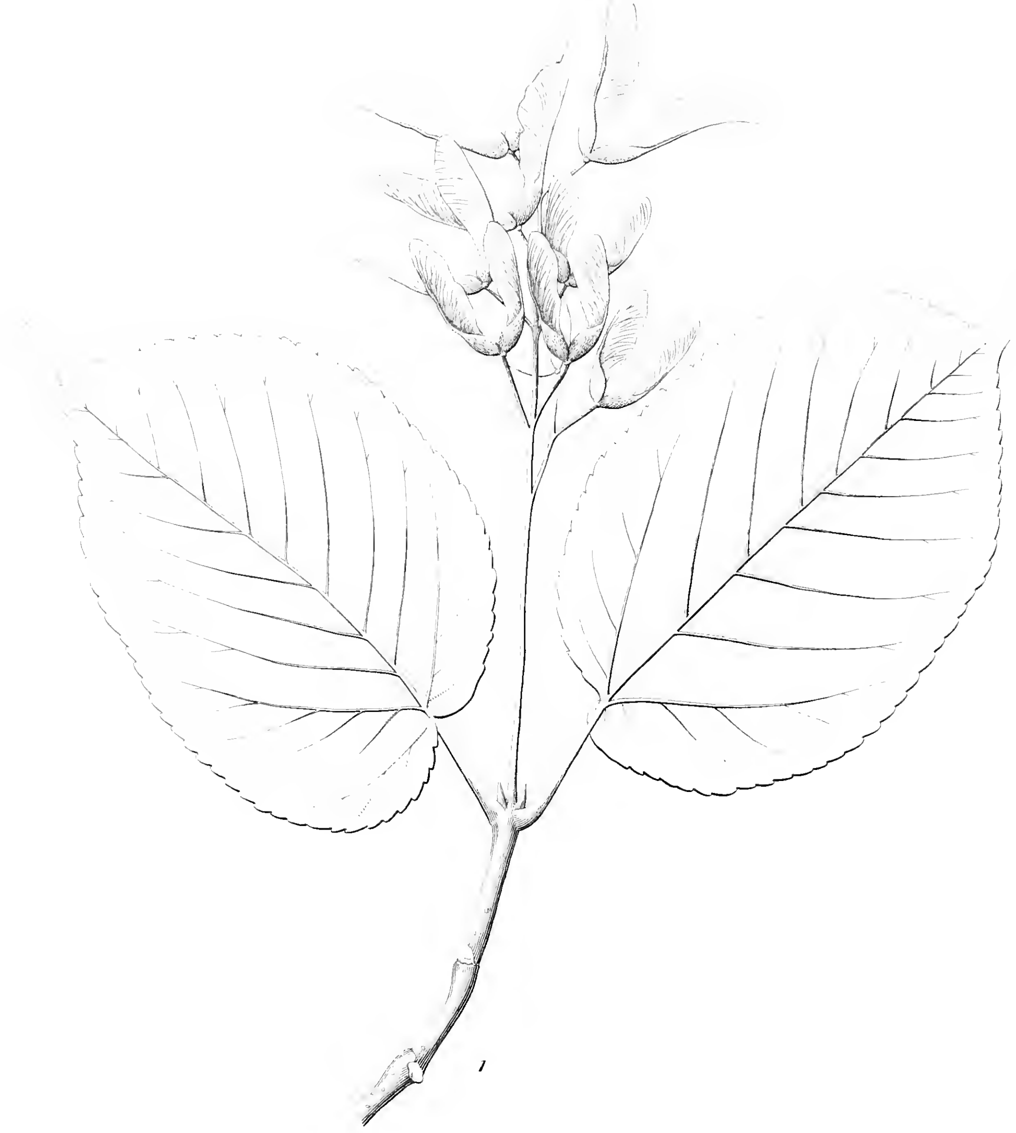
REVISIO ACERACEARUM JAPONICARUM.

PLATE II.

EXPLICATIO TABULAE II.

Acer distylum, S. et Z.

1. Ramulus fructifer (mag. nat.).
2. Flos ♂ (aug.).
3. Sectio ejus verticalis (aug.).



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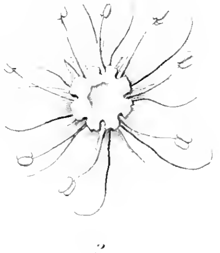

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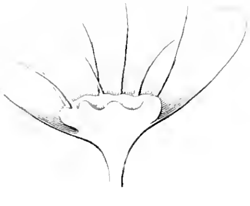

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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE III.

EXPLICATIO TABULAE III.

Acer crataegifolium, S. et Z.

1. Ramuli fructiferi (mag. nat.).
2. Flos hermaphroditus, sepalis petalisque decisis (aug.).
3. Floris ♂ sectio verticalis (aug.).

1

3

2

G. Koidzumi del.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE IV.

EXPLICATIO TABULAE IV.

Acer insulare, Makino.

1. Ramulus fructifer (mag. nat.).
2. Flos hermaphroditus (aug.).

G. Koidzumi del.

Fujisawa sculp.

G. KOIDZUMI.

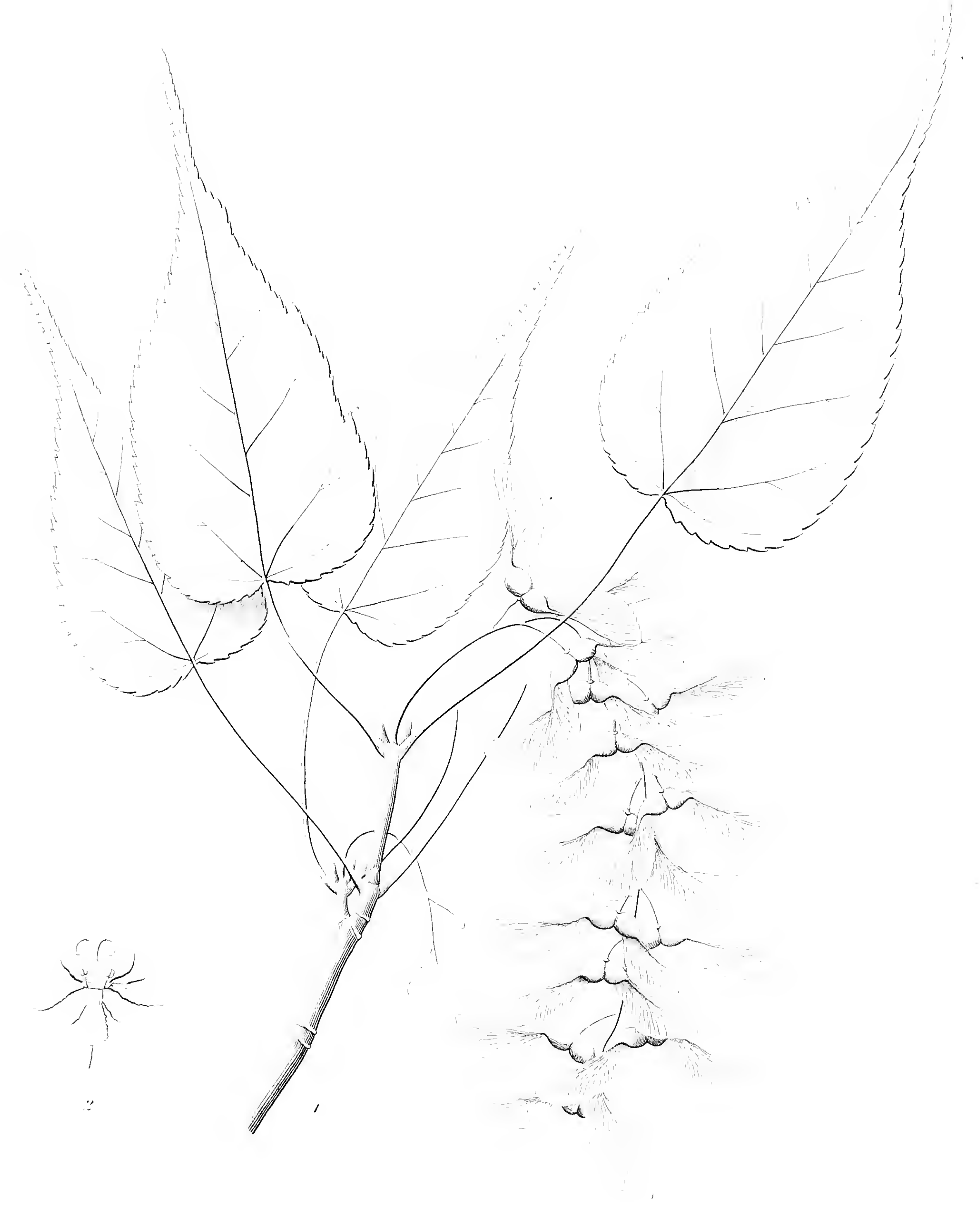
REVISIO ACERACEARUM JAPONICARUM.

PLATE V.

EXPLICATIO TABULAE V.

Acer Kawakamii, Koidz.

1. Ramulus fructifer (mag. nat.).
2. Flos hermaphroditus (aug.).



G. Koidzumi del.

F. Fujisawa sculp.

PLATE VI.

EXPLICATIO TABULAE VI.

Acer ovatifolium, Koidz.

1. Ramulus fructifer (mag. nat.).

2. Folium (mag. nat.).

3.–4. Fructus (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE VII.

EXPLICATIO TABULAE VII.

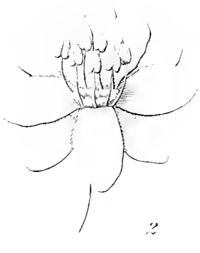
Acer morrisonense, Hayata.

1. Pars plantae floriferae (mag. nat.).

2.-3. Flos ♂ (aug.).

4. Folium adultum (mag. nat).

1



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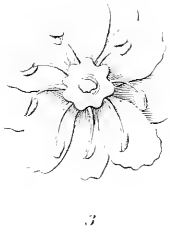

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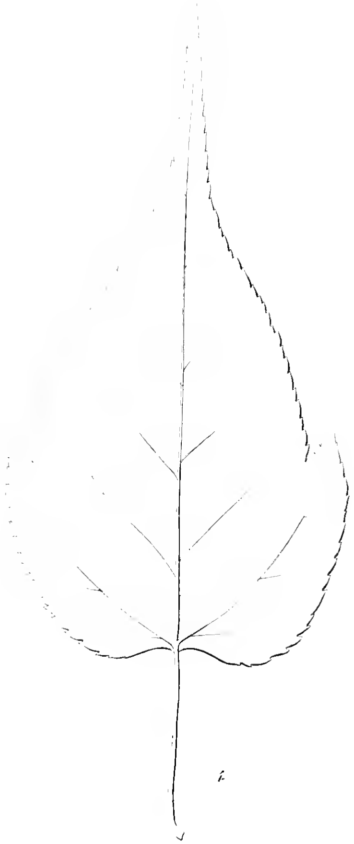

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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE VIII.

EXPLICATIO TABULAE VIII.

Acer carpinifolium, S. et Z.

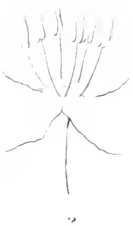
1\. Ramulus fructifer (mag. nat.).

2.-4. Flos ♂ (aug.).

3\. Sectio ejus verticalis (aug.).

5\. Flos hermaphroditus (aug.).

1



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G. Koidzumi del.

T. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE IX

EXPLICATIO TABULAE IX.

Acer rufinerve, S. et Z.

1. Ramulus fructifer (nat. mag.).
2. Flos hermaphroditus, sepalis petalisque decisis (aug.).
3. Verticalis ejus sectio (aug.).
4. Sectio verticalis fl. ♂ (aug.).
5. Sepalum (aug.).
6. Petalum (aug.).

G. Koidzumi del.

F. Fujisawa sculp.

PLATE X.

EXPLICATIO TABULAE X.

Acer capillipes, Max.

1. Pars plantae (mag. nat.).
2. Flos hermaphroditus (aug.).
3. Sectio ovarii verticalis (aug.).
4. Flos ♂ (aug.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

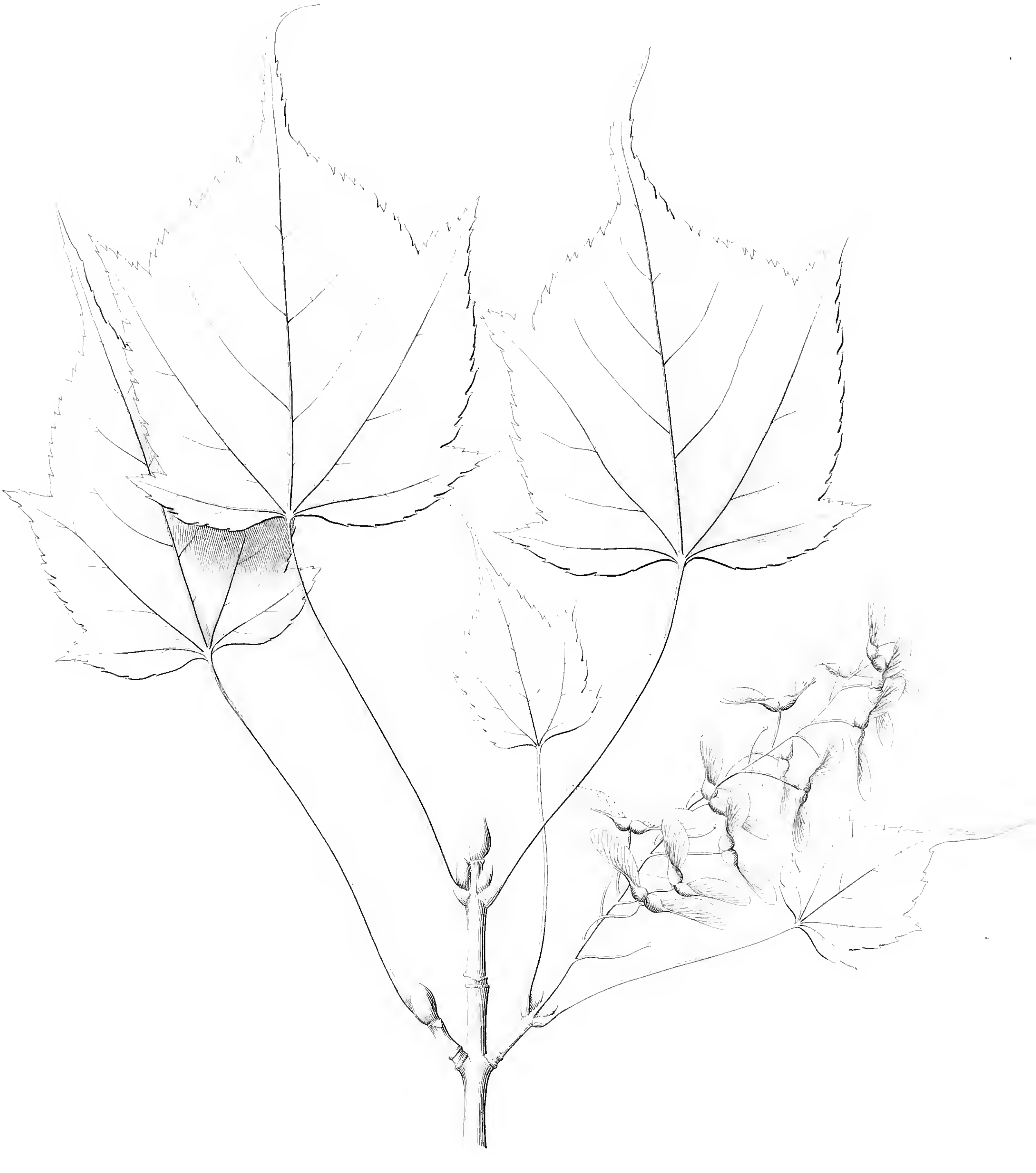
REVISIO ACERACEARUM JAPONICARUM.

PLATE XI.

EXPLICATIO TABULAE XI.

Acer rubescens, Hayata.

Pars plantae fructiferae (mag. nat.).



G. Koidzumi del.

F. Fujisaw. [illegible]

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XII.

EXPLICATIO TABULAE XII.

Acer micranthum, S. et Z.

1. Pars plantae fr. (mag. nat.).
2. Sectio verticalis fl. ♂ (aug.).
3. Stamen (valde aug.).
4. Flos hermaphroditus (aug.).
5. Fructus alis in angulo fere recto divergentibus (leviter aug.).
6. Folium (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

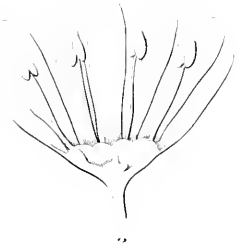
PLATE XIII.

EXPLICATIO TABULAE XIII.

Acer Tschonoskii, Max.

1. Pars plantae fr. (mag. nat.).
2. Sectio verticalis fl. ♂ (aug.).
3. Stamen (aug.).
4. Flos hermaphroditus (aug.).
5. Sectio ovarii verticalis (aug.).

1



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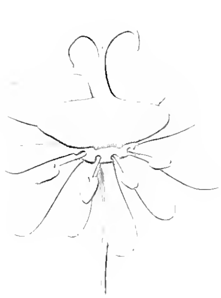

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G. Koidzumi del.

F. Fujisawa sculp.

PLATE XIV.

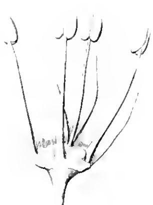
EXPLICATIO TABULAE XIV.

Acer argutum, Max.

1. Ramulus fructifer (mag. nat.).
2. Flos ♂ (aug.).
3.-4. Verticalis ejus sectio (aug.).
5. Flos ♀ (aug.).
6. Flos ♀ cum staminibus abortivis (aug.).
7. Sectio ovarii verticalis (aug.).

1

2



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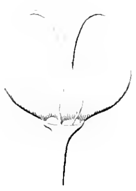

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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XV.

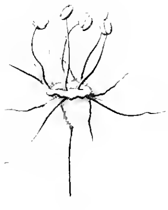
EXPLICATIO TABULAE XV.

Acer cissifolium, S. et Z.

1. Pars plantae fructiferae (mag. nat.).
2. Flos ♀ (valde aug.).
3. Flos ♂ (valde aug.).
4. Fructus mat. (leviter aug.).

1

4



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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XVI.

EXPLICATIO TABULAE XVI.

Acer rubrum, L.

1. Pars plantae fructiferae (mag. nat.).
2. Folia varia (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XVII.

EXPLICATIO TABULAE XVII.

Acer trifidum, Hook. et Arn.

1. Pars plantae (mag. nat.).
2. Sectio floris ♂ verticalis (aug.).
3. Stamen fl. ♂ (aug.).
4. Flos hermaphroditus (aug.).
5. Verticalis ejus sectio (aug.)
6. Sectio ovarii transversalis (aug).
7. Fructus (mag. nat.).

Acer trifidum, var. *formosanum*, Hay.

8. Folium (mag. nat.).
9. Fructus (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp.

PLATE XVIII.

EXPLICATIO TABULAE XVIII.

Acer Ginnala, Max.

1. Pars plantae (mag. nat.).
2. Flos ♂ (aug.).
3. Verticalis ejus sectio (aug.).
4. Flos hermaphroditus (aug.).
5. Sectio ovarii verticalis (aug.).

Acer Ginnala, var. *yezoense*, Koidz.

6. Fructus (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XIX.

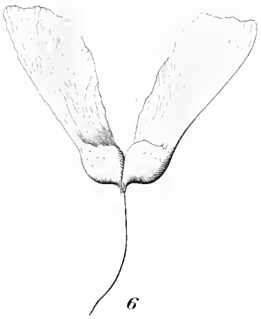
EXPLICATIO TABULAE XIX.

Acer spicatum, Lam., var. *ukurunduense*, Max.

1. Pars plantae (mag. nat.).
2. Flos ♂ (aug.).
3. Verticalis ejus sectio (aug.).
4. Flos hermaphroditus, sepalis petalis staminibusque dicisis (aug.).
5. Sectio ovarii verticalis (aug.).
6. Fructus (mag. nat.).
7. Stamen (aug.).

1

2



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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XX

EXPLICATIO TABULAE XX.

Acer Oliverianum, Pax, var. *Nakaharae*, Hayata.

1. Pars plantae fr. (nat. mag.).
2. Flos ♂ (aug.).
3. Flos hermaphroditus (aug.).

Svar. *formosanum*, Koidz.

4. Folium (mag. nat.).

Svar. *trilobatum*, Koidz.

5. Folium (mag. nat.).

G. Koidzumi del.
F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXI.

EXPLICATIO TABULAE XXI.

Acer Sieboldianum, Miq.

1. Ramulus fructifer (mag. nat.).
2. Sectio floris ♂ verticalis (aug.).
3. Stamen (aug.).
4. Flos hermaphroditus, petalis decisis (aug.).
5. Sepalum (aug.).
6. Petalum (aug.).
7. Fructus (mag. nat.).

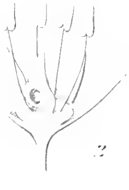
var. *tsusimense*, Koidz.

8. Folium (mag. nat.).

subvar. *laxiflorum*, Koidz.

9. Folium (mag. nat.).


1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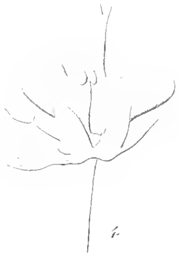
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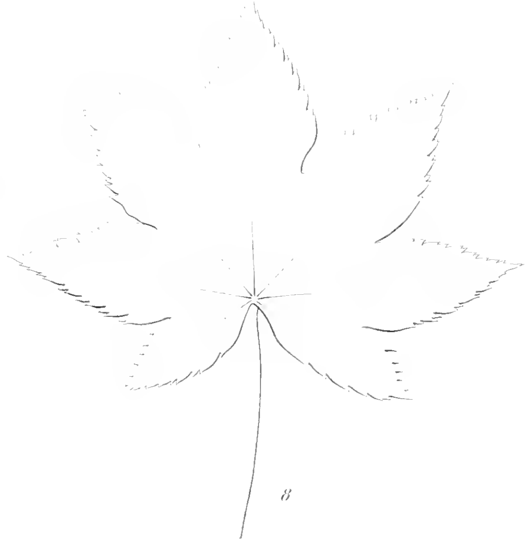
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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXII.

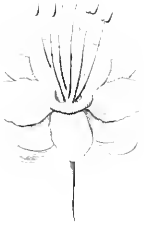
EXPLICATIO TABULAE XXII.

Acer Shirasawanum, Koidz.

1. Pars plantae fr. (mag. nat.).
2. Foliis lobus (mag. nat.).
3. Flos ♂ (aug.).
4. Stamen (aug.).
5. Flos hermaphroditus, (aug.) sepalis petalisque decisis.
6. Fructus (mag. nat.).


1


2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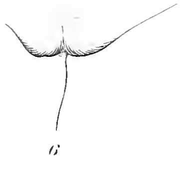
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G. Koidzumi del.

T. Imasawa sculp.

PLATE XXIII.

EXPLICATIO TABULAE XXIII.

Acer Shirasawanum, Koidz. var. *tenuifolium*, Koidz.

1. Ramulus fructifer (mag. nat.).

G. Koidzumi del.

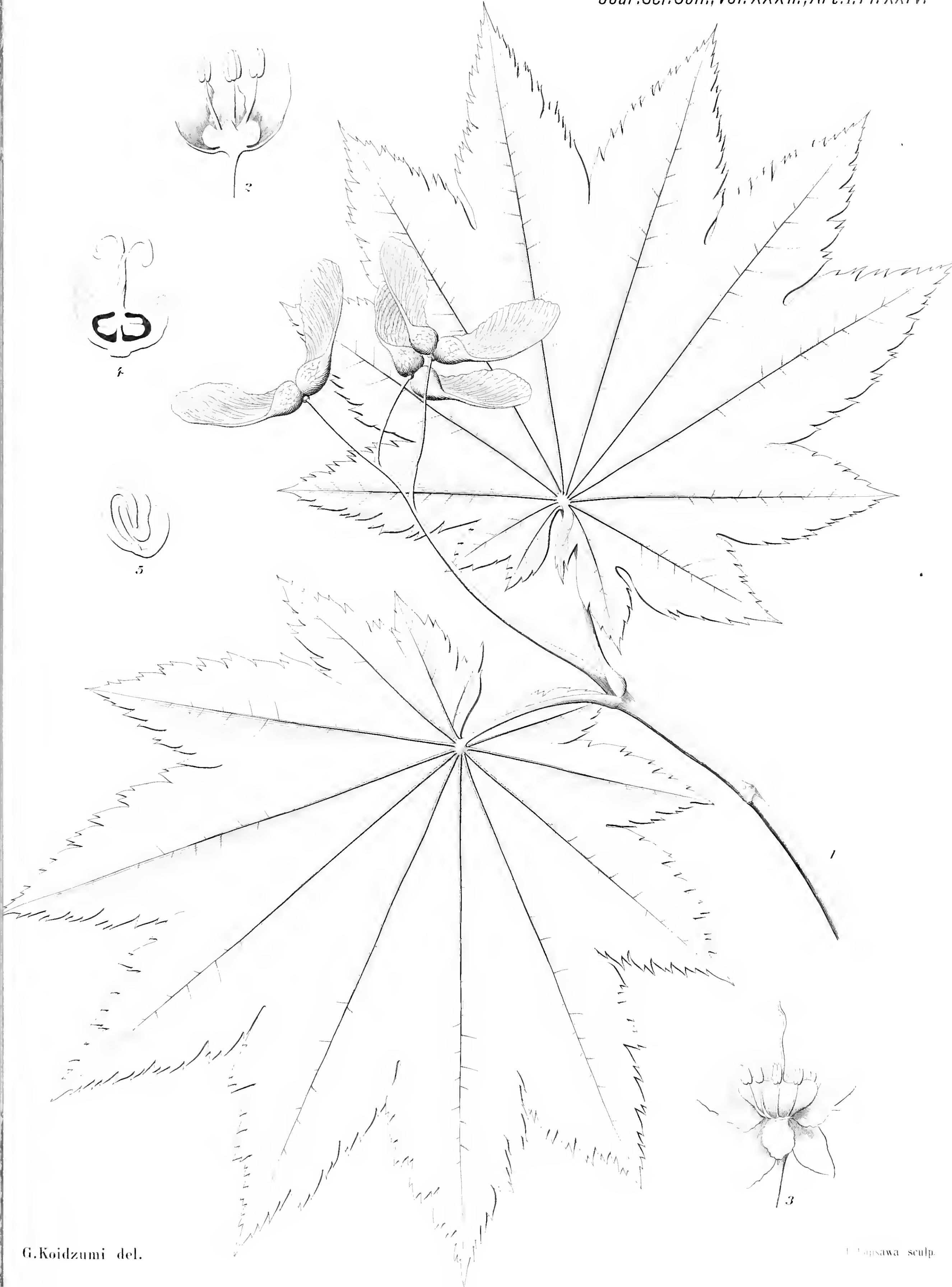
F. Fujisawa sculp.

PLATE XXIV.

EXPLICATIO TABULAE XXIV.

Acer japonicum, Thunb.

1. Pars plantae fr. (mag. nat.).
2. Sectio verticalis floris ♂ (aug.).
3. Flos hermaphroditus (aug.).
4. Sectio verticalis ovarii (aug.).
5. Embryon (aug.).



G. Koidzumi del. T. Fujisawa sculp.

PLATE XXV.

EXPLICATIO TABULAE XXV.

Acer japonicum, Thunb.

var. *typicum*, Gr. v. Schw.

1.-2.-3. Fructus varii (mag. nat.).

var. *circumlobatum*, (Max). Koidz.

4. Folium (mag. nat.).

5. Fructus (mag. nat.).

var. *microphyllum*, Koidz.

6. Folium (mag. nat.).

var. *Heyhachii*, Matsum.

7. Folium (mag. nat.).

1

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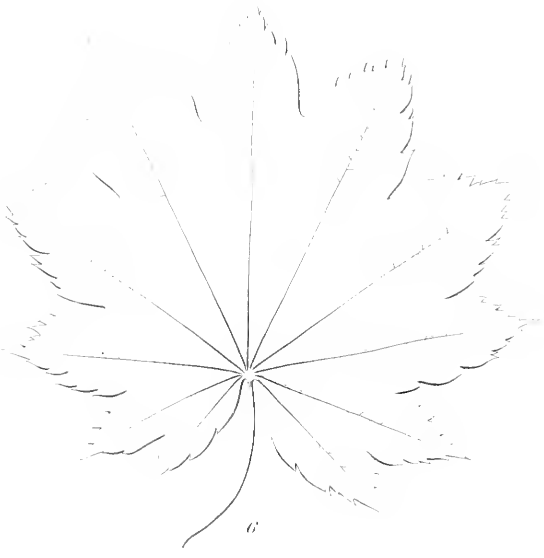

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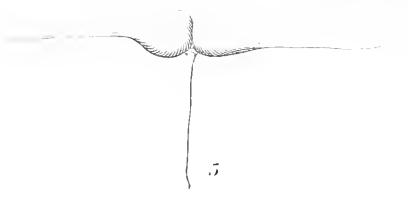

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G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXVI.

EXPLICATIO TABULAE XXVI.

Acer palmatum, Thunb.
subsp. *genuinum*, (S. et Z.) Koidz.
var. *amabile*, Koidz.

1. Pars plantae (mag. nat.).
2. Sectio verticalis floris ♂ (aug.).
3. Flos hermaphroditus (aug.).
4. Fructus (mag. nat.).
5. Verticalis ejus sectio (aug.).
6. Embryon (aug.).

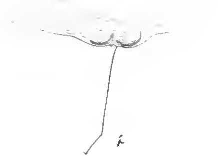
Acer palmatum, Thunb.
subsp. *septemlobum*, (Thg) Koidz.
var. *latilobatum*, Koidz.

7. Folium (mag. nat.).
8. Fructus (mag. nat.).

1

2

3



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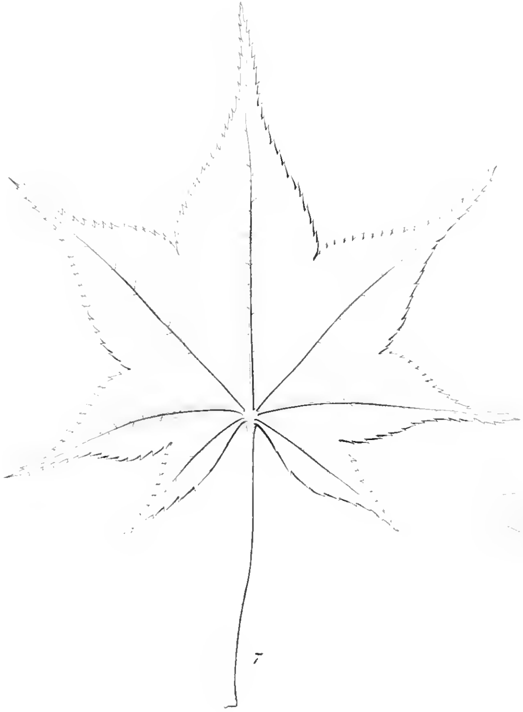

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G. Koidzumi del. [illegible] awa sculp

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXVII.

EXPLICATIO TABULAE XXVII.

Acer palmatum, Thunb.

subsp. *septemlobum*, (Thunb.) Koidz.

1. Pars plantae fructiferae (mag. nat.).

2.-3.-4.-5. Fructus varii (mag. nat.).

G. Koidzumi del.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXVIII.

EXPLICATIO TABULAE XXVIII.

Acer palmatum, Thunb.

subsp. *Matsumurae*, Koidz.

1. Ramulus fructifer (mag. nat.).

a. spontaneum, subvar. *elegans*, Koidz.

2. Fructus (mag. nat.).

Acer palmatum, Thg.

subsp. *genuinum*, var. *spectabile*. Koidz.

3. Folium (mag. nat.).

G. Koidzumi del.
F. Fujisawa sculp.

PLATE XXIX.

EXPLICATIO TABULAE XXIX.

Acer oblongum, Wall.

1. Pars plantae fr. (mag. nat.).
2. Flos ♂ (aug.).
3. Fructus varii (mag. nat.).
4. Folia varia (mag. nat.).

G. Koidzumi del.

[illegible] sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

PLATE XXX.

EXPLICATIO TABULAE XXX.

Acer nikoense, Max.

1. Pars plantae fr. (mag. nat.).
2. Flos ♂ (aug.).
3. Flos ♀ (aug.).

G. Koidzumi del.

F. Fujisawa sculp.

G. KOIDZUMI.

REVISIO ACERACEARUM JAPONICARUM.

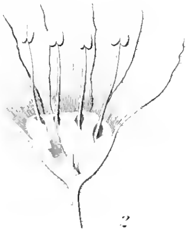
PLATE XXXI.

EXPLICATIO TABULAE XXXI.

Acer Miyabei, Max.

1. Pars plantae fr. (mag. nat.).
2. Sectio verticalis fl. ♂ (aug.).

1



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G. Koidzumi del.

F. Fujisawa sculp.

PLATE XXXII.

EXPLICATIO TABULAE XXXII.

Acer pictum, Thunb.

α. *typicum*, Gr. v. Schw.

subvar. *eupictum*, Pax.

1. Pars plantae fructiferae (mag. nat.).
2. Fructus (mag. nat.).
3. Sectio verticalis floris ♂ (aug.).
4. Flos hermaphroditus, petalis sepalisque decisis (aug.).
5. Verticalis ovarii sectio (aug.).

subvar. *mono*, Pax.

6. Fructus (mag. nat.).

subvar. *Savatieri*, Pax.

7. Fructus (mag. nat.).

subvar. *Mayrii*, Koidz.

8.–9. Fructus (mag. nat.).

var. *glaucum*, Koidz.

10. Fructus (mag. nat.).

G. Koidzumi del.

F. Fujisawa sculp.

PLATE XXXIII.

EXPLICATIO TABULAE XXXIII.

Acer diabolicum, Bl.

1. Pars plantae fr. (mag. nat.).
2. Flos ♀ (aug.).
3. Flos ♂ (aug.).
4. Verticalis ejus sectio (aug.).

G. Koidzumi del.

K. Fujisawa sculp.

RNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY, TOKYO, JAPAN.
VOL. XXXII., ARTICLE 2.

Beobachtungen an einer Süsswasser-Peridinee.

Von

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der Tôhoku Kaiserlichen Universität, Sapporo.

Mit 1 Tafeln.

Im Jahre 1901 und in den darauf folgenden zwei Jahren wurde eine massenhafte Entwickelung einer Peridineenart in einem kürzlich angelegten kleinen Teiche in dem Botanischen Garten der Universität zu Tokyo beobachtet, einem Teiche, der für die Bepflanzung monokotyledoner Wassergewächse bestimmt war. Die Entwickelung der betreffenden Organismen schien mit dem Wandel der Jahreszeiten eng verknüpft zu sein. Die üppigsten Schwärme beobachtete man nämlich im kältesten Monat des Jahres d. i. im Februar; schon Mitte März trat eine beträchtliche Verminderung der Individuenzahl ein, und je weiter die Jahreszeit vorschritt, desto geringer wurde die Entwickelung, um allmählich ganz zu verschwinden. Diese periodische Erscheinung kehrte in den erwähnten drei Jahren mit einer ziemlichen Regelmässigkeit wieder. Die absolute Menge der Individuen war aber in jedem Jahre eine verschiedene. Im Frühjahr 1901, war die Produktion eine ganz ausserordentlich grosse, so dass sogar das Wasser des Grabens auf eine ziemlich grosse Strecke rostfarbig wurde.[1] Die phototaktischen Eigenschaften der Organismen, von denen weiter unten die Rede sein wird, bedingten den Ort der Ansammlung. In den nächsten zwei Jahren nahm die Menge aus unbekannten Gründen beträchtlich ab.

---

[1] Das massenhafte Vorkommen der Meeresperidineen ruft bekanntlich oft die Rotfärbung des Meeres hervor. Dass auch die Peridineen im süssen Wasser zuweilen reichlich genug auftreten, um eine deutliche Färbung des Wassers zu erzeugen, wurde mehrfach beobachtet. Vgl. hierüber Bütschli, Protozoa in Bronns Klassen und Ordnungen des Thier-Reichs. S. 1025.

Die vorliegende Abhandlung bezweckt, die Eigenschaften dieser Organismen eingehend zu betrachten, soweit die angestellten Beobachtungen reichen. Bevor ich die systematische Stellung dieser Organismen näher betrachte, möchte ich eine kurze Beschreibung derselben vorauschicken. Aus dem durch das dichte Anschwärmen der Peridinee rotbraun gefärbten Grabenwasser wurde ein Quantum mit einer Krystallisierschale herausgeschöpft und dieses wurde im Laboratorium mit Leitungswasser mässig verdünnt. Unter diesen Bedingungen dem diffusem Lichte ausgesetzt, gediehen die Organismen gut und die Kulturen waren tagelang lebensfähig. Die einzelnen Individuen konnte man schon mit blossem Auge als sich bewegende gelbbraune Pünktchen in der Kulturflüssigkeit wahrnehmen, besonders dann, wenn das Kulturgefäss gegen das Licht gehalten, oder auf weisses Papier gebracht wurde. Wenn man einen Tropfen der Kultur auf den Objektträger brachte und unter dem Mikroskop beobachtete, so bemerkte man eine Anzahl lebhaft herumschwimmender kleiner gelblich brauner Organismen. Das Individuum ist etwa von halbkugeliger Gestalt. Die Bewegung ist eine vorwärtsgehende combiniert mit einer rotierenden. Die Rotationsrichtung wechselt von Zeit zu Zeit, sie geht nämlich bald von links nach rechts, bald aber von rechts nach links. Zuerst ist die Bewegung sehr lebhaft, und es gelingt äusserst schwer, die Gestalt und die anderen Beschaffenheiten der Organismen näher zu ermitteln. Nach einigen Minuten jedoch wird die Bewegung immer schwächer und schwächer und es tritt ein Desorganisationsvorgang ein. Hierbei ist es beachtenswert, dass Individuen aus ganz frischen Kulturen d. h. solchen, die kurz nach dem Einbringen ins Zimmer dem Gefäss entnommen waren, stets etwas früher eine Sistierung der Bewegung und eine darauffolgende Desorganisation erlitten, als diejenigen, die längere Zeit in Zimmer aufbewahrt wurden. Diese Tatsache findet aller Wahrscheinlichkeit nach darin ihre Erklärung, dass die letzteren sich den gegebenen Bedingungen in höherem Grade angepasst haben. Die früher oder später eintretende Desorganisation der Organismen geht zunächst in der Weise vor sich, dass ihre Bewegung allmählich aufhört, dann beginnt der Vorgang des Lostrennens, oder anderweitige nekrobiotische Erscheinungen treten auf. Von den beiden Arten der Geisseln—der Quer- und Längsgeissel, von welchen später ausführlicher gesprochen werden soll—ist die Quergeissel empfindlicher gegen schädliche Einflüsse und wird bald von ihrer Ausgangsstelle abgeworfen und mit einer sehr eigentümlichen Vorwärtsbewegung von dem Körper abgestossen. Die auf diese Weise losgetrennten toten Geisseln finden sich hie und da als lange geschlängelte Fäden. Die Längsgeissel hingegen beginnt ihre Desorganisation erst später, und wird nicht abgestossen.

Dimensionsverhältnisse.—Die Grösse der schwärmenden Individuen variirt zwischen engeren Grenzen. Im folgenden werden Messungen die für 25 Individuen ausgeführt wurden, zusammengestellt, um diese Verhältnisse einigermassen anschaulich zu machen. Diese Messungen wurden in der Weise ausgeführt, dass die Bilder der zu messenden Individuen mittelst Abbeschem Zeichenapparat auf Papier genau entworfen wurden, bei einer Vergrösserung von 460 Diametern; und die Zeichnungen wurden mittelst Maasstab der Länge und Breite nach gemessen.

Länge		Breite
1	21·7 μ	15·2 μ
2	23·9 „	18·5 „
3	20·6 „	17·4 „
4	25·0 „	21·0 „
5	21·7 „	15·2 „
6	22·6 „	18·5 „
7	20·6 „	15·2 „
8	25·0 „	20·6 „
9	22·6 „	15·2 „
10	20·6 „	17·4 „
11	22·6 „	20·6 „
12	23·9 „	15·2 „
13	22·6 „	16·3 „

	Länge	Breite
14	21·7 μ	17·4 μ
15	20·6 ,,	15·2 ,,
16	25·0 ,,	18·5 ,,
17	21·7 ,,	15·2 ,,
18	20·6 ,,	12·0 ,,
19	20·6 ,,	15·2 ,,
20	22·5 ,,	17·4 ,,
21	20·6 ,,	15·2 ,,
22	23.9 ,,	18·5 ,,
23	23·9 ,,	18·5 ,,
24	20·6 ,,	15·2 ,,
25	21·7 ,,	17·4 ,,
Durchschnitt	22·2 μ	16·9 μ

So besitzt unser Organismus im Mittel eine Länge von 22.2 μ und eine Breite von 16·9 μ.

Begeisselungsverhältnisse.—Bekanntlich sind die Peridineen mit zweierlei Arten von Geisseln versehen. Die eine Art, welche sich in der Querfurche herumbewegt, ist die Quergeissel und die andere Art, welche nach rückwärts gerichtet ist, stellt die sog. Längsgeissel dar. Die Quergeissel wurde lange als ein an der Querfurche angesetzter Cilienkranz aufgefasst. Erst in neuerer Zeit, machte Klebs[1] eine wichtige Entdeckung, dass es keinen Cilienkranz in der Querfurche gibt, sondern eine eigentümliche Geissel, welche mit einem Ende am Körper haftet und in der Querfurche in wellenförmiger Bewegung sich befindet. Dies bildet zweifellos eine Errungenschaft für unsere Kenntnisse der Organisationsverhältnisse der Peridineen. Diese ursprünglich nur an Süsswasserformen gemachte Beobachtung konnte Klebs später auch

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[1] G. Klebs, Über die Organisation einiger Flagellatengruppen und ihre Beziehungen zu Algen u. Infusoriengruppen, Unters. aus dem botan. Institut zu Tübingen, Bd. I. S. 233-262, 1883.

für marine bestätigen[1]. Bütschli konnte diesen Befund ebenfalls bestätigen[2], so dass er den Namen Dinoflagellata anstatt Cilioflagellata vorschlug. Die Längsgeissel nun wurde schon 1833 und 1834 von Ehrenberg bei einem Teil der marinen sowie der Süsswasserformen entdeckt[3]; und dass sie in Einzahl vorhanden ist, gilt als eines der Organisationsmerkmale dieser Organismengruppe. Während ich die Bewegungsweise der im Rede stehenden Organismen mit grossem Interesse beobachtete, schien es mir als ob die nach hinten meist in gerader Richtung befindliche Geissel aus einem Paar gleichlanger und gleichbeschaffner Geisseln bestände, die aus der Kreuzungsstelle der Quer- und Längsfurche hervorspringend etwa $1\frac{1}{2}$ mal grösser waren als die eigentliche Körperlänge des Organismus. Wiederholte Beobachtungen zeigten stets dieselbe Tatsache. Anfangs erwachte in mir das Bedenken, ob es sich hier nicht um eine optische Täuschung handelte, wie in dem Falle, wo ein rasch hin und her schwingender Stab wie zwei Stäbe aussieht. Dieses Bedenken zu beseitigen wurden Fixierungs- und Färbungsmethoden zu Hilfe gezogen. Der Tropfen in dem die Organismen sich in aktiver Bewegung befanden, wurde nämlich auf einem Deckglas ausgebreitet und schnell Osmiumdämpfen ausgesetzt und darauf ausgetrocknet, mit Fuchsin gefärbt und dann in Kanadabalsam eingeschlossen. In wohlgelungen Fällen, konnte man stets zwei unabhängig von einander stehenden Längsgeisseln nachweisen. Da auf diese Weise die Tatsache, dass die Längsgeisseln bei meinem Objecte in Zweizahl vorhanden sind, endgiltig festgestellt wurde, so wurde es nun meine Aufgabe, nachzusehen, ob ein ähnlicher Fall in der Litteratur zu finden sei. Es ergab sich alsbald, dass einige Angaben hierüber vorliegen. So schreibt Bütschli[4], „Von verschiedenen Beobachtern wurde berichtet, dass sowohl bei *Ceratium tetraceros*

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[1] G. Klebs, Ein kleiner Beitrag zur Kenntniss der Peridineen. Bot. Ztg. Jahrg. 42, 1884 S. 721–33 u. 737–45.

[2] O. Bütschli, Einige Bemerkungen ü. gewisse Organisationsverhältnisse der Cilioflagellaten u. der Noctiluca. Morpholog. Jahrb. Bd. X. 1885, S. 529–77.

[3] Ehrenberg, Abhandl. d. Berliner Akad. 1833 u. 1834.

[4] O. Bütschli, Protozoa in Bronns Klassen u. Ordnungen des Thierreichs. S. 958.

(*cornuum*) wie bei *Ceratium Tripos* zuweilen zwei Längsgeisseln statt der einfachen zu finden seien. Für die erstgenannte Form bemerkten dies schon CLAPARÈDE und LACHMANN, welche sich auf das Zeugniss von LIEBERKÜHN beriefen. Auf den prächtigen Originalabbildungen des letzteren Forschers, die mir durch seine Güte zugänglich waren, ist die zweite Geissel denn auch deutlich wiedergegeben. Für *Ceratium Tripos* machte zuerst BERGH auf eine gelegentliche Verdoppelung der Längsgeissel aufmerksam. Man könnte nun diese Beobachtungen, welche aus einer Zeit stammen, wo die Geissel der Querfurche noch unbekannt war, wohl mit KLEBS für zweifelhaft halten, da die zweite Geissel eventuell die Quergeissel gewesen sein könnte, welche speciell bei den Ceratien zuweilen aus der Querfurche hervorzutreten scheint. Da nun aber BÜTSCHLI[1] bei *Cer. Tripos* gelegentlich neben der Quergeissel zwei deutliche Längsgeisseln auffand, so scheint die Angabe der früheren Beobachter doch gerechtfertigt." BÜTSCHLI ist also der Ansicht dass die besprochene Erscheinug nur ausnahmsweise bei einigen Individuen der Art vorkommt, also etwa als Abnormität aufzufassen ist. In einer Arbeit über einige Süsswasserperidineen macht FOLGNER[2] auf eine ähnliche Tatsache aufmerksam und gibt Näheres darüber an. Die Art womit er sich beschäftigte, war *Ceratium Tetraceros* SCHRANK (*C. cornuum* CLAPARÈDE ET LACHMANN) also eine der oben genannten Arten. Er sagt wörtlich: „Ehe ich die Besprechung des *Ceratium tetraceros* schliesse, will ich doch nicht unterlassen, noch einer Eigenthümlichkeit Erwähnung zu tun, die bei dieser Peridinee zwar schon hin und wieder beobachtet wurde, niemals aber bisher meines Wissens als eine bei ihr anscheinend allgemein auftretende Erscheinung bekannt geworden ist, nämlich des gleichzeitigen Auftretens von zwei Längsgeisseln. Bekanntlich haben schon CLAPARÈDE und

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[1] O. BÜTSCHLI, Einige Bemerkungen über gewisse Organisationsverhältnisse d. Cilioflagellaten u. der Noctiluca. Morpholog. Jahrbuch. Bd. X. 1885. S. 529-77.

[2] V. FOLGNER, Beiträge zur Kenntniss der Entwicklungsgeschichte einiger Süsswasser-Peridineen. Arbeiten des botanischen Institutes d. k. k. deutschen Universität in Prag. Nr. XLII. Oesterreichische bot. Zeitschrift. Bd. XLIX 1899.

Lachmann, welche sich auf die Angaben Lieberkühn's stützen, und nach ihnen Bütschli[1] (Die Angaben von Claparède und Lachmann im Original habe ich nicht gesehen. Bergh und später Bütschli beobachteten auch bei Ceratium tripos das ,,gelegentliche" Vorkommen von zwei Längsgeisseln.) auf dasselbe aufmerksam gemacht, es jedoch lediglich als eine gelegentlich vorkommende Abnormität betrachtet."[2] Meines Erachtens, sind mit diesen bisher erschienenen Angaben die Beobachtungen über die Doppellängsgeisseln erschöpft. So wäre es gewiss von einigem Interesse ein neues Beispiel und zwar bei anderen Form anzuführen; und da in vorliegenden Falle, die sämtlichen Individuen mit zwei gleichlangen Längsgeisseln versehen sind, so ist dies keineswegs als Abnormität anzusehen. Man kann wohl mit Sicherheit sagen, dass in gewissen Süsswasserformen von Peridineen die Längsgeissel in der Zweizahl vorhanden ist. Es wäre wünschenswert in dieser Beziehung auch eine Reihe von Meeresformen der Prüfung zu unterwefen. Die Möglichkeit ist wohl nicht ausgeschlossen, dass die Erscheinung eine zeimlich verbreitete unter den Peridineen sei. Da die Zahl und Ausbildung der Geisseln wichtige Organisationsmerkmale bei derartigen Organismen bilden, so ist die Nachprüfung umsomehr von Bedeutung.

Bevor ich die Beschreibung der Begeisselungsverhältnisse unserer Peridinee vollende, möchte ich noch etwas über die abnormalen Verhältnisse der Geisseln angeben. Folgner[3] macht auf ein eigentümliches Gebilde auf der Geissel aufmerksam, welches er bei *Ceratium tetraceros* beobachtet hat. Nach ihm zeigte das Individuum eine Eigentümlichkeit, welche der Autor ,,bisher noch bei keiner anderen Peridinee in irgend welchem Lebensstadium gesehen und auch in der Litteratur nirgends erwähnt gefunden habe, nämlich am Ende der Längsgeisseln Anhangsgebilde resp. Anschwellungen in Form von ziemlich grossen Kugeln. Ob sie massive Kugeln oder aber Blasen, also Hohlkugeln darstellen,

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[1] Siehe oben.

[2] Folgner l. c. S. 140–141.

[3] Folgner, Ebenda.

gelang mir nicht zu entscheiden; die Gestalt kreisförmiger Scheiben schienen sie jedoch nicht zu besitzen.“ Er beschreibt dieses Gebilde sehr ausführlich. Er ist aber geneigt dasselbe mehr als Missbildung aufzufassen, da er die Entstehung desselben nicht beobachten konnte, das Gebilde eben stets schon vorhanden war beim Sichtbarwerden der Geisseln, und da er auch während der Beobachtung für längere Zeit keine bemerkbare Veränderung an ihm bemerkte. Er lässt jedoch, indem er ähnliche Gebilde bei Flagellaten und anderen Organismen in Betracht zieht, die Möglichkeit bestehen dass dies als eine Desorganisationserscheinung aufzufassen sei.

Gelegentlich meiner Beobachtung habe auch ich ein Gebilde das in jeder Beziehung mit dem eben beschriebenen übereinstimmt, hin und wieder gesehen. Allein diese Gebilde waren meist erst dann sichtbar als das Mattwerden des Individuums schon ziemlich weit fortgeschritten war. Man kann die Gebilde von den ersten Anfängen bis zum Grosswerden verfolgen, und es besteht kein Zweifel, dass man es hier mit Desorganistationsvorgängen zu tun hat. Fig 17 zeigt ein solche Gebilde auf den Enden des beiden Längsgeisseln. Auf den Quergeisseln trifft man nie solche Gebilde; und die Verschiedenheit in der Beschaffenheit der beiden Arten von Geisseln kommt hierin auch zum Ausdruck.

Ueber die Desorganisation der Geisseln in allgemeinen machte Bütschli interessante Beobachtungen. Er schildert die Verhältnisse wie folgt: „Die Glenodinien stellen zunächst allmählich ihre Bewegungen ein und liegen ruhig da, wobei von der hinteren Geisseln nichts mehr zu sehen ist. Dann bemerkt man plötzlich, wie sich in der Gegend der Querfurche eine Geissel zu einem dichten Korkzieherartigen Gewinde aufrollt. Ganz kurz darauf löst sich diese zu einem kleinen Packet aufgerollte Geissel mit einem Ruck von dem Körper ab und bewegt sich ein Stück weit fort. Dieses kleine Geisselpacket kann nun zunächst einige Sekunden ruhig liegen bleiben und dann plötzlich in heftig umherflatternde Bewegung übergehen, oder es schwimmt gleich nach der Abstossung in dieser Weise weiter. Diese Bewegung der abgelösten Geissel dauert etwa eine Minute oder wenig länger lebhaft fort. Dabei bleibt die Geissel stets eng aufgerollt. Endlich gelangt sie zur Ruhe, indem sie ohne Zweifel völlig abstirbt."[1] Diese Beobachtung weicht von meiner insoweit ab, als bei unserer Peridinee die beiden Längsgeisseln bis zuletzt sichtbar bleiben—also lange nach dem Wegwerfen des Quergeissels noch dem Körper anhaften— bis die oben erwähnte Desorganisationserscheinung auftritt.

Cystenbildung.—Zwischen schwärmenden Individuen und am Boden befindlichen Schlamm treten uns eine Anzahl encystierte Individuen entgegen. Diese stellen den Dauerzustand unserer Peridinee dar. Die einzelnen Cysten erscheinen, wie Fig. 18–21 und 23–26 zeigen als rundliche Körper mit unregelmässig gewellter Oberfläche. Nicht selten findet man mit Stacheln versehenen Formen. Die Cystenmembran ist ziemlich dick. Dass der Stoff der Membran hauptsächlich aus Cellulose besteht, lässt sich zeigen, indem man die Membran mit Chlorzinkjod behandelt, wobei sie rötlich violett tingiert wird. Der Inhalt der Cysten besteht aus gelblich brauner körniger Masse mit grösseren oder kleineren rötlich braunen Oeltropfen. Ausserdem ist im Innern der Cysten Stärke in reichlicher Menge aufgespeichert, wie es mit Jod leicht nachzuweisen ist, und in diesem Falle scheint deren Verteilung eine gleichmässige zu sein. Ueberdies werden die vorderen und hinteren Leibesenden im encystierten Zustande unerkennbar. Man begegnet zuweilen den in Bildung begriffenen Cysten, die noch mit Geisseln versehen sind und sich noch bewegen, wenn auch ihre Bewegungsenergie wesentlich herabgesetzt ist.

Künstliche Veranlassung zur Cystenbildung.—Es wird von einigem Interesse sein, hier einige Versuche zu besprechen über die Tatsache, dass man durch Veränderungen der Lebensbedingungen die schwimmenden Individuen zur Cystenbildung veran-

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[1] O. Bütschli, Morphologische Jahrbücher 1885, Bd. X. S. 535.

lassen kann. In der Krystallisierschale kann man sie wochenlang halten, ohne dass sie dabei zur Ruhe gehen. Aber durch folgendes Verfahren kann man sie unfehlber zur Ruhe bringen. Einige Tropfen Wasser, in dem die schwimmenden Individuen enthalten sind, waren auf der in Petrischer Schale vorher erstarrten Agarplatte ausgebreitet (Die Gallerte bestand aus 0.2% Knopscher Nährlösung und 2% Agar). Die Individuen schwimmen vor ihrer Encystierung auf den dünnen Wasserschichten über der Gallerte. Die Schale wurde dann mit dem Deckel bedeckt und in feuchter Kammer belassen. Das Verhalten der schwimmenden Individuen auf der Gallerte wurde von Zeit zu Zeit unter schwächerer Vergrössezung beobachtet. Die Bewegung hört bei dieser Behandlung sehr frühzeitig auf, (d. h. nach einigen Stunden). Schon nach etwa einer Woche gingen fast alle Individuen zur Encystierung über. Diejenigen Individuen, welche diese nicht zeigten, waren desorganisierte. Die hierbei beobachteten Cysten sind in Fig. 27 bis 33 abgebildet. Solche Cysten weichen etwas von den natürlichen ab, und sind mehr oder minder unregelmässig gestaltet. Die Stacheln welche unter natürlichen Bedingungen entwickelt werden, wurden hierbei nicht ausgebildet, wenn auch nicht selten Anfänge dazu sich zeigten. Die Oberfläche der Cysten war meist mit unregelmässigen Undulationen versehen. Was nun die dicke der Cystenmembran selbst anbetrifft, so steht sie bei den auf Agar gebildeten der normalen keineswegs nach. Der Membranstoff wurde hier auch als Cellulose konstatiert (nach mehrtägiger Behandlung mit Javelle'scher Lauge und darauf folgender Behandlung mit Chlorzinkjod). Der Inhalt der Zellen war, der Hauptsache nach, derselbe wie derjenige normal gebildeter Cysten, d. h. rote Oeltropfen, reichliche Stärke).

Anderweitige Beobachtungen.—Dass die meisten Peridineen ähnlich wie die gefärbten Flagellaten und die Schwärmsporen der Algen phototaktisch reagieren ist bekannt, aber eingehendere Untersuchungen die besonders mit dieser Organismengruppe an-gestellt wurden, liegen meines Wissens nicht vor.[1] Bei meinen Versuchen mit unserer Peridinee, konnte ich vielfach die hervorragend phototaktische Eigenschaft derselben beobachten. Wenn man das Wasser mit schwimmenden Individuen in eine Krystallisierschale von etwa 10 cm Durchmesser bringt und in $\frac{2}{3}$ m Entfernung von einem hellen Fenster aufstellt, so sieht man schon nach $1\frac{1}{2}$ Minuten, wie sich die schwimmenden Individuen auf dem dem Lichte zugewandten Halbkreis der Schale mehr ansammeln, um nach 3–6 Minuten sich vor allem auf der durch das reflektierte Licht schärfer erhellten Partie der Schale zu konzentrieren. Hierbei bildeten sie auch noch, von oben nach unten reichend, vertikale Ansammlungsstreifen. Einen hübschen Versuch konnte man fernerhin in der Weise anstellen, dass man einen weissen Porzellanteller nahm, denselben mit Wasser füllte, das durch die hohe darin enthaltene Individuenanzahl scheinbar braun gefärbt war, und nun im Dunkelzimmer mittelst eines Prismas Sonnenspektrum darauf fallen liess. Man konnte schon nach 3–4 Minuten eine beträchliche Ansammlung der Organismen unter dem farbigem Lichte beobachten und nach Entfernung des Prismas behielten die angesammelten Organismen noch für einige Zeit deutlich das Bild des Spektrums. Die stärkste Ansammlung zeigte sich dabei in den kurzwelligen Teile des Spektrums, nämlich im blauvioletten Teile.

Ferner sind unsere Kenntnisse über die Fortpflanzungsverhältnisse der Peridineen überhaupt noch recht lückenhaft und jede genaue Beobachtung auf diesem Gebiete ist willkommen. Bei meinen Beobachtungen konnte ich aber keinen neuen Beitrag in dieser Richtung liefern. Betreffs der Art und Weise der

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[1] Ueber die phototaktischen Eigenschaften der verschiedenen pflanzlichen Organismen wird auf folgende bekannte Arbeiten hingewiesen :—

E. Strasburger, Wirkung der Wärme und des Lichtes auf Schwärmsporen. Jen. Zeitschr. Naturw. 1878. 12. S. 551.

F. Oltmanns, Ueber die photometrischen Bewegungen der Pflanzen. Flora 1892. 75. S. 183.

Man wird ferner in Pfeffer : Pflanzenphysiologie. Bd. II. S. 753 u. s. w. u. Oltmanns : Morphologie u. Biologie der Algen. 2. Bd. S. 220. Zusammenstellungen finden.

Fortpflanzung, ist bis jetzt nur die vegetative Zweiteilung sicher gestellt, und diese geschieht entweder im beweglichen oder Ruhezustande. Es gibt Angaben wonach Fortpflanzung durch Konjugation stattfindet, diese ist jedoch noch nicht sicher gestellt und bedürfen weiterer Bestätigung. Bei meinen Beobachtungen traf ich mehrere Male auf Individuen, die in beweglichem Zustande in Teilung begriffen waren, (Fig. 34–37). Die sich teilenden Individuen bieten sehr eigentümliche Gestaltung dar und die Teilungsebene tritt in Schiefstellung ein. Konjugation konnte ich nicht beobachten.

Systematische Stellung.—Ueber die verwandtschaftliche Beziehung der Peridineæ[1] mit anderen Organismengruppen sind die Meinungen noch geteilt. Die Gruppe ist oft mit Diatomeen in engste Beziehung gebracht worden. Näheres darüber kann man bei Schütt[2] finden. Aber gleichzeitig ist ihre verwandtschaftliche Beziehung mit den Protococcaceæ und Volvocaceæ von ihm auch anerkannt.[3] Oltmanns[4] kann die Auffassung, dass die Gruppe den Diatomeen nahe steht, nicht ganz teilen. Er zieht es vor, Bütschli folgend, die Beziehungen zu den Cryptomonadinen zunächst zu betonen, damit auch die Peridineen als Flagellaten zu betrachten und den Namen der Dinoflagellaten beizubehalten. Jedenfalls die nahe Verwandtschaft mit Flagellaten und verwandten Formen ist überall ausgesprochen.

Was nun den systematischen Wert der Zahl und Ausbildung der Geisseln bei der Einteilung der Flagellaten und verwandten Formen anbelangt, so bilden sie wichtige Anhaltspunkte für die systematische Einteilung derartigen Formen. Bütschli legte z. B. ein Hauptgewicht darauf.[5] Klebs[6] aber hat seine Einteilung auf

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[1] Peridineæ (Klebs, 1883). Peridiniales (Schütt in Engler u. Prantl, Die nat. Pfl.-familien. I. Teil. 1896), Cilioflagellata (Claparède u. Lachmann 1858–1861, Arthrodele Flagellaten (Stein 1883) Dinoflagellata (Bütschli 1885).

[2] Schütt, Peridiniales in Engler-Prantl: Die natürl. Pflanzenfamilien I. Teil 1. Abt. b.

[3] Schütt, Ebenda S. 2, 8 u. 16.

[4] Oltmanns. Morphologie und Biologie der Algen, 1904. Erster Bd. S. 35.

[5] Hierüber vgl. man Bütschli, Protozoa in Bronn's Klassen und Ordnungen des Thier-Reichs 1889 2te Abt. Mastigophora.

[6] G. Klebs. Flagellatenstudien. Zeitschr. f. wiss. Zoologie. Bd. LV. 1892.

die gesammte Organisation des Vorderendes und in Verbindung damit auf die Art der Nahrungsaufnahme gegründet. Dieses Prinzip ist auch von Senn in seiner Bearbeitung der Flagellaten[1] in erster Linie angewandt. Senn schätzt ferner den systematischen Wert der verschiedenen morphologischen Eigenschaften wie folgt[2]: „in zweiter Linie ist für die Bildung grösserer Untergruppen die Organisation der contractilen Vaculolen wichtig; ob sie einfache in Einzahl oder zu mehreren vorkommende Bläschen darstellen, oder ob sich mehrere zu einem mehr oder weniger stark differenzierten Apparat vereinigt haben. Ähnlichen systematischen Wert hat wohl auch die Kernstruktur, jedoch ist sie vorläufig noch zu wenig bekannt. In dritter Linie kommt der Grad der Ausbildung der plasmatischen Körperhülle in Betracht; dabei sind aber die Zellausscheidungen, wie Gallerthüllen, Gehäuse und Stielbildungen auszuschliessen; dieselben können zur Begrenzung von Gattungen dienen, von Unterfamilien nur bei grosser Mannigfaltigkeit der Bildungen. Erst in vierter Linie können die Geisseln berücksichtigt werden, und zwar nicht nur ihre Zahl und Anordnung, sondern auch ihre Gestalt und Funktion. Neben der Geisselausbildung, muss auch der Besitz oder Nichtbesitz von Chromatophoren und die Bildung bestimmter Stoffwechselprodukte (Stärke, Paramylon) berücksichtigt werden, schliesslich auch plasmatische Zellanhänge wie Kragen und Peristombildungen.“

Er gibt ferner an, „Als Gattungsmerkmale kommen in Betracht: Zahl und Ausbildung der Geisseln bei sonst gleicher Organisation, Metabolie oder Starrheit, besondere Mundapparate, undulierende Membranen, Gehäuse-, Hüllen-, Stiel- und Colonienbildung; bei grossen Verschiedenheiten der Körpergestalt auch diese; sie wird sonst nur als Artcharakter benutzt.“

Für die Einteilungen einiger grösseren Gruppen jedoch ist die Zahl der Geisseln auch gebraucht. So z. B. wurde die Unterordnung Chrysomonadineæ welche von Klebs[3] nach der Ausbildung der

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[1] G. Senn, Flagellata in Engler-Prantl, Die natürl. Pfl.-fam. I Teil, 1 Abt. S. 93.

[2] Ebenda, S. 109.

[3] G. Klebs, Flagellatenstudien (Zeitschr. f. wiss. Zool. Bd. LV. 1892).

Zellumhüllung in nackte (*Chrysomonadina nuda*) in einem Gehäuse oder Schale sitzende (*loricata*) und in solche mit eng anliegender, hautartiger Hülle (*membranata*) eingeteilt worden ist, von Senn[1] nach der Zahl und Ausbildung der Geisseln bestimmt. Nach seiner Ansicht wäre diese mehr als genetisches Merkmal aufzufassen, indem die Hüllenbildungen der Flagellaten als sekundär erworbene Organe aufzufassen seien. Er teilt nämlich die genannte Unterordnung in 3 Gruppen: Chromulinaceæ (mit 1 Geissel), Hymenomonadaceæ (mit 2 ganz oder annähernd gleichen Geisseln) und Ochromonadaceæ (mit 2 ungleichen Geisseln).

Bei solcher Sachlage könnte man berechtigt sein, auch eine neue Gattung, oder selbst höhere systematische Einheit für unsere Form aufzustellen, da sie Konstant 2 Längsgeisseln trägt im Gegensatz zu anderen Peridineen die nur 1 Längsgeissel besitzen. Dieses um so mehr, da die Gruppe Peridineæ sich in den Begeisselungsverhältnissen sehr einheitlich verhält, so dass das Vorhandensein von 1 Quergeissel und 1 Längsgeissel das wichtigste Organisationsmerkmal dieser Gruppe bildet.

So lange wir aber nicht im Stande sind zu beurteilen, ob das Vorhandensein der Längsgeisseln in der 2-Zahl hier als primäres Merkmal aufzufassen, oder vielmehr als ein sekundäres anzusehen sei, wäre es besser, wie es auch in dieser Arbeit geschieht, vorlaüfig diese Form den bekannten Formen mit denen sie in anderen Punkten übereinstimmt, anzureihen. Es ist sehr wünschenswert auch bei anderen Süsswasser-sowie Meeresformen die Begeisselungsverhältnisse näher zu prüfen und reichlichere Materialien zu sammeln, um einiges Licht auf den systematischen Wert des Vorhandenseins der Doppellängseisseln bei den Peridineen zu werfen. Dann erst kann man die systematische Stellung der in Rede stehenden Form richtig beurteilen.

Die Gruppe Peridiniales teilt man in 3 Familien,[2] Gymnodiniaceæ, Prorocentraceæ und Peridiniaceæ, von denen die erste

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[1] G. Senn, l. c. S. 152.

[2] Schütt in Engler-Prantl, Die natürl. Pfl.-familien. I. Teil.

Familie ohne Panzer ist, während die zwei anderen mit Panzer versehen sind. Unsere Form kommt also unter Gymnodiniaceæ, und zwar ist sie in die Gattung Gymnodinium, deren Vertreter sowohl im Meere als auch im Süsswasser verbreitet sind, zu bringen. Die Artdiagnose lautet demnach:

Gymnodinium biciliatum nov. sp.

Bis jetzt der kleinste bekannte Vertreter der Gattung.[1] Länge 22.2 μ und Breite 16.9 μ. Die seichte Querfurche den Körper in einer kaum ansteigenden Schraubenlinie umziehend. Die beiden Körperhälften einander nahezu gleich. Längsfurche vertikal. Längsgeisseln zwei, gleich lang und gleich gebaut. Ein Augenfleck nicht vorhanden. Durch eine bedeutende Reproduktionskraft ausgezeichnet und auch zur Cystenbildung sehr geneigt. Cysten oft stachelig, derb, durch Chlorzinkjod dunkelrotbraun; auf Agar künstlich zu Encystierung zu veranlassen. Süsswasserbewohner, in Graben.

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[1] Gymnodinium pusillum Schilling besitzt die Grösse 23·0 μ × 18·4 μ und ist von SCHILLING als die kleinste Form dieser Gattung angegeben (Vgl. SCHILLING l. c.). Die kleinsten Formen aus anderen Gattungen sind z. B. Amphidinium lacustre (23.0 μ × 18·4 μ) und Glenodinium pulvisculus Stein (23·0μ × 18·4μ).

Figuren-Erklärung.

Sämtliche Figuren sind mit dem Abbe'schen Zeichenapparat und zwar wo nichts anders angegeben ist, unter Benutzung von Oc. 4 und Obj. F, Zeiss, entworfen.

Fig. 1. Schwimmendes Individuum.
,, 2 u. 3. Fixierte u. gefärbte Exemplare.
,, 4 u. 5. Körperform im Umriss. (Mit Geisseln).
,, 6 u. 9, u. 10 bis 16. Variationen in Körperform. (im Umriss).
,, 7 u. 8. Ein und dasselbe Individuum, einmal bei oberer Einstellung (7) und andersmal tieferer Einstellung (8).
,, 17. Sich desorganisierendes Individuum, dessen Längsgeisselenden mit Bläschen versehen sind.
,, 18 bis 21, u. 23 bis 26. Natürliche Cysten, von denen 19 mit am deutlichsten ausgebildeten Stacheln.
,, 22. Stärkekörner aus dem Zellkörper.
,, 27 bis 33. Künstlich auf Agar erzeugte Ruhezellen.
,, 34 bis 37. Teilungsstadien. 36 (Oc. $2+\frac{1}{12}$ Hom. Imm., Zeiss.)

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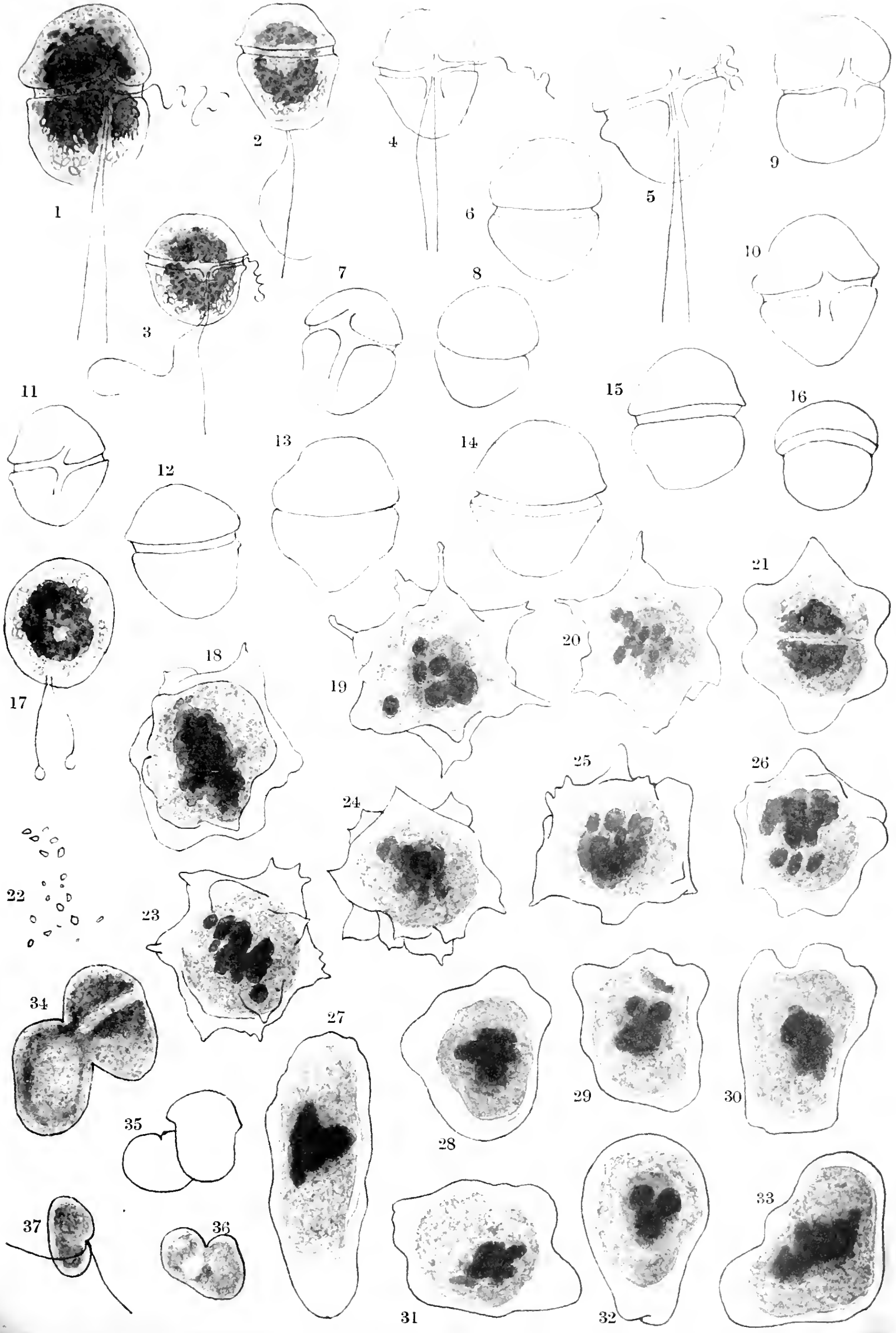

N. Ohno, del.

JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY, TOKYO, JAPAN.
VOL. XXXII., ARTICLE 3.

Observations and Experiments on the Ctenophore Egg:

I. The Structure of the Egg and Experiments on Cell-division.

By

Naohide Yatsu.

Introduction.

The ctenophore egg has become classic in experimental embryology through the invaluable papers of CHUN ('92), DRIESCH and MORGAN ('95), ZIEGLER ('98, '03) and FISCHEL ('97, '98 and '03). Singularly enough, however, since the appearance of these works no further detailed analytical studies on the interesting egg have been undertaken. At the suggestion of Professor E. B. WILSON, the writer made observations and experiments upon the egg of four common species of ctenophore in the spring of 1906, at the Naples Zoological Station.[1]

The present paper deals first with the structure of the egg with a note on the polocytes and on fertilization; secondly, with observation on the process of cell-division, mainly that of the first cleavage; and thirdly with experiments performed upon the egg of *Beroë ovata*. It will be followed by two other papers; one on cytogeny and experiments on cleavage physiology, and the other on germinal localization.

As to experimentation, I wish to lay especial stress upon the following points. Great care was taken to secure good water quite

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[1] This study was made with the aid of a grant from the CARNEGIE Institution at Washington, for which I take this opportunity to express my gratitude. I also have pleasure in acknowledging my indebtedness to the staff of the Naples Zoological Station.

far from the shore. The water taken near the city of Naples was so polluted that it was unfit for use in developing egg-fragments into embryos. This is the indispensable condition for ctenophore experiments. The high mortality in DRIESCH and MORGAN'S work seems to have been due to the neglect of this precaution ('95 p. 217). To obtain eggs two or three animals were kept in a rather small cylindrical jar, so that they stirred the water more or less when swimming and kept the eggs they laid constantly in motion. If, on the contray, the ctenophores be put in a large jar, the eggs are liable to stay near the surface: there they become weak and give rise to less lively larvae or fail to develop at all.

I. Structure of the Egg.

The eggs of the following four common species of ctenophores were studied; namely *Beroë ovata*, *B. forskålii*, *Callianira bialata* and *Eucharis multicornis*. The relative sizes of the eggs of these forms are shown in Fig. I (*cf.* CHUN '80 p. 100). The egg of *Beroë ovata* was the one most carefully studied and exclusively used in experiments, being peculiarly suited for the purpose on account of its large size (1–1.2 mm) and of its consistency.

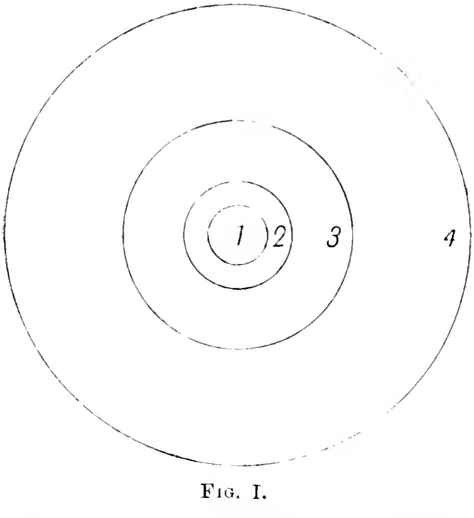

FIG. I.

Diagram showing the relative sizes of the eggs of *Callianira bialata* (1). *Eucharis multicornis* (2), *Beroë forskålii* (3) and *B. ovata* (4). ×60

When the eggs are laid, they are found entangled in a string-like mass of jelly. Close to the egg is a thin gelatinous covering that turns into a thick layer of jelly after fertilization.[1] The egg has three visible con-

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[1] The eggs of *Eucharis multicornis* can be more easily taken out of the jelly than those of *Beroë*.

centric differentiations; namely (a) the extremely thin homogeneous outer layer, (b) the ectoplasm and (c) the entoplasm.

The outer "membrane" is a very thin semifluid layer free from granules. It can hardly be called membrane. It is difficult, if not impossible, to detect it. When the egg is compressed or wherever accumulation of the ectoplasm takes place, one can see it fairly well. I should not hesitate to homologize this with the ectosarc described by ANDREWS in the egg of *Hydra* ('98) and with a similar layer found in the sea-urchin egg, to which ZIEGLER has attached so much importance ('03, '04). It can not be looked upon as identical with the hypothetical cell-membrane of RHUMBLER ('99). What *rôle* this thin layer actually plays during cleavage is problematical. I am rather inclined to think that it has very little to do with that process.

The ectoplasm is, as has been described by many authors, a rather thick layer of finely alveolar plasm. It is of uniform thickness until fertilized. This layer is, contrary to ZIEGLER's view, not at all of the same nature as the "ectoplasm" of the sea-urchin egg. It is fluorescent and looks green under reflected light, reminding one of a piece of uramium glass (*cf.* CHUN '80 p. 100). In stimulating the egg with a weak electric current this layer alone seems to emit a beautiful greenish light. It should be mentioned, that, as the development advances, the ectoderm comes to monopolize this property. In a Wood's Holl species, *Mnemiopsis*, the egg before cleavage, according to PETERS ('05), was not phosphorescent.

It need hardly be mentioned that the entoplasm is a coarse alveolor structure. The alveoles of the *Callianira* egg are much fewer in number than those of the *Beroë* egg, the individual alveole of the former being much larger than that of the latter (Pl. II, Figs. 27 and 28). On crushing the *Callianira* egg I could count in one case 67, in another 64, and in still another 54 alveoles. ZIEGLER calls the alveoler substance "transparent yolk granules" ('98 p. 36). This seems to have given RHUMBLER the impression that it was made up of a rather highly viscous substance. But as a matter of fact, this is not so. CHUN ('80) has called it "Zellsaft." Though this term is not happily chosen, yet it is far better than "yolk." In the material fixed with **Flemming**'s fluid the alveolar substance is completely dissolved, being represented by holes. Whatever its chemical nature may be, it is certainly not similar to what commonly goes under the term yolk. In the entoplasm no axial differentiation can be detected: the size and nature of the alveoles are the same throughout the egg.[1]

II. Polocytes.

I have nothing to add about the formation of the polocytes, excepting that in one case a maturation spindle with no pole-rays was met with in an ectoplasmic accumulation (**Flemming**'s fluid material).

In the living egg it was not difficult to see the polocytes. Pseudopodia are seen on both the polocytes. The first polocyte loses them and invariably divides in two; each part has a smooth surface. The pseudopodia, however, remain on the second polocyte (Pl. I, Fig. 4). As to whether or no the polocytes perform an amoeboid locomotion by means of the pseudopodia I have had no means of determining. Yet I am rather inclined to believe that they do not (*cf.* **Chun** '80 p 101). As is shown in Figs. 1, 2 and 3 (Pl. I) a thickened portion of the ectoplasm is found beneath the polocytes. The egg nucleus undoubtedly lies in this. The accumulation lasts for some time after the formation of the second polocytes. But it soon disappears.

III. Entrance of the Spermatozoon into the Egg.

As already mentioned, when the eggs are discharged, they have a thin gelatinous covering about them. When fertilized this membrane changes into a thick layer of jelly. I could not ascertain how the process took place. It is highly probable that the change is of the same nature as that of echinoderm eggs. In any

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[1] In this connection it may be of some interest to note that **Fewkes** saw in the egg of *Agalma* a mass of rosy entoplasm at one pole ('85 p. 247).

event this jelly layer gives a splendid criterion for distinguishing at a glance fertilized egg from unfertilized.

One other phenomenon accompanying fertilization is that the oöplasm suddenly acquires greater consistency. This is especially frappant after the formation of an ectoplasmic thickening around the spermatozoon. One can hardly fail to notice this change when experimenting upon various stages of the egg.

The entrance of the spermatozoon can readily be seen in the egg of *Beroë*. Fig 5 (Pl. I) shows a surface view soon after its penetration into the egg. A refringent body (acrosome?) is seen a little apart from the head. Behind the head is a dark body, sperm-centre, provided with long rays. Soon, however, the rays disappear. In a side view one sees an entrance-cone consisting of a thickened external homogeneous layer and also considerable accumulated ectoplasm. The entoplasmic alveoles are arranged radially (Pl. I, Fig. 6). In them no rays are seen in the living egg. In section, however, distinct long rays come into view, which extend from the straightened alveolar walls of the ectoplasm into those of the entoplasm. As is seen in Figs. 7 and 8 (Pl. I) the ectoplasmic accumulations remain for some time, so that by them one can tell at once how many spermatozoa have entered the egg. On one occasion I saw an egg with as many as five of them in it. Polyspermy in this form is not at all a physiological phenomenon. It usually takes place when eggs are kept too crowded in a jar. I know nothing about the fate of those sperm-nuclei which fail to unite with the egg-nucleus. Yet judging from the fact that in many cases polyspermy does not lead to abnormal cleavage; those solitary sperm-nuclei seem to degenerate *in situ*.

IV. Cell-division.

a) *The First Cleavage.*

I could not make out how or where the germ-nuclei meet.[1] At any rate prior to the first cleavage, there takes place a change in the distribution of the ectoplasm: it thickens considerably near the macromere pole,[2] while at the opposite pole it thins out a great deal (Pl. I, Figs. 9 and 10). Cleavage goes on, as has been observed by a good many investigators. Sometimes the cleavage furrow is bent slightly to one side near its completion (Pl. I, Fig. 11). It should here be especially mentioned that the cleavage is not strictly unilateral, contrary to Ziegler's observation ('98, p. 41; '03 p. 159 and his diagram Fig. 7), and also to Rhumbler's opinion based upon Ziegler's results. A shallow depression is always present at the micromere pole, as is seen in the sketches drawn one upon another at different periods (Pl. I, Fig. 11). And it will be also noted that the top of each blastomere becomes more rounded. The lateral elongation is almost nil. The rate of the cleavage from the macromere pole is 8–19μ per minute, 17μ on an average, at a room temperature of 65°–67°F. The rate of cleavage from the opposite pole is a little slower, 13μ per minute on an average.

To supplement Ziegler's observations, the process of cleavage and especially the "cleavage head" (Furchenkopf) will be described in some detail. In the beginning a slight depression appears near the polocytes. Its optical section is shown in Fig. 12 (Pl. II). Here is a pair of prominences in the outer homogeneous layer (*cf.* Andrews '98). Sometimes they are continuous, forming a bridge over the now deepening furrow.[3] Sometimes there is one process on one side and two on the other (Pl. II, Fig. 12) (*cf.* Kleinenberg '72 p. 49., Taf. 4, Fig 4: Wager '09 p. 23, Pl. III, Fig. 23a). Around the process a fine display of spinning activity is visible. At the bottom of the cleavage depression are rays in the homogeneous layer.

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[1] As is seen in Figs. 10 and 11, the polocytes are usually situated at some distance from the cleavage furrow. Whether the egg-nucleus or cleavage-nucleus moves a little from the spot where the polocytes have been formed, or whether the polocytes are transported by some means, is not certain. But the latter alternative seems to be the more probable one.

[2] Macromere pole = vegetative pole of Hatschek (Korschelt and Heider '02 p. 24). Throughout the plates the macromere pole is above, and the micromere pole below.

[3] The bridge is not so distinct as was observed by Tannreuther in the *Hydra* egg, where yolk granules were seen to pass from one blastomere to the other ('08 p. 267).

As a digession, the results from the study of sections of this stage may here be given. Cleavage begins at the telophase of the first mitosis. Rays (pole-rays) of a considerable length extend into the entoplasm of both blastomeres, centering about the newly formed nuclei (the centres are in all probability situated very close to the nuclei). Besides, something like sheath-rays are found between two asters. They are evidently cut apart by the growing "cleavage head." A similar condition has been observed in the *Hydra* egg by BRAUER ('91 Taf. IX, Figs. 16 and 17).

Now coming to the next stage (Pl. II, Fig. 13). The bottom of the depression has been carried farther down. Usually the clear protuberances at the entrance of the furrow are drawn in. Fine spinning is seen. The protoplasmic threads are not parallel to one another. Often they decussate. At the "head" are radiations as in the foregoing stage.

A fully formed "cleavage head" is shown in Fig. 14 (Pl. II). By this time protoplasmic spinning is restricted to the entrance and bottom of the furrow. The "head" is a thickened ectoplasm Here one notices that the outer homogeneous layer also has increased in thickness. Refringent alveoles in the ectoplasm are arranged radially as extensions of fine radiations of the homogeneous layer. Towards the entoplasm are processes (Zacken) as has been rightly observed by ZIEGLER ('98, '03). I tried hard to detect rays extending from the tips of the processes into the entoplasm, but contrary to RHUMBLER's assumption ('99 p. 203 Fig. 12 and p. 205 Fig. 13), there were no such things; here the ectoplasm simply comes in contact with the entoplasm. The alveoles of entoplasm here show a peculiar arrangement worth noting. Those along the walls of the cleavage furrow seem to have been carried down with it and those found at the tip of the "head" are somewhat flattened (*cf.* Pl. II, Fig. 28). This undoubtedly shows that the "cleavage head" pushes downward instead of being pulled by the contraction of rays, stretching between the cleavage head and the micromere pole. At the next stage the alveoles recede from the median plane as is shown in Fig. 15 (Pl. II). It will be of some interest here to examine two cleavage stages of the egg of *Beroë forskålii* (Pl. II, Figs. 19 and 20). In this particular egg the second cleavage has begun before the first has come down nearly two thirds of this entire course. By the precocious second division the typical alveolar arrangement has been considerably disturbed, a flow-figure having been formed in each blastomere. For all that, the first cleavage cuts through the egg normally as through nothing had happened near the macromere pole.

Pari passu with the coming-down of the cleavage furrow, the ectoplasm thickens near the micromere pole as has been observed by ZIEGLER. And the "cleavage head" meets the ectoplasmic accumulation there (Pl. II, Fig. 15.). The walls of the cleavage furrow near the "head" become irregularly wrinkled and the spinning activity increases (*cf.* ANDREWS '98). The hole now assumes a triangular shape. As the entoplasmic alveoles quickly retreat, the ectoplasmic bridge[1] is left between two fartmeres (Pl. II, Figs. 17, 18, 21, 21). It is interesting to recall that LOEB observed cytoplasm flow away from the furrow towards the end of unilateral cleavage ('06 p. 66). No particular movement as seen by BUNTING in *Hydractinia* ('94 p. 216) takes place (*cf.* ZIEGLER's experiments). Finally the ectoplasm also goes into the blastomeres, leaving behind a fine thread of homogeneous layer. By the time one finds an ectoplasmic thickening with radially arranged entoplasmic alveoles near the micromere pole of each blastomere (Pl. II, Fig. 18) In studying this stage with a low power one soon notices that the greater part of the ectoplasm has come down towards the micromere pole (Pl. II, Figs. 31, 22)

Incidentally I might mention that the cell-wall between the two blastomeres of *Eucharis* and *Callianira* has a sieve-like appearance (Pl. II, Figs. 22, 24, 27). In the latter form I was able to see this peculiarity between two entoderm cells as late as the gastrula stage. The fenestrated appearance is due to the lenticular accumulation of a certain fluid as correctly observed by CHUN ('80 p. 102) (*cf.* FOL '73 Tf. 24, Fig. 5).

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[1] The surface of the bridge has radiating wrinkles.

b) *Subsequent Cleavages.*

Soon after the first cleavage is completed, the ectoplasmic thickening near the micromere pole disappears and at the same time an accumulation comes in view over the macromere pole (Pl. II, Fig. 23). The second cleavage takes place in exactly the same manner as the first (Pl. II, Fig. 24). In the beginning of the third cleavage an accumulation of the ectoplasm near the macromere pole is also seen (Pl. II, Figs. 25, 26, 27). At the fourth division the micromeres are formed, which are almost entirely made up of the greenish ectoplasm (Pl. II, Figs. 29, 30). Subsequent divisions of the micromere are carried on in unilateral fashion similar to the division of the entire egg. So also the divisions of the macromeres (Text fig. II).

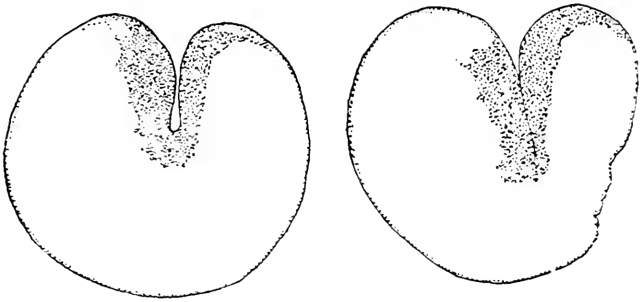

Fig. II.

Two dividing entoderm cells of *Beroë ovata*. ×60.

V. Experiments on Cell-division.[1]

Fifty eggs of *Beroë ovata* were operated on during the first cleavage in twelve different ways with the intention of testing, if possible, hypotheses hetherto put forth regarding the division mechanism of the ctenophore egg. On account of the large size and favorable consistency of the egg, the operations were performed with the greatest ease by means of a small knife. Sometimes, however, in case the jelly around the egg was unusually hard,

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[1] This part of the present paper was read as a preliminary note before the Seventh International Zoological Congress at Boston 1907.

cutting was accompanied with some difficulty. Very soon after the operation the cut surfaces close; so rapid is the closure that one cannot, as a matter of fact, see exposed entoplasm(*cf.* MAAS '03 p. 45). Each of the eggs operated on was placed in a compressorium[1], and the subsequent progress of cleavage was followed. From a single egg several sketches of successive stages were made. In the plates of the present paper in most cases only the first and the last stages have been reproduced, since the intervening ones would be of little value in illustrating the following experiments.

a) *Experiment I* (four cases).

A portion of the egg was cut below the "cleavage head" at various angles and along various levels, and the enucleated pieces were watched to see if they showed any sign of division activity.[2] Even in the case in which the cutting plane passed very near the "cleavage head," nothing happened in the enucleated piece—it simply rounded up and ceased to develop further (Pl. III, Fig. 31).

b) *Experiment II* (one case).

The above experiment was modified in the following way. An incision extending two thirds of the diameter of the egg was made below the "cleavage head" to see if the connection with the nucleated part of the egg would impart some division activity (Pl. III, Fig. 32). The cleavage went on normally, cutting the upper part in two, but the lower past remained undivided (Pl. III, Fig. 33).

The above two experiments (Exp. I and Exp. II) clearly show that portions devoid of the "cleavage head" do not manifest any division activity whatever.

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[1] This was not used for compressing the eggs but as a sort of live-box for keeping them alive.

[2] I have a case in which both pieces produced by a horizontal cut cleaved. It can hardly be doubted that it was a dispermic egg.

c) *Experiment III* (thirteen cases).

Sections were made on the egg above the "cleavage head" at various periods and along various planes, and the behavior of the enucleated fragments containing the "cleavage head" were studied.

In eight cases out of thirteen the cleavage went on normally. The rate of downward progress of the furrow was normal, or a little slower than the normal that is 15μ per minutes on an average. It was sometimes 10μ or even as slow as 8μ per minutes. In Fig. 34 (Pl. III) the section passed through the middle of the cleavage furrow and in Fig. 39 (Pl. III) the cut was made when the cleavage had just begun. In both the enucleated pieces cleavage went on as though they were a part of the whole egg. It is interesting to note that the movement of the ectoplasm is the same as in the entire egg, that is, a thick ectoplasmic accumulation is formed about the micromere pole towards the end of the division (Pl. III, Fig. 35), and after that thickenings in the neighborhood of the macromere pole (Pl. III, Figs. 36, 40). Here one notices that the thickness of the above ectoplamic accumulation depends upon the size of the enucleated pieces. It also may be remarked that similar up-and-down movement of the ectoplasm takes place in the nucleated pieces (Pl. III, Fig. 41).

In studying carefully the relation between the angle of the cuts and the direction of the cleavage furrow, the following results were obtained. If the section be made when the cleavage furrow is shallow, then the division goes on normally irrespective of the angle of the cut (Pl. III, Figs. 39, 40). If, on the other hand, the operation is performed in later stages, the cleavage is usually accomplished normally only when the section is horizontal or approximately so; if otherwise, the furrow is bent and the bending is always towards the side with more cytoplasm, so that the resulting blastomeres are of nearly the same size (Pl. III, Figs. 37, 38).

In three cases out of thirteen something unexpected happened. One of these cases is represented in Figs. 41 and 42 (Pl. III). The other two were very much like this. The cleavage furrow went down near the micromere pole and turned upward so that in the end a bridge was formed between the two blastomeres. The bridge was not cut through. One case of this peculiar mode of cleavage was the result of a horizontal section. In the other two, the curving of the furrow faced the side of more cytoplasm (in Fig. 41, Pl III to the left). CONKLIN observed in the egg of *Linerges mercurius* the turning-up of the cleavage furrow (Pl. 3, fig. 13) and thought it probable that this might be due to the flowing of cytoplasm through the bridge from one cell to the other (p. 160). In the *Beroë* egg no streaming phenomenon accompanies this curling-up of the cleavage furrow.

In two cases for some unknown reason the division stopped at a certain stage and did not cut through. In one case at the beginning of the division the "cleavage head" was thick but as it proceeded the ectoplasm thinned out somewhat (Pl. III, Figs 43, 44).

From this experiment it may be concluded that after the "cleavage head" is established, the cell-division is accomplished without the instrumentality of either the uncleus or the centrosomes. Furthermore it should be noted in this experiment that there is no perceptible difference between the cut and the uncut eggs in the thickness of "cleavage head," though in some cases a little retardation of the progress of the cleavage is seen in the cut eggs. The up-and-lown flow of the ectoplasm takes place independently of the presence or absence of either the nucleus or the centrosome.

d) *Experiment IV* (Six cases).

In order to test whether either the nucleus or the centrosome exerts any influence on the deepening cleavage furrow, the nucleated portion of one side was cut off at various angles and periods, and the behavior of the cleavage furrow was studied.

In all cases division took place undisturbed by the operation (Pl. III, Figs. 45, 46). In one case, however, the cleavage furrow was bent near its end towards the nucleated side, but such a bending occurs so often in eggs not operated upon (Fig 11 Pl. I) that the cause of the bending in this particular case cannot be ascribed to the operation.

This experiment strengthens the results obtained from the preceding one (Exp. III); that is, the nucleus, centrosome, and the amount of cytoplasm above the cutting plane have little to do with the growth and direction of the cleavage furrow.

e) *Experiment V* (One case).

To slightly modify the above experiment, the cut was extended to the middle of the nucleated part as is shown in Fig. 47 (Pl. IV). The "cleavage head" came down uninterrupted by the operation. But the cleavage furrow stopped at a certain point (Pl. IV, Fig. 48) owing probably to the fact that the nuclei had already enterd the phases of the second cleavage.

f) *Experiment VI* (Seven cases).

In this experiment the "cleavage head" were split in two at various stages by a vertical cut to see if the furrow proceeds from the end of the cut or from some other place.

In no cases were two "cleavage heads" formed. In one case out of seven the cleavage furrow made its appearance at the bottom of the incision, dividing the egg in two equal blastomeres.

In the six cases a remarkable phenomenon was met with. A new "cleavage head" emerged on one side of the incision below the original bottom of the furrow and in most cases a little above the end of the cut. It proceeded almost at right angles to the old cleavage plane. The portion of the cut below the new cleavage furrow dwindled and was either obliterated entirely or remained as a hole for a fairly long time. In Fig. 49 (Pl. IV) the operation was made when the cleavage furrow was very shallow,[1] and the result was Fig. 50 (Pl. IV). In passing, it may be remarked that in the egg of *Pennaria* HARGITT ('00) observed a similar figure (his Pl. II, Fig. 2).

It is interesting to note that in this case an ectoplasmic thickening was foomed at the side of the egg (Pl. IV, Fig. 50). When the

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[1] The original bottom of the cleavage furrow is marked with ×× in this and the following figures.

operation was performed at a later stage (Pl. IV, Figs. 51, 52) a new accumulation of the ectoplasm appeared at the end of the incision which reinforced that of the old "cleavage head" to form the new one. The resulting cleavage furrow was exactly the same as that in the foregoing case.

In five cases the new "cleavage head" was formed on the side with more cytoplasm, while in one case it was just reverse. This may be interpreted in two different ways, *viz.*, (a) that a new cleavage furrow is formed on the side of more cytoplasm, or (b) on the side of more ectoplasm or "cleavage head"-substance due to oblique section. The above experiment fails to decide which of the alternatives is the correct view. The following experiments were especially directed to this point.

g) *Experiment VII* (One cass).

The "cleavage head" was split vertically and a nucleated portion was cut off as is shown in Fig. 52 (Pl IV). A new cleavage furrow was formed at an angle to the old and on the side of more cytoplasm.

h) *Experiment VIII* (Three cases).

For the same purpose, the "cleavage head" was split and a portion of the cytoplasm was cut off. In all cases as in Exp. VI a new "cleavage head" appeared at some angle to the old one. In one case a new division plane was directed towards the cut surface (Pl. IV. Figs. 55, 56) while in the other two the new furrow was formed on the side of the larger cytoplasmic mass and turned upwards as in some cases in Exp. III (Pl. IV. Figs. 58, 59).

This experiment clearly shows that the new "cleavage head" develops on the side of larger cytoplasmic portion.

i) *Experiment IX* (One case).

In one egg the "cleavage head" was split and another incision was made on one side of it (Pl. IV, Fig. 60). A new "cleavage head" was formed on the left hand side which turned to the right (Pl. IV, Fig. 61). This cleavage furrows finally cut off an enucleated portion (Pl, IV, Fig. 62).

j) *Experiment X* (One case).

This is a modification of Exp. VIII. The "cleavage head" was cut in two by a vertical incision, a small nucleated portion was cut off (from the left side of the figure Fig. 63, Pl. V), and the micromere portion was removed. A new cleavage plane was established at the end of the vertical incision that cut through almost straight. This failed to yield anything of interest, being exactly the same as Figs. 55, 56 (Pl. IV).

k) *Experiment XI* (Eleven cases).

In this experiment an incision was made in the egg at the micromere pole to see if that would affect the course of cleavage. In nine cases out of eleven the cleavage furrow passed by the incision as though nothing had happened to the egg (Pl. V, Figs. 65, 67, 68). One notices in Fig. 66 an ectoplasmic accumulation at the left hand corner. In one case the cleavage plane stretched towards the incision and became continuous with it (Pl. V, Figs. 61. 70). In another case the cleavage furrow, which had attained a considerable length, dwindled owing to the operation, and two new furrows were formed giving rise to a three lobed egg (Pl. V. Figs. 71, 72, 73). As the original cleavage furrow shriveled up, a peculiar ray-like arrangement of entoplasm was seen. Whether it was due to the effect of the incision or to preparation for the formation of two new "heads" I could not determine. At any rate this double "headed" cleavage seemed to be an exceptional case. and should not be taken as of constant occurrence.

l) *Experiment XII* (One case).

Two cuts were made on one egg (Fig. 75 Pl. V) and the result was as in Fig. 76 (Pl. V). The cleavage furrow stretched towards one of the incisions and cut through the egg.

VI. Summary.

Observational part:

1. The ctenophore egg is composed of (a) the outer homogeneous layer, (b) ectoplasm and (c) entoplasm.

2. The outer homogeneous layer is homologous with ZIEGLER'S "hyaline Aussenschicht" of the echinoderm egg.

3. The ectoplasm is an alveolar plasm and rays may be formed in it.

4. The ectoplasm is phosphorescent.

5. The sperm-rays and pole-rays of the first division enter the entoplasm, the alveolar walls of the latter taking a radial arrangement.

6. Polyspermic eggs may cleave normally.

7. Cleavage is not strictly unilateral, the furrow being formed in the micromere region.

8. Fine spinning of the homogeneous layer can be seen at entrance and at the bottom of the cleavage furrow.

9. In the "cleavage head" radiations are seen in the homogeneous outer layer and ectoplasm, but they do not extend into the entoplasm.

10. Beneath the "cleavage head" the entoplasmic alveoles are considerably compressed.

11. The micromeres consisting almost entirely of the ectoplasm cleave very similarly to the whole egg.

12. In the beginning of each cleavage, ectoplasmic accumulation is seen at the macromere pole. Towards the end of cleavage, an accumulation appears in the micromere region.

Experimental Part:

13. Enucleated fragments destitute of the "cleavage head" not manifest any division activity.

14. The cleavage plane is not predetermined in the egg.

15. An enucleated piece provided with the "cleavage head" divides by itself without the aid of either nucleus or centrosome. Nor is the ray system necessary for the cleavage of enucleated pieces.

16. The cytoplasm above the level of the cleavage head has little influence upon the accomplishment of the division.

17. The accumulation of ectoplasm over the micro-[1] and macromere poles is formed in enucleated fragments in the same way as in the whole egg.

18. If the removal of the nucleated portions is done at the beginning of the division, the cleavage furrow goes on normally irrespective of the angle of the section. If, however, the same operation is performed upon an egg in which the cleavage has further advanced, the division plane is in most cases turned towards the side of larger amount of cytoplasm, the enucleated fragment being divided into nearly equal parts.[2]

19. Sometimes in the egg operated on the cleavage furrow curls up towards the macromere pole.

20. If the "cleavage head" be split lengthwise, a new head" forms nearly at right angles and towards the portion with larger amount of cytoplasm.

21. If an incision is made in the egg in the micromere region the cleavage is not affected.

VII. General Discussion.

Three views have been put forth regarding the mechanism of the cytodieresis of the ctenophore egg. Ziegler maintains that the cleavage is accomplished by the constriction of a meridional ectoplasmic thickening,[3] which is in turn caused by the "action at a distance" of the centres and no rays are necessary for cleavage ('03 p. 162).

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[1] Strictly speaking, at the end of the cleavage furrow, since the accumulation takes place at the side of the egg in case a new cleavage furrow is formed at right angles to the old, *e.g.*, Pl. IV, Fig. 50.

[2] This result was obtained when a large portion was cut off from the egg. No experiment was carried out, to my regret, to test whether or no the removal of a small amount of cytoplasm from an egg with an already far advanced cleavage furrow affects the remaining course of the cleavage plane.

[3] It is interesting to recall how Kowalevsky was impressed when he observed cleaving ctenophore eggs: "wie sonderbar es auch klingen mag, so scheint mich doch diese, so zu sagen, todte unbewegliche centrale Masse ganz der mechanischen Pressung von Aussen zu und keine innen active Kraft zu besitzen" ('67 p. 3).

Based upon ZIEGLER's observations RHUMBLER tried to explain the cytodieresis of the ctenophore egg by adding a few subsidiary assumptions to his own theory of cell-division in general previously put forth ('99), viz., that (a) the nuclear fluid is present along the axis of the egg; (b) at the expense of the nuclear fluid the membrane grows rapidly; (c) the "cleavage head" is a structure comparable to the centrosome; and (d) the rays radiating from the "cleavage head" contract and pull down the cleavage furrow to the micromere pole.

FISCHEL expresses his view of the probable existence of the pole-rays, which function as in ordinary cases of cytodieresis ('98 p. 620 *et seq.*).

My experimental study on the ctenophore egg makes it impossible for me to accept any of the above three hypotheses for the following reasons. If, as ZIEGLER maintains, the cleavage is due to the contraction of an elastic ring around the egg, the curling-up of the cleavage furrow towards the macromere pole after the removal of the nucleated portion is a thing not easily accounted for. Still more difficult is it to apply his view to the case in which a new cleavage furrow is formed at right angles to the old. The above two facts are also against RHUMBLER's assumption. And the fact that there are no rays radiating from the "cleavage head" into the entoplasm makes his view untenable. It is certain that the cleavage is not accomplished by the contraction of pole rays, as FISCHEL incidentally states, as is seen in the cases in which the nucleated part is removed.

In his paper on the development of *Linerges mercurius*, CONKLIN puts forth the view that the unilateral cleavage of the cœlenterate egg in general is at least in part due to the structure of the oöplasm itself, that is, thin central entoplasm with a firmer peripheral layer ('08 p. 167). This we have no reason to deny, yet how such a structure is favorable to one-sided constriction is hard to understand. When we come to study the unilateral cleavage of the micromeres of the ctenophore egg, which are almost entirely made up of ectoplasm, it becomes doubtful how much influence the original structure of the oöplasm exerts on the performance of such cell division. It is also interesting to note, as I have done elsewhere, that unilateral cleavage is seen in some parthenogenetically developing sea-urchin eggs and also in lamprey eggs, whose oöplasm is uniformely laden with yolk granules.

At present I am not in a position to construct any hypothesis to account for the cleavage mechanism of the ctenophore egg. Further detailed biophysical experimentation on the egg will undoubtedly shed a new light on the problem. As a working hypothesis this much can be said. Through the action of the centres (centrosomes) surface tension is increased along the cleavage plane first at the animal region and then towards the micromere pole[1] and thus the ectoplasm is gradually collected. The optical section of the bottom of the cleavage furrow is the " cleavage head, that is a passive structure. The entoplasm now tends to round up around two centres (geometrical) and the two blastomeres are formed. My experimental study seems to have furnished two important data regarding the above rather vague general interpretation of the cleavage phenomenon. Firstly, the cleavage furrow tends to divide the egg equally, as for instance in the cases where a portion of oöplasm is removed and thus the symmetry is disturbed, the new cleavage furrow being bent toward the larger mass of cytoplasm. Secondly, the ectoplasm flows up and down just as well without the nuclei and centres, as with them. This change may be caused by the unequal increase of surface tension due to the internal division phases. At any rate my results do not indicate that the ectoplasm alone is an active cleaving agent as ZIEGLER and RLUMBLER seem to believe.

Misaki Marine Biological Station
Aug. 11. 1910.

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[1] As has been pointed out by ZIEGLER unilateral cleavage is doubtless in some way connected with the eccentric position of the nuclei and centres. But it should be noted that their being in the ectoplasm is not an essential condition of one-sided cleavage. In the egg of a good many cœlenterates the nuclei are in the entoplasm and the cleavage is unilateral, *e. g.*, *Linerges* (CONKLIN), *Geryonia* (FOL), *Hydra* (BRAUER, TAUNREUTHER).

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PLATE I.

PLATE I.

Figs. 1–8, 10 and **11** *Beroë ovata.*
Fig. 9 *Eucharis multicornis.*

Figs. 1, 2 and **3.** Three successive stages of the division of the first polocyte. ×270.

Fig. 4. Surface view of three polocytes. Clear spot indicates the egg-nucleus. ×270.

Fig. 5. Sperm-head in the egg (surface view). Notice an aster around the centre and a refringent body situated a little apart from the sperm-head. ×270.

Fig. 6. Side view of an ectoplasmic accumulation caused by the spermatozoon. ×270.

Fi.g 7. The same drawn from a polyspermic egg. ×270.

Fig. 8. Trispermic egg (surface view). ×60.

Fig. 9. Dividing egg of *Eucharis* (optical section), a stage preceding Figs 23 and 24 (Pl. II), 3.23 P.M. ×140.

Fig. 10. Dividing egg, the cleavage having proceeded nearly one third the diameter. ×60.

Fig. 11. Dividing egg, showing outlines of four stages; a–a' 10 A.M., b 10.8 A.M., c–c' 10.25 A.M., and d–d' 10.35 A.M. ×60.

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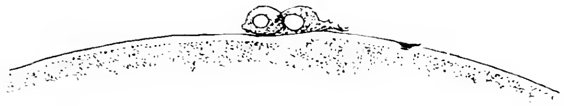

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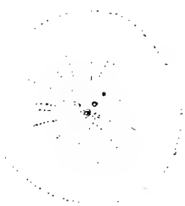

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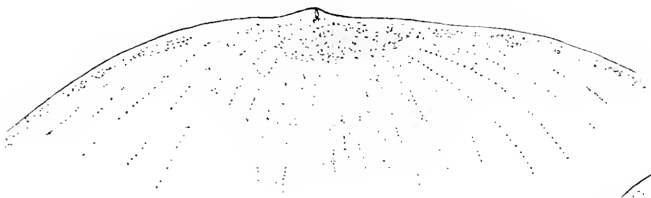

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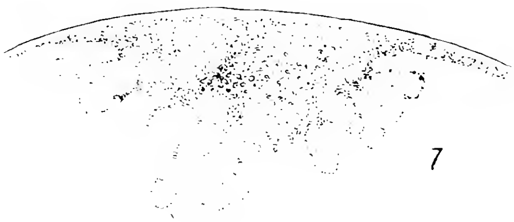

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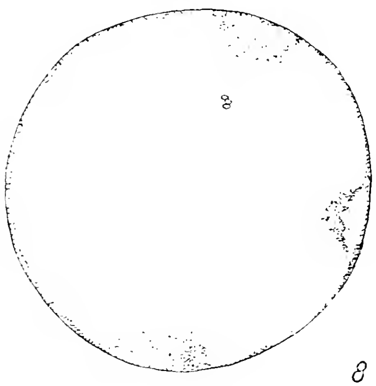

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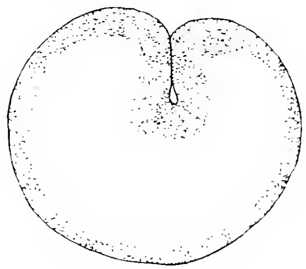

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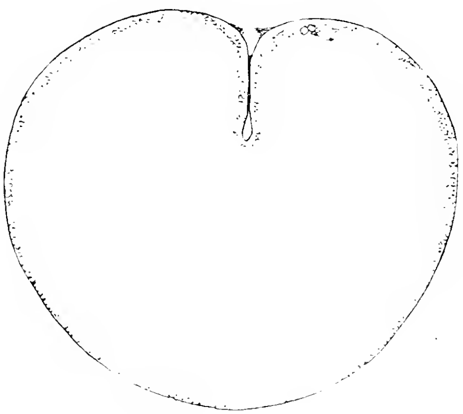

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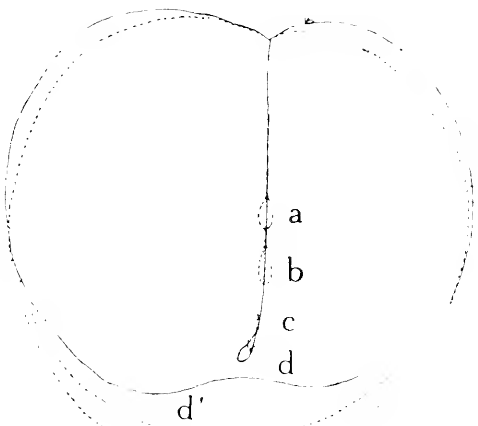

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N. YATSU.

OBSERVATIONS AND EXPERIMENTS ON THE CTENOPHORE EGG.

PLATE II.

PLATE II.

Figs. 12-18, 21, 25 and **26** *Beroë ovata*
Figs. 19 and **20** *Beroë forskålii*
Figs. 22, 27-30 *Callianira bialata.*
Figs. 23 and **24** *Eucharis multicornis.*

Fig. 12. Very young cleavage-head. ×270.

Figs. 13 and **14.** Two stages of the elongation of the cleavage furrow. ×270.

Fig. 15. Cleavage-head having fused with the ectoplasm in the micromere region. ×270.

Figs. 16-18. Last three stages of the first division. ×270.

Figs. 19 and **20.** Two stages of the first division of the egg of *B. forskålii*, drawn respectively at 10.4 A.M. and 10.15 A.M. ×71.

Fig. 21. Early two-cell stage showing the ectoplasmic accumulation in the micromere region. ×60.

Fig. 22. Early two-cell stage of *Callianira.* Notice fenestrated cell-wall and thicker ectoplasm at the micromere region. ×390.

Fig. 23. Two-cell stage of *Eucharis*, in which the cleavage is about to begin. 3.55 P.M. ×140.

Fig. 24. The same; in one of the blastomeres the second cleavage has been taking place. ×140.

Fig. 25. Blastomere of the four-cell stage. ×71.

Fig. 26. Beginning of the third division. ×60.

Fig. 27. Beginning of the third division (*Callianira*); cf. Fig. 22. ×390.

Fig. 28. Blastomere of the four-cell stage, in which the third cleavage has more advanced (*Callianira*). ×200.

Fig. 29. Upper cell of the eight-cell stage, giving off a micromere towards the micromere pole (*Callianira*) ×390.

Fig. 30. Lower cell of the eight-cell stage giving off a micromere horizontally (*Callianira*). ×390.


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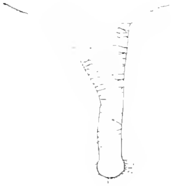
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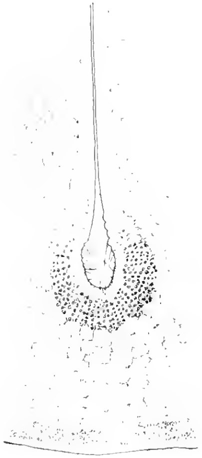
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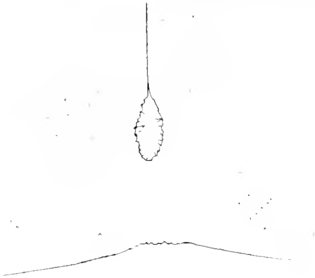
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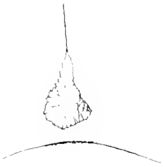
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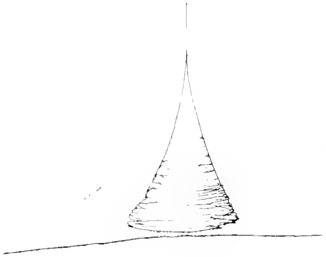
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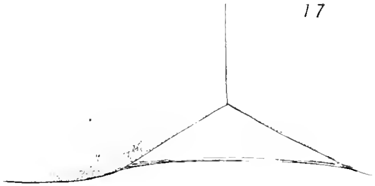
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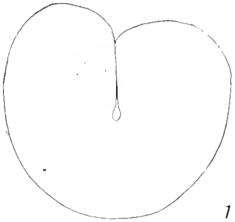
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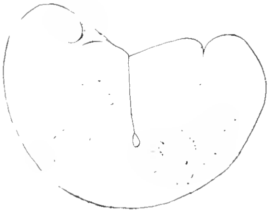
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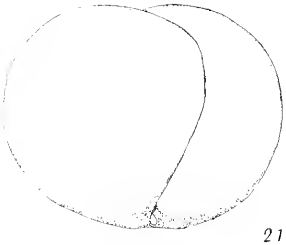
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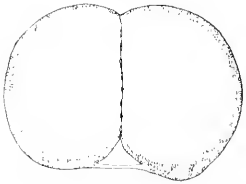
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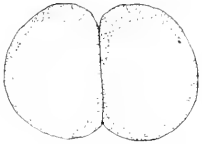
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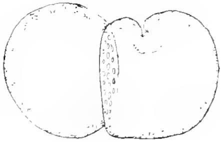
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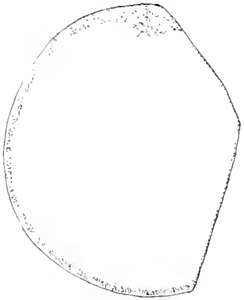
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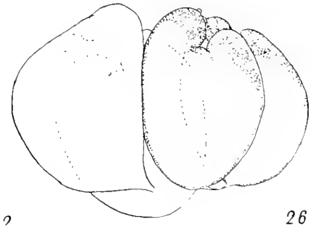
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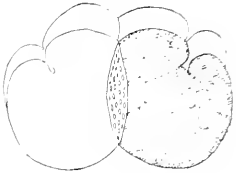
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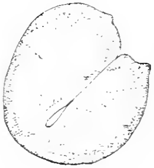
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N. YATSU.
OBSERVATIONS AND EXPERIMENTS ON THE CTENOPHORE EGG.

PLATE III.

PLATE III.

Beroë ovata. ×60 (with the exception of Fig. 44 ×102).

Fig. 31. Egg cut horizontally below the "head." The enucleated cytoplasm cut off did not show any division activity.

Fig. 32. Egg cut below the "head" horizontally nearly two third of its diameter. 10.15 AM.

Fig. 33. The same. 10.38 AM.

Fig. 34. Egg cut in two horizontally at the stage when the "head" had come down nearly two-thirds of its course. 10.10 AM.

Fig. 35. Enucleated fragment of the same showing ectoplasmic thickening in the micromere region as in the normal case. 11;25 AM.

Fig. 36. The same showing a very thin ectoplasmic layer over the cut surface. 11.45 AM.

Fig. 37. Egg cut obliquely just above the "head." 11.22 AM.

Fig. 38. Enucleated fragment of the same divided by a slightly curved cleavage plane. 0.10 PM.

Fig. 39. Egg cut a little above the "head." 9.35 AM.

Fig. 40. Enucleated fragment of the same showing a thick ectoplasmic accumulation along the cut surface. The nucleated part was at the four-cell stage. 10,55 AM.

Fig. 41. Egg cut horizontally a little above the "head." Notice the thickening of the ectoplasm along the cut surface of the nucleated pieces. 2.40 Pm. The "head" at a, 2.50 PM., and at b, 3.25 PM.

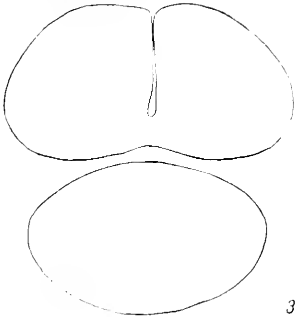
Fig. 42. Enucleated piece of the same. 4.40 PM. At 6 PM. the upper bridge became broader.

Fig. 43. Enucleated fragment obtained by a horizontal cut (outline in dotted line) 10.2 AM.; the same (in full line) 11.15 AM. In the beginning the "head" came down at the rate of 18 μ per minute, and stopped at the spot represented in the latter.

Fig. 44. Cleavage furrow and "head" of the same magnified ×102. 11.15 AM.

Fig. 45. Egg from which the right-hand nucleated portion has been cut off horizontally. Irregular mass attached to the nucleated fragment is the portion that flowed out. 10.45 AM.

Fig. 46. The same. 11.27 AM.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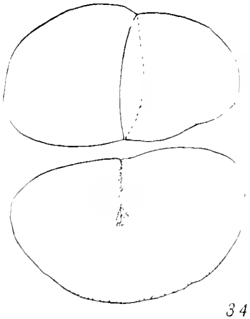
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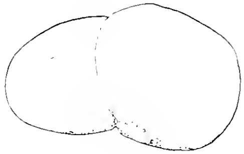
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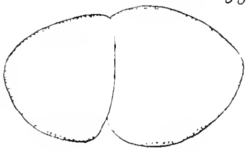
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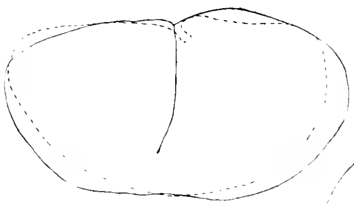
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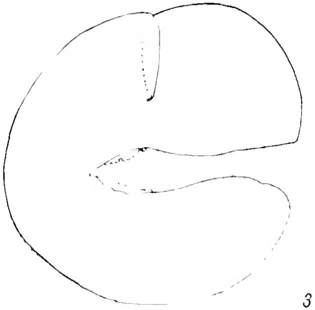
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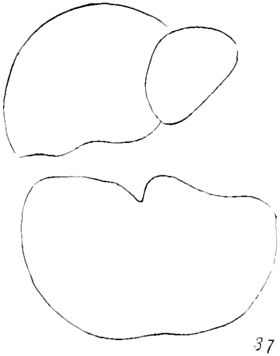
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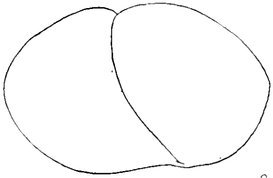
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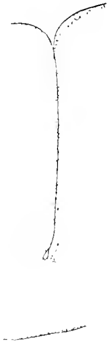
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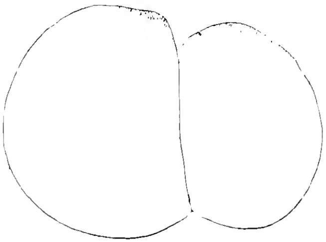
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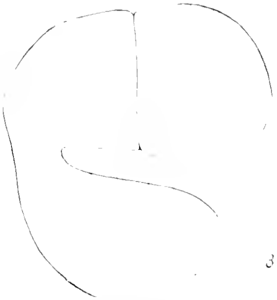
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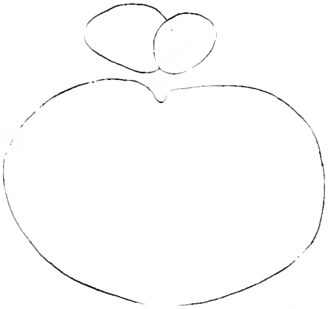
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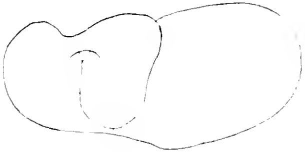
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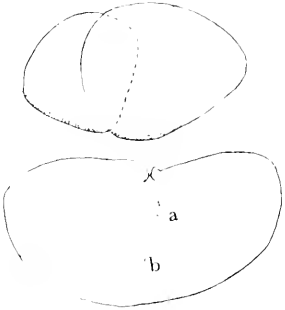

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N. YATSU.

OBSERVATIONS AND EXPERIMENTS ON THE CTENOPHORE EGG.

PLATE IV.

PLATE IV.

Beroë ovata. ×60.

×× in some of the figures in this plate indicate the bottom of cleavage furrow at the time of operation.

Fig. 47. Egg partially cut in two horizontally, a little above the "head" 0.45 PM.

Fig. 48. The same. 2 PM.

Fig. 49. Egg an which young "head" has been split lengthwise by a vertical incision. 9.55 AM.

Fig. 50. The same 11.35 AM.

Fig. 51. Operation similar to Fig. 49. The "head" had got halfway when cut. 11.15 AM.

Fig. 52. The same. 11.35 AM. The cleavage furrow cut through the egg at 0.5 PM.

Fig. 53. Egg with two cuts, one longitudinal and the other horizontal, separating nucleated portion from right-hand prominence. 10.29 AM.

Fig. 54. The same. 11.24 AM.

Fig. 55. Egg from which a portion of cytoplasm has been cut off and the "head" split lengthwise. 11.15 AM.

Fig. 56. The same. 11.55 AM.

Fig. 57. Egg operated on similarly to Fig. 55.

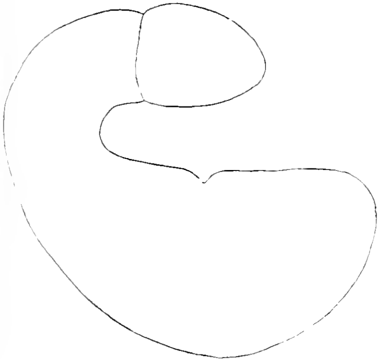
Fig. 58. Cleavage furrow has been formed from the bottom of the cut towards the left.

Fig. 59. Cleavage furrow has cut through the egg. Nucleated portions of both the blastomeres have divided.

Fig. 60. Egg in which the "head" has been split lengthwise and an incision made at the micromere pole. 9.42 AM.

Fig. 61. The same. 10.40 AM.

Fig. 62. The same. Cleavage furrow has cut through the egg, forming an enucleated mass on the right.



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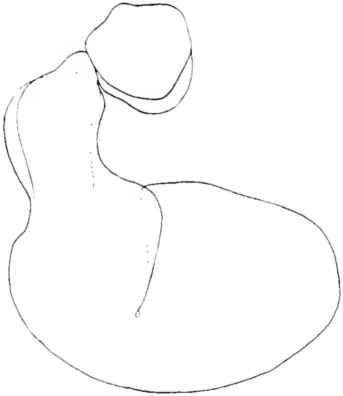

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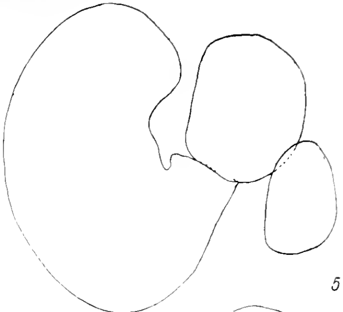

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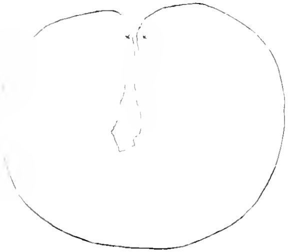

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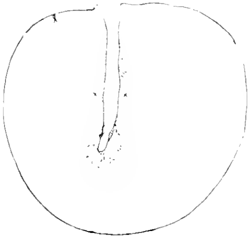

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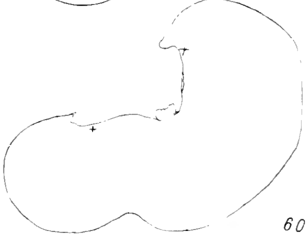

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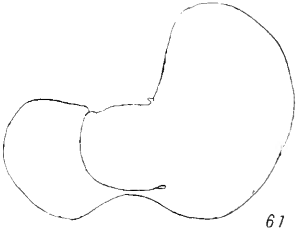

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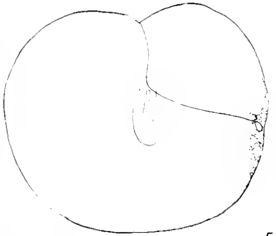

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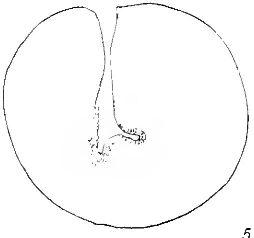

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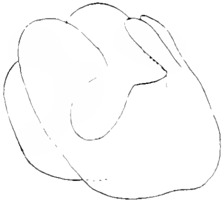

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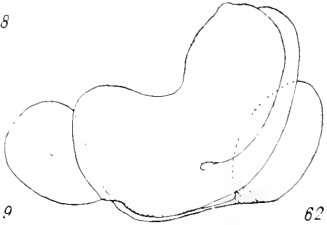

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N. YATSU.
OBSERVATIONS AND EXPERIMENTS ON THE CTENOPHORE EGG.

PLATE V.

PLATE V.

Beroë ovata. ×60.

Fig. 63. Egg with three cuts, namely, the nucleated part was cut off from the left half, which is found attached to the right portion, the "head" was split lengthswise (it was at ×× when operated upon) and a portion of cytoplasm was cut off obliquely from the micromere region. 11.10 AM.

Fig. 64. The same. 0.35 PM.

Fig. 65. Egg with an incision at the micromere region. 9 AM.

Fig. 66. The same. Ectoplasmic thickening is very conspicuous over a prominence to the left of the incision. 11.45 AM.

Fig. 67. Egg with an incision on the right side. 0.5 PM.

Fig. 68. The same. 0.50 PM.

Fig. 69. Egg with an incision at the micromere region. 9.45 AM.

Fig. 70. The same. Cleavage furrow has become continuous with the cut. 10.18 AM.

Fig. 71. Egg with a vertical incision at the micromere region. 2.15 PM.

Fig. 72. The same. "Head" has become irregular and a flow figure is seen.

Fig. 73. The same. Cleavage furrow has fused and two new furrows have been formed. 3.11 PM. (at 2.55 PM. two slight indentations were formed).

Fig. 74. The same. 4.18 PM.

Fig. 75. Egg with two incisions on both sides. 10.53 AM.

Fig. 76. The same. 11.28 AM.


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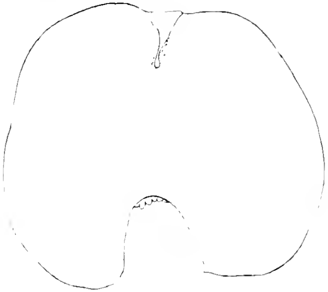
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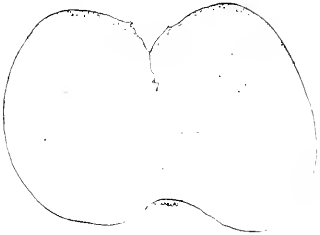
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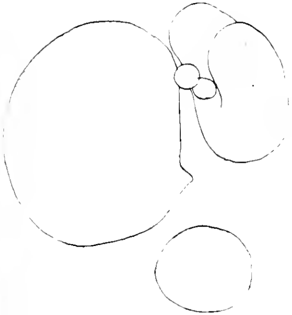
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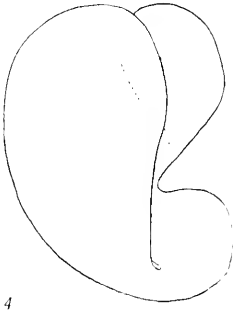
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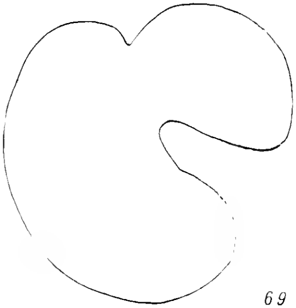
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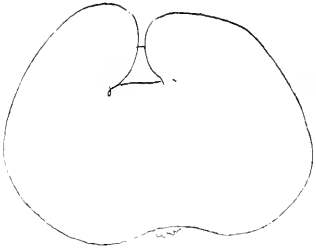
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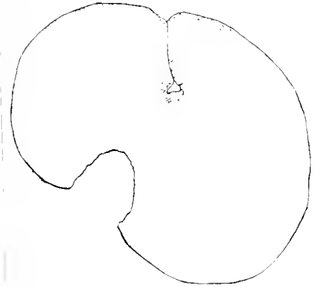
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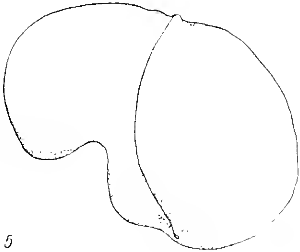
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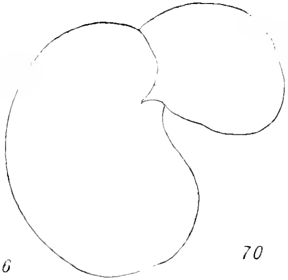
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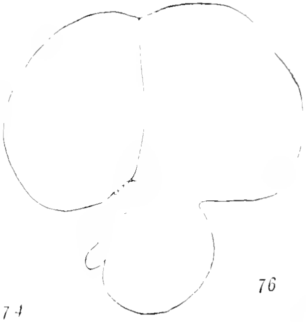
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JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XXXII., ARTICLE, 4.

Études Anthropologiques.

Les Aborigènes de Formose.

(2^e Fascicule.)

par

R. Torii.

Chargé de cours d'Anthropologie à l'Université Impériale de Tōkyō, membre du bureau des affaires concernant les Aborigènes, département de l'Administration civile, Gouvernement de Formose.

Avec 7 planches.

I. Caractères physiques.

A. Tribu Yami

Cette étude sur les "Aborigènes de Formose" comprend 2 parties:

1°. Caractères physiques.
2°. Mensurations.

Je commencerai par décrire les "Caractères physiques" des Aborigènes, en passant en revue les 9 tribus qui peuplent l'île.

Ce premier chapitre est consacré à l'étude des caractères physiques de l'une de ces tribus: les Yami qui habitent Kō-tō-shō.

J'ai déjà publié un album de photographies des Indigènes de Kō-tō-shō (1) et une note sur les coutumes locales de cette île.—(2) M. Otto Scheerer(3) a fait paraître une traduction en allemand de ces 2 travaux dans la revue: "Mitteilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens."

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(1) R. Tōrii, "Kō-tō-shō shashin-shū" Tōkyō 1899.

(2) R. Tōrii, "Kō-tō-shō dōzoku hōkoku" Tōkyō 1902.

(3) Otto Scheerer, Ein Ethnographischer bericht über die Insel-Botel Tobago in "Mitteilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens"—Band XI. 1906.

Déjà, auparavant, le même auteur avait publié dans la même revue, une étude sur les relations d'origine entre les aborigènes de Luçon (Philippines) et ceux de Kō-tō-shō,(1) dans laquelle il cite les 2 ouvrages dont je viens de parler, et celui de M. Davidson.(2) M. Davidson et M. Fischer(3) ont visité Kō-tō-shō, et ont publié le résultat de leurs investigations sur les aborigènes de cette île. M. Davidson s'exprime ainsi au sujet de leurs caractères physiques: "The natives are small, averaging only five feet two inches in height. They are yellowish brown in color; and, with one individual exception, possess straight hair, black with a brownish tint. While thus conforming with the Malayan type in their straight hair and complexion, they appear, so far as face character is concerned, to be two types. We find the rather small nose and non-protruding lips of the Malay; and again a type with projecting eyebrows, deeply sunk orbits, short noses rather depressed at the root and with large nostrils,—in fact almost a Negrito nose,—together with the comparatively large mouth and thick lips of the pure papuan type. One of the chief characteristics of the Papuan is his frizzled hair, of which no trace is found among the Botel-Tobago natives, save in the case of one male adult who possesses hair distinctly curly. So much for their physical characteristics. In their usages and rites, their canoes and dwellings, they possess much in common with the Papuan, and in some instances opposed to the Malay......."

A la suite des travaux ci-dessus mentionnés, que j'ai publiés au retour de mon voyage à Kō-tō-shō, je vais maintenant parler des caractères physiques des aborigènes de cette île.

"Kō-tō-shō" est une petite île située au sud-est de Taï-Wan.(4) Les Européens l'appellent "Botel-Tobago." Elle est habitée par des aborigènes qui l'appellent "Yami," et se nomment eux-mêmes "Gourougourousera."—

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(1) O. Scheerer, Zur Ethnologie der Inselkette zwischen Luzon und Formosa in "Mitteil. der deutsch. Gesell. für Nat. und Völk. Ost"-Band XI. 1906.

(2) Z. W. Davidson, The Island of Formosa. London and New York 1903. (p. 585–6).

(3) A. Fischer, Streifzüge durch Formosa. Berlin 1900. (p. 359).

(4) Formose.

Il y a encore, au sud de Kō-tō-shō, une autre petite île qui s'appelle " Ri-Taiwan." Les Européens l'appellent " Little-Botel-To-bago." Elle n'est pas habitée.

L'île de Kō-tō-shō mesure 22 à 23 ri(1) environ de pourtour. L'île étant entièrement formée de montagnes rocheuses, les villages des aborigènes sont situés sur le bord de la mer.

Les aborigènes de " Kō-tō-shō " nomment leurs villages " nahmen." On n'en compte que 8 à savoir: Yayou, Ibatashi, Irarai, Iwao, Ibariminouk, Ibarinou, Imorod, et Iratai.
Le village de Yayou compte un nombre de maisons assez élevé, 50 environ. Le village d'Imorod en compte 30, et chacun des villages d'Irarai, d'Ibariminouk, d'Ibarinou, 25. Il n'y en a que 3 au village d'Iwao, et 2 au village d'Iwatashi.

D'après les légendes des aborigènes de Kō-tō-shō, à une époque reculée, il n'y avait dans l'île qu'un homme et une femme, au village d'Irarai. Ils eurent une nombreuse descendance. L'homme mourut de bonne heure. La femme, restée seule, éleva les enfants.

Un jour, des Indigènes le l'île d'Ibatan étant arrivés dans l'île, s'emparèrent de la femme et l'emmenèrent avec eux. Dans la suite, les enfants, étant devenus grands, se marièrent entre eux. Ce fut l'origine du village d'Irarai.

Les légendes du village d'Ibarinou racontent que des indigènes de l'île d'Ibatan, venant du village d'Irarai, où ils avaient enlevé cette femme, ayant eu toutes sortes de tribulations sur mer, ne purent retourner dans leur pays, et s'arrêtèrent à Ibarinou. De là date la fondation de ce village.

Au village d'Imorod, existe la légende suivante: Les ancêtres des habitants de ce village étaient des indigènes de l'île d'Ikoubarat. Un jour, alors qu'ils étaient sortis pour pêcher, un grand vent s'éleva tout-à-coup. Emportés par le courant, ils atterrirent à l'endroit où se trouve aujourd'hui le village d'Imorod.

Ils prirent des femmes dans le village voisin d'Iratai. De ces unions naquirent des enfants, qui, s'étant peu à peu multipliés, formèrent le village d'Imorod.

---

(1) Le ri équivaut à 3 kilom. 927.

Les légendes que je viens de rapporter, parlent d'îles nommées Ibatan et Ikoubarat.

Où étaient situées ces îles? J'ai fait des recherches à ce sujet. Je suppose que, comme ces îles étaient situées au sud du détroit de Bashi, elles doivent avoir quelque rapport avec les îles Batan.

Ibatan serait alors Batan, et Ikoubarat serait l'île Ibayat qui fait partie du groupe des îles Batan.

Fig. 1. Vue de l'île Botel-Tobago.

Il me parait donc évident que les aborigènes de Kō-tō-shō ont eu quelque relation avec les aborigènes du nord des Philippines.

La population totale des 8 villages de Kō-tō-shō, s'élève au chiffre de 1300 habitants environ.

J'estimais que des recherches anthropologiques sur les aborigènes de Kō-tō-shō offriraient un grand intérêt.

L'Université Impériale de Tōkyō m'y envoya dans ce but.

Parti de Ke-Lung le 21 octobre 1896, j'arrivai à Kō-tō-shō le 26 du même mois. Je séjournai d'abord quelque temps sous la tente, au village d'Imorod; puis, je visitai, ultérieurement, tous les autres villages.

J'ai poursuivi ces recherches anthropologiques jusqu'au 29 décembre, c'est-à-dire, pendant 70 jours.

Il n'y a à Kō-tō-shō, ni Japonais, ni Chinois. Aucun navire ne faisant le service entre cette île et Taiwan (Formose), le Gouverneur de Formose, M. le Baron Nogi eut la bonté d'en mettre un spécialement à ma disposition pourque je pûsse me rendre à Kō-tō-shō.

Je lui adresse ici l'expression de ma respectueuse gratitude.

Fig. 2. Un village de l'île Botel-Tobago.

Je suis également respectueusement reconnaissant à M. K. Ouchida, gouverneur civil de Formose, ainsi qu'à M. R. Otsu, qui ont bien voulu me faciliter l'accomplissement de ma mission.

C'est à l'appui de M. le Profes. S. Tsuboï, que je dois d'avoir été envoyé à Kō-tō-shō. M. le Profes. J. Ijima m'a aimablement prété son concours pour la publication de cet ouvrage. M. S. Hashimoto a bien voulu également m'aider dans les calculs des mensurations. J'ai enfin reçu l'aide aimable et les conseils de Mrs. U. Mori membre du bureau des affaires concernant les aborigènes,

T. Goto, Y. Noro et K. Miyajima. Enfin, Mr. le docteur Chemin a bien voulu se charger de la traduction en français de cet ouvrage. Je leur adresse à tous mes bien sincères remerciements.

Je dois aussi remercier mon assistant Mr. T. Nakajima, dont l'aide m'a été précieuse dans l'accomplissement de ce travail.

CHAPITRE I

Caractères Descriptifs.

COULEUR DE LA PEAU

La peau est fine et lisse. Je n'ai trouvé, au village d'Imorod, qu'un seul individu présentant des boutons sur la figure; beaucoup, cependant, seraient atteints de cette particularité pathologique.

Les riches s'enduisent la peau de graisse de porc; la peau devient luisante, et dégage une odeur désagréable; mais ils en retirent une certaine considération.

Pour mes recherches sur la couleur de la peau chez les aborigènes de Kō-to-shō, je me suis servi de la table qui se trouve dans l'ouvrage publié par la Société Anglaise d'Anthropologie.(1)

Broca donne également, dans son ouvrage,(2) une table des différentes couleurs de la peau: (couleurs de la peau et du système pileux.) Mais le nombre des couleurs donné dans le manuel de la Société Anglaise d'Anthropologie est moins élevé que celui que donne Broca. Il n'y en a que 10. Le n° 1, la couleur la plus foncée est le "coal-black (noir de charbon)"; la plus claire, le n° 10 est "florid, or rosy (couleur fleurie ou rosée)." Au milieu se trouvent le "yellow (jaune)"; le "brown (brun)" etc......Cette table est très commode pour l'explorateur.

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(1) Notes and queries on Anthropology. London 1892. (p. 16; pl. III.)

(2) P. Broca, Instructions anthropologiques générales. Paris 1879.

J'ai observé la couleur de la peau sur les parties suivantes: front, dos et paume de la main.

La couleur de la peau est la même chez les hommes et chez les femmes.

Couleur du front.

La couleur du front est le “brown (brun)”; elle n'est pas tout-à-fait aussi fonçée que la couleur n° 5 de la table “copper coloured (cuivrée).” Elle me parait être un mélange des couleurs n° 9 et n° 7 (n° 30 de Broca).

Couleur de la Paume de la Main.

Cette couleur diffère de celles du front et du dos de la main. C'est le n° 10 de la table, c. à. d. “florid (fleurie)” ou “rosy (rosée).”

J'ai fait porter mes recherches à ce sujet sur des individus de 20 à 50 ans, hommes, femmes, vieillards, enfants, indifféremment.

Ils ont tous la même couleur de peau.

Sur les reins, elle ne différe pas lorsqu'ils sont nus, même à l'endroit où ils portent d'habitude le “gigat.”(1) V. la fig. A de la pl. XIV de l'Introduction.

J'ai, cependant, observé, au village d'Ibarinou, un sujet, nommé Shaman-Barrou dont la peau présentait la couleur n° 9 “pale-white (blance pâle),” au niveau du grand-trochanter, à l'endroit où la peau était cachée par son “gigat.” J'ai aussi observé, ultèrieurement, le même fait sur 2 autres sujets.

Chez les enfants, la couleur du front et du dos de la main est un peu plus claire que celle des adultes qui est le “yellow-brown (jaune brun).” Elle un peu plus foncée que le n° 10 de la table.

Couleur des Yeux.

En prenant comme base, pour observer la couleur des yeux, “l'Échelle chromatique des yeux” de Broca,(2) j'ai constaté que

---

(1) Sorte de pagne de 3 mètres de longueur et de 15 centimètres de largeur, en toile de chanvre, que les indigènes portent enroulé autour de la ceinture à partir de l'âge de 7 à 8 ans.

(2) Loc. cit.

la couleur des yeux des aborigènes de Kō-tō-shō, répond aux numéros 1,2 et 3 de la série "brun-noir," de cette échelle.

CHEVEUX.

Les cheveux des indigènes de Kō-tō-shō sont absolument droits. Leur couleur est noire, un peu mélangée cependant de brun. Ils sont fins et souples, et sont très fournis.

Les enfants ont les cheveux bruns au début; mais, à mesure qu'ils grandissent, la couleur de leurs cheveux se rapproche peu à peu de celle des cheveux des adultes.

Voici une section des cheveux, examinée au microscope: (fig. 3).

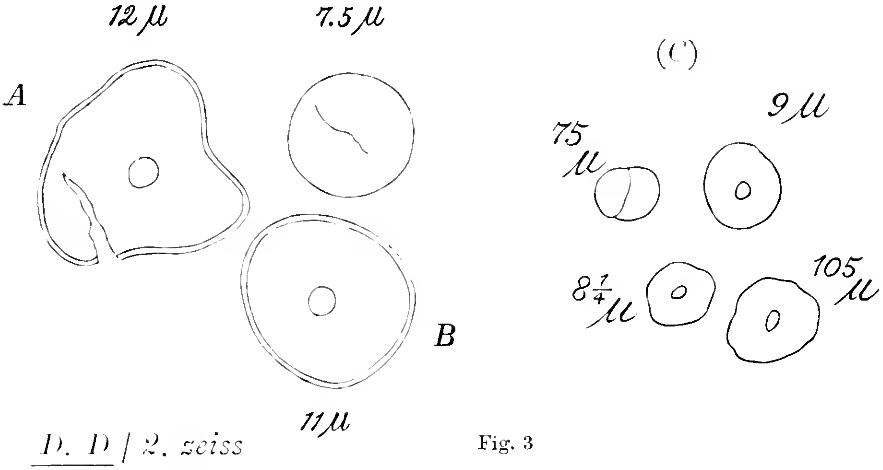


Fig. 3

A. Section à la racine. B. Section à la partie moyenne.
C. Section à l'extrémité.

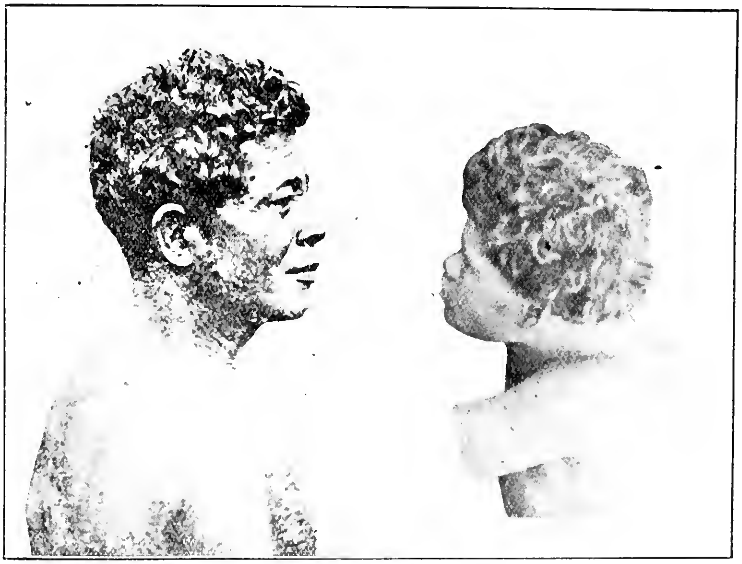
Comme on le voit par ces figures, la section à la racine est légèrement triangulaire; elle est ronde à la partie moyenne et absolument circulaire à l'extrémité.

Dans le nombre, il y a des cheveux de forme très irrégulière; mais ils sont rares.

Au milieu de la section, il y a un canal.

J'ai trouvé au village d'Imorod, un sujet du nom de Shikashi, dont les cheveux étaient frisés. Il est représenté en B dans la fig. 4.

Les indigènes actuels de Kō-tō-shō ont le type que Mr. Deniker appelle "indonésien"(1) Je n'ai jamais trouvé le type "Negrito." Tous les autres indigènes de Kō-tō-shō que j'ai examinés, ayant les cheveux droits, je pense que ce cas de cheveux


A Fig. 4. B

frisés chez le nommé Shikashi est unique (B), et je suis porté ā le considérer comme un phénomène de retour, les ancêtres des indigènes actuels s'étant métissés autrefois, ailleurs, avec le type negrito, avant leur arrivée à Kō-tō-shō.

Le type A de la fig. 4, qui est extrait de l'album du Dr. Myer(2) (Pl. XII) est un indigène venu des Philippines, habitant Calayan, dans le nord de Luçon, et issu d'un métissage entre malais et negrito. En les comparant ensemble, on peut constater qu'ils se ressemblent.

BARBE.

Il ressort des recherches que j'ai pratiquées sur 79 indigènes de Kō-tō-shō, que leur barbe presente 3 variétés.

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(1) J. Deniker, Les races et les peuples de la terre. Paris 1900.

(2) A. B. Meyer, Album von Philippinen typen. Dresden 1885 (Pl. XII).

Type *a*) Sujets ayant de la barbe sur quatre parties du visage: des moustaches, la mouche, de la barbe au menton et sur les joues.

Cette barbe est extrêmement rude, et peu abondante.

Sur 79 sujets observés, 2 à peine, appelés l'un Manigad, l'autre Shimagon, tous deux du village d'Ibarinou appartenaient à ce type.

Fig. 5.

Type *b*). Sujets n'ayant de barbe que sur 3 parties du visage: moustaches, mouche et barbe au menton. C'est le type le plus fréquent: 73 sujets sur 79 le présentaient.

Type *c*) Sujets n'ayant pas du tout de barbe sur les quatre parties du visage. Je n'ai trouvé que 4 sujets de ce type sur les 79 que j'ai observés: 2 étaient originaires du village d'Ibarinou; ils s'appellent Shaman-Shagerrou et Kourongo; le troisième Shaman-Shabougai, est du village d'Imorod; je n'ai pu savoir le nom du quatrième, originaire du village d'Iratai.

Poils du Corps.

On peut établir dans chaque race 4 divisions relatives au degré d'abondance des poils: absents, rares, moyennement abondants, abondants.

Chez les indigènes de Kō-tō-shō, la variété "rares" est fréquente; mais parmi ceux qui composent cette variété, il y en a chez qui les poils sont presque "absents," de même que d'autres sont à la limite de la variété "moyennement abondants." Voici le résultat de mes recherches relatives à l'abondance du système pileux sur 120 sujets.

a) Sujets ayant des poils fins aux jambes. Les sujets de cette variété sont nombreux à Kō-tō-shō; j'ai, cependant, observé que les poils du membre inférieur poussaient très rudes chez un individu du nom de Shaman-Manigad, au village d'Ibarinou.

b) Sujets ayant des poils fins aux avant-bras et aux jambes. Ils sont également nombreux.

c) Sujets ayant des poils fins à la fois aux épaules, aux avant-bras et aux jambes. Dans cette variété, les poils sont plus rares que dans les variétés précédentes. Je n'ai trouvé qu'un seul sujet, du nom de Shaman-Barrou, du village d'Ibarinou, appartenant à ce groupe.

d) Sujets qui n'ont pas de poils du tout sur le corps. 2 individus seulement, Shaman-Shagai, et Shaman-Kwakou, tous deux du village d'Imorod, appartenaient à cette variété.

e) Sujets dont presque tous les poils du corps sont rudes. Je n'ai trouvé qu'un seul sujet de cette variété. Cet individu, nommé Shap-Makarrou, du village d'Iratai, était âgé de 50 ans environ. Les poils étaient rudes partout où ils poussaient, sur les épaules, sur le dos, les bras, le ventre, les jambes. Ces poils, assez abondants, avaient la longueur suivante: sur les bras, $26^{\text{mm.}}$; sur les épaules, $24^{\text{mm.}}$; aux jambes, 26.$^{\text{mm.}}$. On peut le ranger dans la variété "abondants."

Sourcils.

La couleur des sourcils est noire; ils sont généralement épais, la queue étant plus fournie. Chez 4 sujets sur 130 examinés, des poils fins poussaient entre les sourcils. L'un d'entre eux était du village d'Ibarinou; je n'ai pu avoir son nom; un autre, Shap-Makarrou, était du village d'Iratai; enfin, les deux autres étaient de jeunes garçons de 15 à 16 ans, l'un Sekoa, du village d'Imorod, l'autre Sheramaza, du village d'Iratai.

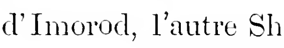

Fig. 6.

Si l'on regarde sans trop d'attention ces 4 sujets, leurs sourcils semblent se rejoindre, en raison des poils fins qui poussent au milieu (fig. 6).

INSERTION DES CHEVEUX SUR LE FRONT.

Ayant examiné le mode d'implantation des cheveux sur le front sur 80 indigènes, j'ai trouvé les 3 formes suivantes (fig. 7).

a) Insertion à courbe très prononcée.

b) Insertion à courbe moyenne.

c) Insertion à courbe peu prononcée.

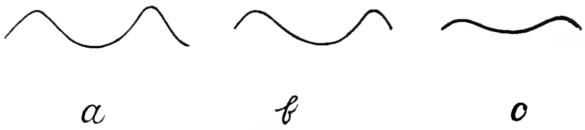

Fig. 7.

Sur les 80 sujets examinés, 48 présentaient la forme *a*), 14 la forme *b*), 19 la forme *c*). Le forme *a*) semble donc être la plus fréquente.

FACE.

La face est plate. Elle est déprimée à sa partie médiane. Sa forme est, le plus souvent ronde.

Le front est un peu incliné en arrière et bombé.

L'os malaire est, le plus souvent proéminent; l'angle du maxillaire inférieur fait saillie. Il en résulte que la forme de la face semble carrée.

Fig. 8

Voici quelques spécimens de profils de la face chez les indigènes de Kō-tō-shō (fig. 8).

On peut les comparer ici, avec les profils de Japonais et d'Européens qui sont reproduits dans la fig. 8.(1)(2)

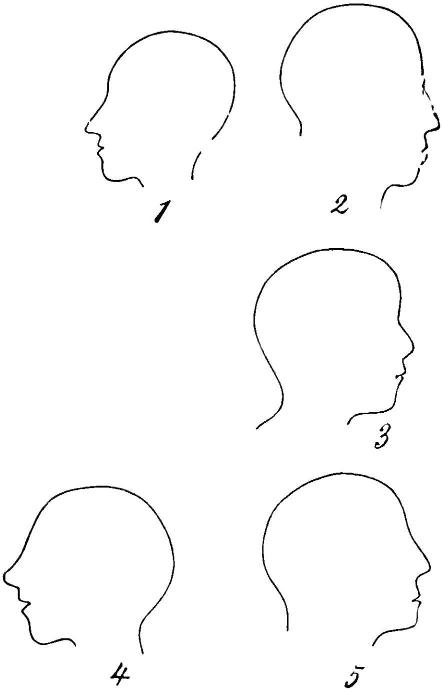

Fig. 9.

1, 2, 3. Sont des profils de Japonais.

4–5. d'Européens.

Les lèvres des aborigènes de Kō-tō-shō sont épaisses.

La bouche est large.

YEUX.

Les yeux ont des dimensions moyennes. Leur direction est toujours horizontale.

Ayant examiné attentivement la forme des yeux sur 98 individus, j'ai constaté que des 2 formes d'œil que donne M. Topinard,(2) presque tous les sujets avaient l'œil "européen." Je n'ai trouvé que chez un seul individu nommé Sheriton, du village d'Ibarinou, l'œil "oblique," caractéristique de la race mongole.

L'orbite est très excavé; le globe de l'œil s'y enfonce profondément.

La couleur des yeux est, comme je l'ai déjà dit plus haut, "brun-noir."

La paupière supérieure présente deux replis.

NEZ.

Dans mes recherches sur les profils des nez chez les aborigènes de Kō-tō-shō, j'ai trouvé 3 types. Dans ces 3 types, le sillon qui

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(1) Tiré de J. Ranke, Der Mensch II. Leipzig 189. (p. 278).

(2) P. Topinard, Eléments d'anthropologie générale. Paris 1885 (-p. 999).

sépare les ailes du nez des joues, est profondément marqué, l'ouverture des narines est large.

Voici un exposé détaillé des caractéristiques de chacun de ces types (fig. 10).

Fig. 10.

a) La forme de ce nez est un mélange du n° 1 et du n° 7 de la table des "Types de nez; profils" de Topinard.

18 individus sur 85 présentaient ce type. J'ai dessiné la forme de ce nez d'après un indigène du village d'Ibarinou, nommé Shaman-Ayou.

b) 19 sujets sur 85. La forme de ce nez a été prise sur un nommé Shapoun-Magaro, du village d'Imorod.

c) Au milieu du dos du nez, il existe une dépression; les ailes sont larges; l'ouverture des narines est grande. 48 sujets présentaient ce type. Chez l'un deux, nommé Shap-Magarrou, du village d'Iratai, existe une profonde dépression; à proprement parler, il semble qu'il n'y ait pas de dos du nez; les ailes seules ressortent. Ce type extrême de nez me fait penser au type negrito, dont il se rapproche beaucoup. J'ai dessiné ce type de nez d'après un nommé Kateshana-Yappanko, du village d'Imorod.

De ces 3 types de nez, le type *c* est donc le plus fréquent. Les profils ont été pris dans les villages d'Imorod, d'Ibarinou et d'Iratai. Le type *a* est fréquent au village d'Ibarinou; j'ai vu souvent le type *c* au village d'Imorod.

La forme du nez est caractéristique d'une race. C'est vrai pour les aborigènes d'Australie, les Papous, les Boshimen, les Hottentots, demême que pour les Européens et les Juifs.

Les formes extrêmes des types *a* et *c* devaient exister avant l'arrivée des aborigènes dans l'île; la forme *b* est probablement le résultat du mélange des types *a* et *c* après l'arrivée dans l'île.

J'ai trouvé dans l'album des photographies des types des

Philippines du Dr. Myer,(1) des formes de nez semblables au type *c* des aborigènes-de Kō-tō-shō chez les Igorrotes et les Tinguianen. Il y a donc probablement une relation d'origine entre les deux.

DENTS.

Les aborigènes de Kō-tō-shō ont généralement de bonnes dents; elles sont régulièrement plantées. Chez certains d'entre eux, le bord de l'arcade dentaire inférieure est horizontal. Sur 73 sujets de 20 à 50 ans que j'ai examinés, je n'en ai vu qu'un, nommé Shaman-Magaro, à qui manquaient les dents molaires.

OREILLE.

Tantôt le bord du pavillon de l'oreille est droit, tantôt il présente une échancrure; de même, chez les uns, le lobule est nettement séparé de la tête, tandis que chez d'autres il y est rattaché.

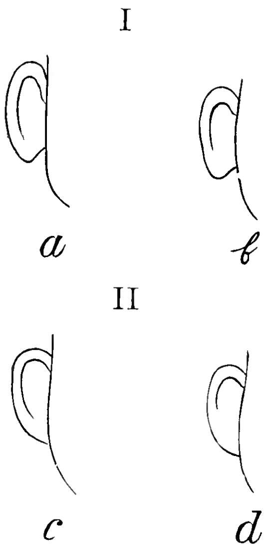

Fig. 11.

Dans le dessin I de la fig. 11, ci-dessus, en *a* le bord du pavillon est très droit, le lobule nettement séparé de la paroi du crâne.

En *b* le lobule est également séparé de la paroi du crâne; mais le bord du pavillon présente une échancrure.

En II, le bord du pavillon de *c* est droit; mais le lobule est rattaché à la paroi du crâne; en *d* le pavillon est droit, le lobule adhérent.

Sur 73 sujets examinés 46 présentaient le type *a*, 17 le type *b*, 14 le type *c*; enfin 3 seulement répondaient au type *d*.

Les femmes perçent dans le lobule de l'oreille un petit trou, dans lequel elles introduisent un fil auquel est attaché un pendant d'oreilles que l'on appelle dans le pays "oubai."(2)

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(1) Meyer, Album von Philippinen-typen (Pl. XIV et XXIV).

(2) Coquillage taillé en forme de 8 provenant du *Nautilus Pompilius L.*

Les hommes ne portent pas de pendants d'oreille, mais ils présentent encore une petite cicatrice en trou d'aiguille dans le lobule.

Voici le résultat de mes recherches sur 115 sujets:

a) Sujets chez lesquels le petit trou du lobule est encore ouvert.

b) Sujets chez lesquels persiste une cicatrice des deux côtés.

c) Sujets chez lesquels cette cicatrice ne persiste que d'un côté.

d) Sujets ne portant plus aucune trace du trou.

Un seul sujet nommé Shaman-Shabougai, du village d'Imorod appartenait à la catégorie *a*. Parmi 99 sujets venant se ranger dans la catégorie *b*, un d'entre eux, nommé Kourougo, du village d'Imorod, avait le lobule fendu. Enfin, il y avait un seul sujet dans la catégorie *c*, et 5 dans la catégorie *d*. Les sujets présentant encore des vestiges du trou dans le lobule, sont donc les plus nombreux. (99 sur 115).

D'après les indigènes de Kō-tō-shō, ceux des îles Ibatan (Batan) et Ikoubarat (Ibayat) se perçent un grand trou dans le lobule de l'oreille, et y introduisent des morceaux de bambou ou de bois. En outre, les aborigènes de ces îles s'appelleraient du nom de "gourougourousera"(1) de même que ceux de Kō-tō-shō. On peut donc en déduire que les aborigènes de Kō-tō-shō se perçaient également autrefois de grands trous dans le lobule de l'oreille.

DIMENSIONS DE L'INDEX ET DE L'ANNULAIRE.

Sur 95 indigènes chez lesquels j'ai recherché les dimensions de l'index et de l'annulaire, 84 avaient l'index plus long; chez 8 autres ces deux doigts étaient d'égale longueur. Chez 3 seulement, l'annulaire était plus long. L'index est donc généralement plus long que l'annulaire.

FORME DE L'ONGLE.

Les 3 formes suivantes existent:

---

(1) Hommes qui ont les cheveux taillés en rond. (de "gourou," cercle et "sera," homme.)

Sur 70 sujets, 13 présentaient la forme *a*, 48 la forme *b*, 9 seulement la forme *c*; la forme *b*, est donc celle que l'on trouve le plus fréquemment.

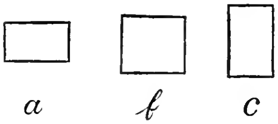


Fig. 12.

Courbe du bras.

Voici le résultat de mes recherches sur le degré de courbure du bras chez 97 sujets:

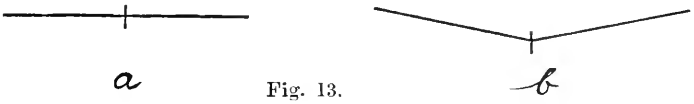


Fig. 13.

En faisant tendre le bras autant que la force le permet, 94 sujets sur les 97 présentaient la forme en *a*), 3 seulement la forme en *b*). Le bras ne présente donc pas de courbure; il est le plus souvent horizontal.

DEGRÉ D'ÉCARTEMENT DES MEMBRES INFÉRIEURS.

Ayant fait placer 79 sujets dans la position debout pour rechercher le degré d'écartement des membres inférieurs, j'ai constaté que 74 les avaient écartés, alors que 5 seulement les avaient réunis. L'écartement est donc la généralité.

DIMENSIONS DES 1ER ET 2ÈME ORTEILS.

Le deuxième orteil est généralement plus long que le premier, ainsi qu'il résulte de ce tableau établi d'après des recherches pratiquées sur 82 sujets.

a)	$\mathrm{I} > \mathrm{II}$	8 sujets.
b)	$\mathrm{I} = \mathrm{II}$	23 ,,
c)	$\mathrm{I} < \mathrm{II}$	51 ,,

Chez un sujet, en outre, la longueur des 1er et 2me orteils du pied droit et du pied gauche différaient: d'un côté le 1er était plus long que le 2e, tandis que c'était l'inverse de l'autre côté.

Mes recherches ont surtout porté sur les hommes; je n'ai pas étudié les femmes.

Les hommes que j'ai examinés sont surtout des adultes; j'ai laissé de côté les enfants et les vieillards.

Voici la liste des sujets sur lesquels j'ai pratiqué des mensurations:

(* Ce signe indique les enfants au dessous de 12 ans).

Numéros	Noms des Villages	Noms des Individus.
1	Imorod	Kateshana Yappanko
2	,,	Shapou Magaro
3	,,	Shennikotan
4	Ibarinou	Jaraboi
5	Ibariminouk	Sheriton
6	Ibarinou	Shenemararop
7	?	Shipanigaman
8	Ibariminouk	Shaman Garap
9	,,	Shaman Jagaraou
10	,,	Banaibinko
11	Ibarinou	Shaman Manigad
12	,,	Shigatok
13	Imorod	Shaman Norain
14*	Ibarinou	Shijariga
15	Iratai	Shap Makarou
16*	Ibarinou	Shitokourin
17	Imorod	Shagerrou
18	Ibarinou	Shaman Noyau
19	?	Shaman Ranrounkó
20	Iratai	Shegawoshi
21	Ibarinou	Panaman
22*	,,	Shijempou
23	Imorod	Garap
24	Ibarinou	Shaman Barrau
25	Imorod	Shaman Shabougai
26	,,	?

Numéros	Noms des Villages	Noms des individus.
27	Iratai	Shaman Kouyamako
28	Imorod	Shaman Kwakó
29*	Ibariminouk	Shiramaya
30	Ibarinou	Shaman Panama
31	,,	Shimagou
32	,,	Shaman Jokourin
33	,,	Shaman Jonankó
34	Imorod	Amanikotan
35	,,	Shaman Maroukanko
36	?	Shaman Marougan
37	Ibarinou	Shaman Jōaji
38	,,	?
39	Imorod	?
40	,,	Shaman Roumai
41	Ibarinou	Pountan Shagai
42	Imorod	Shaman Riprin
43	,,	Shap kara Watouko
44	?	?
45	Imorod	?
46	,,	Chikojiratai
47	Iratai	Shaman Joumanoud
48	Imorod	Shaman Roup
49	Ibarinou	?
50	Ibariminouk	Shaman Marârou
51	Iratai	Shaman Kwakó
52*	Imorod	Shekoa
53*	,,	Chichiagod
54	,,	Shap Morainbinko
55	,,	Shaman Panigoun
56	Ibarinou	Shaman Chinapi
57	,,	Shaman Kotoukó

Numéros	Noms des Villages	Noms des individus.
58	Imorod	Shaman Karawakó
59	,,	Shaman Shadaji
60	Ibarinou	Kakoutoōkó
61	Iratai	Shaman Kwakó
62	Imorod	Shaman Garouwash
63	Iratai	Shaman Chinapi
64	Ibarinou	Shap Megatok Shoun
65	Imorod	Shaman Matāpo
66	Iratai	Kagon
67	Imorod	Set'machiang
68	Ibarinou	Shaman Masori
69	,,	Sham Norain
70	,,	Shaman Joubout
71	Yayou	Shépoposou
72	Ibarinou	Shiratou
73	?	Shaman Shagerrou
74	Ibarinou	Kaurougo.
75	,,	Shaman Patō
76	,,	Shaman Magato
77	Yayou	Matounara
78	,,	Shaman Jagagi
79	Iratai	Shaman Gararóp
80	Imorod	Shenegapouri
81*	?	Shenaoijei
82*	Imorod	Shijabat
83*	Iratai	Sherakounkó
84	Ibarinou	Shaman Jombou
85	Iratai	Shaman Japourrou
86	,,	?
87	Iratai	Maroshi
88	,,	?

CHAPITRE II.

Mensurations.

A. Mensurations de la tête et de la face.

I. Diamètre antéro-postérieur maximum.

Mensurations pratiquées sur 48 sujets.

Le chiffre moyen est de 178 millimètres ; les dimensions extrêmes sont de 169 millim. et de 189 millim.

Voici le tableau de ces mensurations.

Numéros d'ordre	Diam. ant. post. maxim.	Numéros d'ordre	Diam. ant. post. maxim.
1	176 mm.	34	178 mm.
2	184	35	184
3	180	36	174
4	175	39	177
5	170	40	180
6	172	41	182
7	182	42	182
9	169	43	183
11	172	47	188
12	180	48	174
13	174	50	177
15	176	51	180
17	174	55	185
18	175	57	172
21	177	58	171
23	179	59	184
24	184	60	184
25	172	61	179
27	182	62	179
28	176	63	170
30	175	64	176
31	178	65	172
32	176	66	188
33	175	74	189

Diamètre transversal maximum.

Mensurations pratiquées sur 44 sujets.

La moyenne est de 141$^{\text{mm.}}$,3; les dimensions extrêmes de 130$^{\text{mm.}}$,0 et de 153$^{\text{mm.}}$,0.

Voici le tableau de ces mensurations.

Numéros d'ordre	Diam. transv. maxim.	Numéros d'ordre	Diam. transv. maxim..
1	130 mm.	35	153 mm.
2	137	36	140
3	137	39	146
4	139	40	140
5	144	41	145
6	137	42	138
7	139	43	140
9	149	47	138
11	140	48	138
12	153	55	138
13	150	57	138
15	130	58	132
17	145	59	143
18	141	60	145
21	139	61	139
25	151	62	139
27	161	63	130
28	140	64	141
30	145	65	139
31	145	66	144
32	139	74	143
33	141	—	—
34	140	—	—

Longueur totale du visage.

(Du point mentonnier à la racine des cheveux).

Sur une série de 45 individus, la longueur moyenne a été de 178$^{\text{mm.}}$, 4; les variations extrêmes de 161$^{\text{mm.}}$,0 et de 198$^{\text{mm.}}$,0.

Numéros d'ordre	Long. tot. du visage	Numéros d'ordre	Long. tot. du visage
1	183 mm.	36	172 mm.
2	182	39	176
3	185	40	198
4	164	41	184
5	161	42	191
6	171	43	182
8	191	47	177
11	171	48	180
12	173	50	183
15	182	51	176
17	176	55	181
18	172	58	174
21	184	59	186
23	170	60	189
24	181	61	171
25	164	62	174
27	189	63	175
28	179	64	176
31	165	65	186
32	172	66	191
33	177	67	177
34	167	74	187
35	181	—	—

Longueur totale de la face.

(du point sus-nasal au point mentonnier.)

Sur une série de 47 individus, le chiffre moyen a été de 106$^{\text{mm.}}$,0 les variations extrêmes, de 94$^{\text{mm.}}$,0 et de 116$^{\text{mm.}}$,0.

Numéros d'ordre	Long. tot. de la face	Numéros d'ordre	Long. tot. de la face
1	108 mm.	36	103 mm
2	107	39	107
3	103	40	111
4	101	41	112
5	101	42	111
6	111	43	113
8	100	47	112
11	104	48	105
12	104	50	107
15	107	51	104
17	104	55	106
18	101	57	107
21	103	58	101
23	105	59	108
24	106	60	111
25	95	61	107
27	109	62	103
28	106	63	105
30	110	64	94
31	103	65	110
32	107	66	116
33	112	67	100
34	104	74	113
35	106	—	—

Largeur totale de la face (distance bi-zygomatique maxima).

Examen pratiqué sur 49 individus.

Largeur moyenne 128mm.,6; variations extrêmes 109mm.,0 et 139mm.,0.

Numéros d'ordre	Larg. tot. de la face	Numéros d'ordre	Larg. tot. de la face
1	137 mm.	36	122 mm.
2	136	39	130
3	131	40	128
4	127	41	138
5	128	42	133
6	125	43	139
8	125	47	136
9	127	48	125
11	127	50	125
12	135	51	137
15	121	54	134
17	130	55	135
18	124	57	122
21	116	58	124
23	121	59	127
24	109	60	138
25	125	61	130
27	125	62	128
28	129	63	128
30	132	64	124
31	127	65	136
32	122	66	128
33	114	67	136
34	135	74	129
35	139	—	—

Hauteur du front.

Le chiffre moyen de la hauteur du front mesurée chez 46 sujets est de 72$^{\text{mm.}}$,4 ; les variations extrêmes sont de 60$^{\text{mm.}}$,0 et 91$^{\text{mm.}}$,0.

Numéros d'ordre	Haut. du front	Numéros d'ordre	Haut. du front
1	75 mm.	36	69 mm.
2	75	39	69
3	82	40	87
4	63	41	72
5	60	42	80
6	65	43	65
8	91	47	65
11	67	48	75
12	69	50	76
15	75	51	72
17	72	53	71
18	71	55	75
21	81	58	73
23	65	59	78
24	75	60	78
25	69	61	64
27	80	62	71
28	73	63	70
31	62	64	82
32	65	65	76
33	65	66	75
34	63	67	77
35	75	74	74

Longueur du nez.

La longueur moyenne, prise sur 48 individus est de $42^{\text{mm.}}$, 9, les variations extrêmes de $34^{\text{mm.}}$,0 et $53^{\text{mm.}}$,0.

Numéros d'ordre	Long. du nez	Numéros d'ordre	Long. du nez
1	36 mm.	36	43 mm.
2	45	39	45
3	46	40	43
4	46	41	47
5	41	42	45
6	43	43	48
8	42	47	44
11	42	48	40
12	42	50	46
15	34	51	45
17	45	54	51
18	50	55	39
21	41	57	44
23	39	58	38
24	41	59	41
25	39	60	45
27	44	61	37
28	42	62	42
30	49	63	43
31	45	64	37
32	41	65	39
33	53	66	47
34	41	67	40
35	42	74	42

Largeur du nez.

Largeur moyenne prise sur une série de 48 individus: 40$^{mm.}$,3. ; variations extrêmes : 32$^{mm.}$,0 et 50$^{mm.}$,0.

Numéros d'ordre	Larg. du nez	Numéros d'ordre	Larg. du nez
1	41 mm.	36	41 mm.
2	46	39	46
3	38	40	40
4	35	41	42
5	34	42	39
6	45	43	40
8	40	47	34
11	41	48	42
12	35	50	40
15	33	51	43
17	41	54	41
18	39	55	42
21	41	57	43
23	35	58	42
24	37	59	38
25	32	60	41
27	42	61	38
28	41	62	44
30	50	63	37
31	37	64	40
32	38	65	43
33	42	66	44
34	42	67	41
35	50	74	36

Largeur palpébrale (Longueur de l'œil).

Largeur moyenne sur 49 individus: $31^{mm.},8$. Variations extrêmes : $24^{mm.}$, 0 et $39^{mm.}$,0.

Numéros d'ordre	Larg. palpébrale	Numéros d'ordre	Larg. palpébrale
2	28 mm.	40	32 mm.
3	31	41	31
4	24	42	31
5	35	43	34
6	28	47	39
9	29	48	29
11	29	50	34
12	32	51	33
15	30	52	29
17	28	53	30
18	31	54	31
21	33	55	34
22	28	57	31
23	32	58	31
24	25	59	31
25	33	60	33
27	33	61	28
28	36	62	33
31	30	63	34
32	30	64	34
33	36	65	32
34	37	66	35
35	37	67	36
36	33	74	31
39	33	—	—

Largeur bicaronculaire (distance minima des yeux).

La largeur bicaronculaire moyenne sur 49 individus est de 34$^{mm.}$,9. Les variations extrêmes sont de 28$^{mm.}$,0 et 44$^{mm.}$,0.

Numéros d'ordre	Larg. bicaroncul.	Numéros d'ordre	Larg. bicaroncul.
2	33 mm.	40	34 mm.
3	37	41	38
4	36	42	33
5	39	43	38
6	36	47	35
9	40	48	31
11	30	50	34
12	34	51	34
15	37	52	32
17	37	53	29
18	36	54	42
21	33	55	33
22	30	57	35
23	35	58	29
24	30	59	34
25	28	60	35
27	32	61	32
28	35	62	35
31	39	63	32
32	35	64	35
33	44	65	35
34	39	66	38
35	40	67	32
36	34	74	38
39	36	—	—

Largeur buccale.

48 sujets observés. Largeur moyenne: $53^{\text{mm.}}$,3 Chiffres extrêmes: $40^{\text{mm.}}$,0 et $64^{\text{mm.}}$,0.

Numéros d'ordre	Larg. buccale	Numéros d'ordre	Larg. buccale
1	60 mm.	35	59 mm.
2	60	36	55
3	40	40	41
4	51	41	63
5	49	42	54
6	54	43	54
8	47	47	51
9	50	48	53
11	55	50	52
12	58	51	55
15	59	54	54
17	57	55	57
18	54	57	54
21	52	58	54
23	52	59	47
24	52	60	49
25	51	61	56
27	64	62	56
28	56	63	52
30	57	64	46
31	51	65	49
32	46	66	61
33	55	67	52
34	53	74	51

Longueur des oreilles.

Chiffre moyen sur 51 individus: $59^{\text{mm.}},7$. Chiffres extrêmes $46^{\text{mm.}},0$ et $69^{\text{mm.}},0$.

Numéros d'ordre	Long. des oreilles	Numéros d'ordre	Long. des oreilles
1	62 mm.	36	63 mm.
2	65	39	64
3	52	40	59
4	59	41	58
5	61	42	63
6	61	43	66
8	60	47	56
9	60	48	56
11	62	50	62
12	57	51	58
15	69	53	59
17	61	54	61
18	60	55	58
21	57	57	67
23	59	58	63
24	63	59	61
25	46	60	51
27	46	61	54
28	56	62	65
29	55	63	62
30	57	64	59
31	57	65	59
32	65	66	56
33	67	67	59
34	59	74	61
35	68	—	—

Indice céphalique.

Le chiffre moyen de l'indice céphalique, sur une série de 44 individus, est de 79$^{\text{mm.}}$,4. Les chiffres extrêmes sont de 70$^{\text{mm.}}$,6 et 88$^{\text{mm.}}$,5.

Cette moyenne correspond aux Sous-dolichocéphales de "l'Indice céphalique sur le vivant" de Deniker.(1)

Voici le tableau de ces indices.

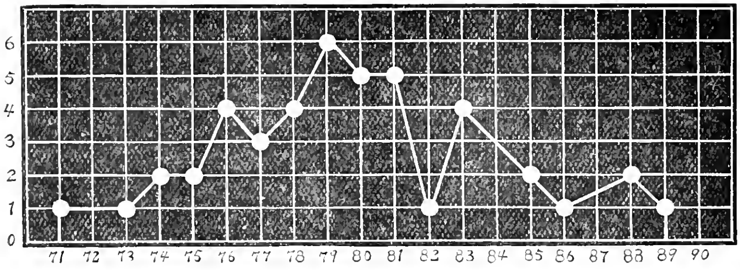
Numéros d'ordre	Indice céphal.	Numéros d'ordre	Indice céphal.
1	73,9	35	83,2
2	74,5	36	80,5
3	76,1	39	82,5
4	79,4	40	77,8
5	84,7	41	79,7
6	79,7	42	75,8
7	76,4	43	76,5
9	87,6	47	73,4
11	81,4	48	79,3
12	85,0	55	74,6
13	86,2	57	80,6
15	73,9	58	77,2
17	83,3	59	77,7
18	80,6	60	78,8
21	78,5	61	77,6
25	87,8	62	77,6
27	88,5	63	70,6
28	79,6	64	80,1
30	82,9	65	80,8
31	81,5	66	76,6
32	79,0	74	75,7
33	80,6	—	—
34	78,6	—	—

(1). J. Deniker, Races et peuples de la terre. p. 89. Paris 1900.

En établissant un rapport entre ces indices céphaliques et le nombre des individus observés, on obtient ce qui suit :

70,1 — 71,0	....	0	Dolichocéphales.
71,1 — 72,0	....	1	
72,1 — 73,0	....	0	
73,1 — 74,0	....	1	
74,1 — 75,0	....	2	
75,1 — 76,0	....	2	
76,1 — 77,0	....	4	
77,1 — 78,0	....	3	Sous-dolichocéphales.
78,1 — 79,0	....	4	
79,1 — 80,0	....	6	
80,1 — 81,0	....	5	Mésocéphales.
81,1 — 82,0	....	5	
82,1 — 83,0	....	1	Sous-brachycéphales.
83,1 — 84,0	....	4	
84,1 — 85,0	....	0	
85,1 — 86,0	....	2	Brachycéphales.
86,1 — 87,0	....	1	
87,1 — 88,0	....	0	Hyperbrachycéphales.
88,1 — 89,0	....	2	
89,1 — 90,0	....	1	
90,1 — 91,0	....	0	
		44	

Ce rapport est figuré dans la courbe ci-dessous:



Indice du visage.

(obtenu en comparant la longueur totale du visage, de la racine des cheveux au point mentonnier, à la largeur totale de la face ou distance bizygomatique maxima.)

Chiffres obtenus sur une série de 32 individus:

Indice moyen: 71,9. Variations extrêmes: 60,2 et 80,8.

Numéros d'ordre	Indice du visage	Numéros d'ordre	Indice du visage
1	74,9	27	66,1
2	74,7	28	72,1
3	69,3	31	77,0
4	77,4	32	70,9
5	79,5	33	64,4
6	73,1	34	80,8
8	65,4	35	76,8
11	74,3	36	70,9
12	78,0	39	73,9
15	66,5	40	64,6
17	73,9	41	75,0
18	72,1	42	69,6
21	63,0	43	76,5
23	71,2	47	76,8
24	60,2	48	69,4
25	76,2	50	68,3

Indice facial.

(obtenu en comparant la longueur totale de la face, (du point sus-nasal au point mentonnier), à la distance bi-zygomatique maxima.)

Chiffres obtenus sur une série de 47 individus: indice moyen: 121,1. Variations extrêmes: 101,8 et 136,0

Numéros d'ordre	Indice facial	Numéros d'ordre	Indice facial
1	126,9	36	118,4
2	127,1	39	121,5
3	127,2	40	115,3
4	125,7	41	123,2
5	126,7	42	119,8
6	112,6	43	123,0
8	125,0	47	121,4
11	122,1	48	119,0
12	129,8	50	116,8
15	113,1	51	131,7
17	125,0	55	127,4
18	122,8	57	114,0
21	112,6	58	122,9
23	115,2	59	117,6
24	102,8	60	124,3
25	131,5	61	121,5
27	114,7	62	124,3
28	121,7	63	121,9
30	120,0	64	131,9
31	123,3	65	123,6
32	114,0	66	110,3
33	101,8	67	136,0
34	129,8	74	114,2
35	131,1	—	—

Indice nasal.

Indice moyen sur une série de 48 individus: 94,3. Chiffres extrêmes: 76,1 et 119,0.

Numéros d'ordre	Indice nasal	Numéros d'ordre	Indice nasal
1	113,9	36	95,3
2	102,2	39	102,2
3	82,8	40	93,0
4	76,1	41	89,4
5	82,9	42	86,7
6	104,7	43	83,3
8	95,2	47	77,3
11	97,6	48	105,0
12	83,3	50	87,0
15	97,1	51	95,6
17	91,1	54	80,4
18	78,0	55	107,7
21	100,0	57	97,7
23	89,7	58	110,5
24	90,2	59	92,7
25	82,1	60	91,1
27	95,5	61	102,7
28	97,6	62	104,8
30	102,0	63	86,0
31	82,2	64	108,1
32	92,7	65	110,3
33	79,2	66	93,6
34	102,4	67	102,5
35	119,0	74	85,7

B. Mensurations du tronc et des membres.

Taille.

La moyenne de la taille, sur une série de 46 sujets, est de 160cm·5. Les chiffres extrêmes sont de 151cm.,0 et de 172cm.,0.

Cette moyenne correspond à la "Taille au dessus de la moyenne" de M. Topinard.(1)

Numéros d'ordre	Taille	Numéros d'ordre	Taille
	cm.		cm.
1	161,0	33	165,5
2	159,0	34	157,5
3	165,0	35	169,0
4	154,5	36	158,5
5	154,5	39	159,5
6	163,0	40	159,5
7	155,0	42	165,5
8	154,0	47	161,0
11	160,0	48	158,5
12	160,0	50	162,5
13	168,0	51	160,5
15	163,0	54	162,0
17	163,5	55	155,5
18	156,0	57	154,0
20	172,0	58	162,0
21	155,0	59	157,0
23	162,5	60	162,0
24	156,0	61	154,0
25	159,0	62	161,0
27	163,5	63	151,0
28	171,5	65	170,0
29	163,5	66	164,5
31	156,5	67	158,0

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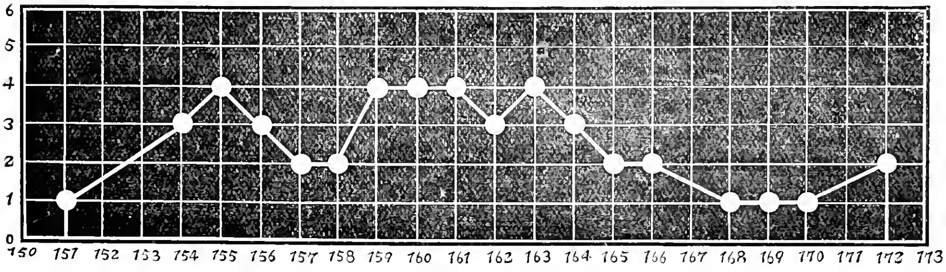
(1) P. Topinard. Elements d'anthropologie générale. Paris 1885. (p. 462.)

Si l'on établit un rapport entre ces chiffres, en partant des plus faibles pour arriver aux plus forts, et le nombre des individus observés, on obtient ce qui suit :

Taille	Nombre des sujets
cm. cm.	
151,1–152,0	1
152,1–153,0	—
153,1–154,0	—
154,1–155,0	3
155,1–156,0	4
156,1–157,0	3
157,1–158,0	2
158,1–159,0	2
159,1–160,0	4
160,1–161,0	4
161,1–162,0	4
162,1–163,0	3
163,1–164,0	4
164,1–165,0	3
165,1–166,0	2
166,1–167,0	2
167,1–168,0	—
168,1–169,0	1
169,1–170,0	1
170,1–171,0	1
171,1–172,0	—
172,1–173,0	2
	46

C'est ce rapport que représente également la courbe ci-jointe :



Grande envergure.

La longueur moyenne sur une série de 43 individus, est de 166$^{\text{cm.}}$,6. Les variations extrêmes sont de 156$^{\text{cm.}}$,5 et 178$^{\text{cm.}}$,0.

Numéros d'ordre	Grande envergure	Numéros d'ordre	Grand envergure
	cm.		cm.
1	171,0	34	163,5
2	165,5	35	177,0
3	173,0	36	161,0
4	156,5	39	162,5
5	156,5	40	163,0
6	165,5	42	173,5
7	165,0	47	170,0
11	165,0	48	160,5
12	167,0	50	165,5
13	176,5	51	167,5
15	165,5	54	168,0
17	173,0	55	157,5
18	157,0	57	165,0
21	157,5	58	170,0
23	173,5	59	165,0
24	160,0	60	169,0
25	169,0	61	160,0
27	167,5	62	171,0
28	176,5	63	161,0
29	162,5	65	178,0
31	169,5	66	169,5
33	174,5	—	—

Si l'on établit un rapport entre ces chiffres, en partant des plus faibles pour arriver aux plus élevés, et le nombre des individus observés, on obtient ce qui suit :

Grande envergure	Nombre des sujets
cm. cm.	
155,1–156,0	—
156,1–157,0	—
157,1–158,0	3

Grande envergure	Nombre des sujets
cm. cm. 158,1-159,0	2
159,1-160,0	—
160,1-161,0	2
161,1-162,0	3
162,1-163,0	—
163,1-164,0	3
164,1-165,0	1
165,1-166,0	4
166,1-167,0	4
167,1-168,0	1
168,1-169,0	3
169,1-170,0	2
170,1-171,0	4
171,1-172,0	2
172,1-173,0	—
173,1-174,0	2
174,1-175,0	2
175,1-176,0	1
176,1-177,0	—
177,1-178,0	3
178,1-179,0	1
	43

Rapport de la grande envergure à la taille.

Ayant recherché ce rapport sur une série de 43 individus, j'ai constaté qu' à l'exception d'un seul individu (le n° 29 de la série, dont la taille est de 163$^{\text{cm.}}$,5 et la grande envergure de 162$^{\text{cm.}}$,5), la grande envergure était toujours supérieure à la taille. Le rapport moyen de la grande envergure à la taille est de 103,7.

Voici le tableau de ce rapport :

Numéros d'ordre	Grande envergure	Taille	Différence	Rapport entre la gr. enverg. et la taille
1	cm. 171,0	cm. 161,0	cm. 10,0	106,2
2	165,5	159,0	6,5	104,1
3	173,0	165,0	8,0	104,9

Numéros d'ordre	Grande envergure	Taille	Différence	Rapport entre la gr. enverg. et la taille
	cm.	cm.	cm.	
4	156,5	154,5	2,0	101,3
5	156,5	154,5	2,0	101,3
6	165,5	163,0	2,5	101,5
7	165,0	155,0	10,0	106,5
11	165,0	160,0	5,0	103.1
12	167,0	160,0	7,0	104,4
13	176,5	168,0	8,5	105,1
15	165,5	163,0	2,5	101,5
17	173,5	163,5	10,0	106,1
18	157,0	156,0	1,0	100,6
21	157,5	155,0	2,5	101,6
23	173,5	162,5	11,0	106,8
24	160,0	156,0	4,0	102,5
25	169,0	159,0	10,0	106,3
27	167,5	163,5	4,0	102,4
28	176,5	171,5	5,0	102,9
29	162,5	163,5	—1,0	93,9
31	169,5	156,5	13,0	108,3
33	174,5	165,5	9,0	105,4
34	163,5	157,5	6,0	103,8
35	177,0	169,0	8,0	104,7
36	161,0	158,5	2,5	101,6
39	162,5	159,5	3,0	101,9
40	163,0	159,5	4,5	102,2
42	173,5	165,5	8,0	104,8
47	170,0	161,0	9,0	105,6
48	160,5	158,5	2,0	101,3
50	165,5	162,5	3,0	101,8
51	167,5	160,5	7,0	104,4
54	168,0	162,0	6,0	103,7
55	157,5	155,5	2,0	101,3
57	165,0	154,0	11,0	107,1
58	170,0	162,0	8,0	104,9
59	165,0	157,0	8,0	105,1
60	169,0	162,0	7,0	104,3
61	160,0	154,0	6,0	103,9
62	171,0	161,0	10,0	106,2
63	161,0	151,0	10,0	106,6
65	178,0	170,0	8,0	104,7
66	169,5	164,5	5,0	103,0

Hauteur du conduit auditif au-dessus du sol.

La hauteur moyenne est de 147cm.,0 d'après les mensurations prises sur une série de 25 sujets.

Les variations extrêmes sont de 140cm,0 et 157cm.,5.

Numéros d'ordre	Haut. du cond. audit.	Rapport de la haut. du cond. audit. à la taille
	cm.	
4	141,0	91,3
5	144,0	93,2
11	147,0	91,9
12	149,5	93,4
13	157,5	93,8
17	150,0	91,7
18	143,0	91,7
21	140,0	90,3
23	145,0	89,2
24	140,5	90,1
25	144,5	90,9
27	143,5	87,8
28	153,0	89,2
29	147,0	89,9
31	143,0	91,4
32	151,0	93,1
33	154,0	92,1
34	145,0	92,3
35	156,0	94,3
36	149,5	90,7
43	143,5	89,0
47	146,0	92,3
48	141,0	89,9
50	150,0	—
67	142,0	—

Hauteur du bord inférieur du menton au-dessus du sol.

La hauteur moyenne, sur 25 sujets, est de 139$^{\text{cm.}}$,1.
Les variations extrêmes sont de 131$^{\text{cm.}}$,5 et 152$^{\text{cm.}}$,5.
Le rapport de la hauteur du menton au-dessus du sol à la taille est de 86,7.

Numéros d'ordre	Haut. du menton	Rapport de la haut. du ment. à la taille
	cm.	
4	132,5	85,8
5	135,0	87,4
11	137,5	85,9
12	149,5	93,4
13	149,0	88,7
15	142,0	87,1
17	141,5	86,5
18	135,5	86,9
21	132,5	85,5
23	139,5	85,7
24	131,5	84,3
25	137,0	86,2
27	137,5	84,1
28	145,0	84,6
31	135,5	86,6
32	141,5	92,2
33	152,5	87,3
34	137,5	87,3
35	147,5	86,1
36	136,5	85,1
43	135,0	85,5
47	137,0	87,1
48	135,5	84,2
50	141,5	—
67	133,0	—

Hauteur de l'acromion au-dessus du sol.

Hauteur moyenne : 133$^{\text{cm.}}$,1 (sur une série de 21).

Variations : 123$^{\text{cm.}}$,5 et 145$^{\text{cm.}}$,0. Rapport de la hauteur de l'acromion à la taille : 82,9.

Numéros d'ordre	Haut. de l'acrom.	Rapport de la haut. de l'acrom. à la taille
	cm.	
4	130,5	84,5
11	130,5	81,6
13	143,5	85,6
17	137,5	84,1
18	127,5	81,7
21	131,5	84,8
23	135,0	83,1
24	127,5	81,7
25	130,5	82,1
27	134,5	82,3
28	145,0	84,6
31	123,5	78,9
32	133,5	85,7
33	135,0	82,0
34	138,5	83,6
36	132,5	81,1
43	130,5	83,6
47	130,5	83,1
48	132,5	82,0
50	135,0	—
67	129,5	—

Hauteur de l'extrémité inférieure du medius au-dessus du sol.

Hauteur moyenne: 57$^{cm.}$,3 (sur une série de 24). Variations extrêmes: 49$^{cm.}$,5 et 65$^{cm.}$,0.

Le Rapport de la hauteur de l'extrémité inférieure du médius à la taille, sur une série de 22, est de 35,8.

Numéros d'ordre	Haut. de l'extrém. du medius	Rapport de la haut. du med. à la taille
	cm.	
4	56,5	36,6
5	55,5	35,9
11	58,0	36,3
12	62,0	38,8
13	61,5	36,6
15	58,5	35,9
17	61,5	37,6
18	62,0	39,7
21	55,0	35,5
24	49,5	31,7
25	62,5	39,3
27	60,0	36,7
28	57,0	33,2
31	56,0	35,8
32	60,5	32,6
33	54,0	36,5
34	57,5	38,5
35	65,0	35,6
36	55,5	31,1
43	50,0	33,1
47	50,0	36,0
48	52,5	34,8
50	58,5	—
67	55,0	—

Hauteur de l'ombilic au-dessus du sol.

Hauteur moyenne : 95$^{cm.}$,3 (sur une série de 23).

Variations extrêmes: 88$^{cm.}$,0 et 103$^{cm.}$,5. Rapport de la hauteur de l'ombilic à la taille, (sur une série de 21): 59,3.

Numéros d'ordre	Haut. de l'ombilic	Rapport de la haut. de l'ombil. à la taille
	cm.	
4	88,0	57,0
5	92,5	59,9
11	94,5	59,1
12	99,5	62,2
13	103,5	61,6
15	98,5	60,4
17	93,5	57,0
18	89,5	57,4
21	92,5	59,7
23	96,0	59,1
24	92,5	59,3
25	94,5	59,4
27	97,5	59,6
28	99,5	58,0
32	94,5	61,9
33	102,5	58,4
34	92,0	60,1
35	101,5	57,7
36	91,5	57,5
43	92,5	60,3
47	92,5	59,4
48	95,5	—
50	96,5	—

Hauteur du grand trochanter au-dessus du sol.

Hauteur moyenne: $92^{cm.}$,0 (sur une série de 20.)
Variations extrêmes : $83^{cm.}$,0 et $100^{cm.}$,0.

Rapport de la hauteur du grand trochanter à la taille : 57,2 (sur une série de 19).

Numéros d'ordre	Haut. du grand troch.	Rapport de la haut. du gd. troch. à la taille
	cm.	
2	84,5	53,1
4	87,5	56,6
5	91,5	59,2
11	83,0	51.9
12	96,5	60,0
13	100,0	59,5
15	93,5	57,4
18	87,5	56,1
21	87,5	56,5
23	95,0	58,5
24	89,5	57,4
25	91,5	57,6
27	93,5	57,2
28	98,5	57,4
31	90,0	57,5
32	93,0	60,4
33	100,0	55,9
34	88,0	58,0
35	98,0	56,8
47	91,5	—

Hauteur du vertex dans la position assise.

Hauteur moyenne: 86cm.,9 (sur une série de 25).
Variations extrêmes: 83cm.,0 et 93cm.,5.

Rapport de la hauteur du vertex dans la position assise à la taille : 54,0 (sur une série de 24).

Numéros d'ordre	Haut. du vertex dans la posit. assise	Rapport de la haut. du vertex pos. ass. à la taille
	cm.	
2	84,0	52,8
3	85,0	51,5
4	86,5	56,0
5	88,5	57,3
6	85,0	52,2
11	85,0	53,1
12	83,0	51,9
15	86,5	53,1
17	88,0	53,8
18	86,5	55,5
21	85,5	55,2
23	89,5	55,1
24	84,0	53,9
25	85,5	53,8
27	85,5	52,3
28	88,5	51,6
31	88,5	56,6
32	90,5	55,6
33	92,0	55,2
34	87,0	55,3
35	93,5	55,2
36	87,5	53,4
47	86,0	54,3
48	86,0	51,7
50	84,0	—

Distance bi-acromiale.

La moyenne est de $40^{cm.}$,5 (sur une série de 39,) les variations extrêmes étant de $37^{cm.}$,0 et $48^{cm.}$,0

Le rapport de la distance bi-acromiale à la taille est de 25,3 (sur une série de 33).

Numéros d'ordre	Dist. bi-acromiale	Rapport de la dist. bi-acrom. à la taille
	cm.	
2	43,0	27,1
4	42,5	27,5
5	38,5	24,9
9	39,0	26,9
11	43,0	28,6
13	48,0	25,6
18	40,0	25,2
21	39,0	24,6
23	40,0	25,0
24	39,0	25,8
25	41,0	25,7
27	42,0	23,9
28	41,0	25,5
30	39,0	27,6
31	40,0	25,7
32	44,0	23,3
34	43,5	23,8
35	43,5	26,0
36	37,0	24,5
39	38,0	24,3
42	43,0	26,2
44	43,0	24,9
47	39,5	23,5
48	38,5	23,8
50	42,5	25,0
51	40,0	26,2
54	38,0	25,5
55	37,0	24,7
57	38,5	23,9

Numéros d'ordre	Dist. bi-acromiale	Rapport de la dist. bi-acrom. à la taille
	cm.	
58	42,5	26,2
59	40,0	23,5
61	38,0	24,3
62	38,5	26,9
63	39,5	—
64	37,0	—
65	40,0	—
66	40,0	—
67	42,5	—
74	39,0	—

Circonférence de la poitrine.

Moyenne prise sur une série de 37 individus: $86^{\text{cm.}},9$. Variations extrêmes: $78^{\text{cm.}},0$ et $94^{\text{cm.}},0$

Numéros d'ordre	Circonf. de la poitr.	Numéros d'ordre	Circonf. de la poitr.
	cm.		cm.
2	85,5	42	91,0
4	84,0	43	90,0
9	94,0	47	89,5
11	85,0	48	83,5
13	86,0	50	84,0
17	88,5	51	82,0
18	81,0	54	86,0
21	92,0	55	87,0
23	89,0	57	87,0
24	85,0	58	87,5
25	85,0	59	88,5
27	92,0	61	78,0
28	89,0	62	84,5
30	93,5	63	86,0
32	83,5	64	80,5
33	89,0	65	91 0
34	86,0	66	84,0
35	91,0	77	88,0
39	86,0	—	—

Longueur du membre supérieur.

(de l'acromion à l'extrémité du médius).

Longueur moyenne: 75$^{cm.}$,2 (sur une série de 19). Variations extrêmes : 65$^{cm.}$,0 et 82$^{cm.}$,5.

Numéros d'ordre	Long. du memb. sup.	Rapport de la long. du m. sup. à la taille
	cm.	
4	74,0	47,2
11	72,5	45,3
13	82,0	48,8
17	75,5	46,2
18	65,0	41,7
21	76,0	49,0
24	78,0	50,0
25	68,0	42,8
27	77,5	47,4
31	67,5	43,1
33	72,5	43,8
34	77,5	49,2
35	73,0	43,2
36	77,5	48,9
40	80,0	50,2
47	82,5	51,2
48	79,5	50,2
50	76,5	47,1
67	74,5	47,1

Longueur du membre inférieur.

(hauteur du grand trochanter au-dessus du sol.)

Longueur moyenne: 91$^{cm.}$,9 (sur une série de 20). Variations extrêmes : 83$^{cm.}$,0 et 100$^{cm.}$,0.

Numéros d'ordre	Longueur du m. infér.
	cm.
4	87,5
5	91,5

Numéros d'ordre	Longueur du m. infér.
	cm.
11	83,0
12	96,5
13	100,0
15	93,5
18	87,5
21	87,5
23	95,5
24	89,5
25	91,5
27	93,5
28	98,5
31	90,0
32	93,5
33	100,0
34	88,0
35	91,5
47	90,0
48	90,0

Rapport entre la longueur du membre supérieur et du membre inférieur.

La moyenne de ce rapport est de 82,5 sur une série de 14. Les chiffres extrêmes sont 72,5 et 91,7.

Numéros d'ordre	Longueur du m. supér.	Longueur du m. infér.	Rapport entre ces 2 long.
	cm.	cm.	
4	74,0	87,5	84,6
11	72,5	83,0	87,4
13	82,0	100,0	82,0
17	75,5	?	?
18	65,0	87,5	74,4
21	76,0	87,5	86,9
24	78,0	89,5	87,2
25	68,0	91,5	74,3

Numéros d'ordre	Longueur. du m. supér	Longueur du m. infér.	Rapport entre ces 2 long.
	cm.	cm.	
27	77,5	93,5	82,9
31	67,5	90,0	75,0
32	?	93,5	?
33	72,5	100,0	72,5
34	77,5	88,0	88,1
35	73,0	91,5	79,8
36	77,5	?	?
43	8,00	?	?
47	82,5	90,0	91,7
48	79,5	90,0	88,3
50	76,5	?	?
67	74,5	?	?

Circonférence du bras.

Moyenne: $26^{cm.}$,0 (sur une série de 43). Dimensions extrêmes: $20^{cm.}$,5 et $29^{cm.}$,0.

Numéros d'ordre	Circonf. du bras	Numéros d'ordre	Circonf. du bras
	cm.		cm.
4	26,0	39	27,5
5	24,5	41	25,5
6	25,0	42	27,5
8	28,0	43	27,5
9	27,0	47	26,5
11	26,0	48	23,5
12	26,5	50	24,0
13	26,5	51	26,5
17	28,0	54	26,0
18	25,0	55	27,0
21	25,5	57	25,0
23	26,0	58	25,0
24	25,0	59	26,5
25	26,0	60	27,0
27	27,0	61	23,5
28	29,0	62	24,0

Numéros d'ordre	Circonf. du bras	Numéros d'ordre	Circonf. du bras
	cm.		cm.
30	28,5	63	26,0
31	27,0	64	22,0
33	20,5	65	26,5
34	27,5	66	26,0
35	26,0	67	28,0
36	25,0	—	—

Circonférence de la cuisse.

Moyenne : $47^{\text{cm.}}$,3 sur une série de 43. Dimensions extrêmes: $39^{\text{cm.}}$,5 et $51^{\text{cm.}}$,0.

Numéros d'ordre	Circ. de la cuisse	Numéros d'ordre	Circ. de la cuisse
	cm.		cm.
4	46,5	41	46,0
5	46,5	42	47,5
9	47,0	43	50,5
11	48,5	47	48,5
12	49,5	48	45,0
15	45,5	50	47,0
18	49,5	51	49,5
21	51,0	54	45,0
23	50,0	55	50,0
24	47,0	57	47,0
25	47,0	58	44,0
27	50,0	59	46,0
28	48,5	60	43,0
30	49,0	61	44,5
31	49,0	62	49,0
32	43,0	63	48,0
33	47,5	64	39,5
34	48,0	65	49,0
35	49,0	66	46,0
36	44,5	67	48,5
39	45,5	74	48,5
40	50,0	—	—

Circonférence du mollet.

Moyenne: 32$^{cm.}$,3 sur une série de 44. Dimensions extrêmes: 28$^{cm.}$,5 et 36$^{cm.}$,0.

Numéros d'ordre	Circ. du mollet	Numéros d'ordre	Circ. du mollet
	cm.		cm.
2	31,5	39	32,0
4	31,0	40	31,0
5	32,5	42	33,0
9	33,0	43	36,0
11	32,5	47	33,0
12	32,5	48	31,0
13	32,0	50	31,0
17	35,5	51	30,0
18	33,0	54	31,0
21	33,0	55	32,0
23	33,0	57	33,5
24	29,0	58	31,0
25	32,0	59	31,0
27	33,0	60	31,0
28	32,0	61	30,0
30	35,5	62	35,0
31	33,0	63	33,0
32	32,0	64	28,5
33	35,0	65	32,0
34	33,0	66	33,0
35	33,5	67	32,0
36	30,5	74	33,5

Longueur totale du pied.

Les indigènes de Kō-tō-shō marchant toujours pieds-nus, la plante de leur pied est très large.

La longueur moyenne est de 25$^{cm.}$,1 (sur une série de 43), les variations extrêmes étant de 21$^{cm.}$,0 et de 29$^{cm.}$,5.

Numéros d'ordre	Long. tot. du pied	Numéros d'ordre	Long. tot. du pied
	cm.		cm.
4	23,0	40	25,0
5	21,0	41	25,5
9	24,5	42	25,5
11	27,0	43	25,5
12	26,0	47	25,0
13	26,5	48	24,0
15	24,5	50	24,5
16	25,5	51	24,5
18	23,5	54	25,5
21	29,5	55	25,5
23	25,5	57	24,5
24	24,5	58	25,0
25	24,5	59	24,5
27	25,0	60	25,5
28	29,0	61	25,5
30	25,5	62	26,5
31	24,0	63	24,5
32	26,5	64	23,5
34	24,5	66	25,0
35	25,0	67	25,0
36	25,5	74	24,5
39	25,0	—	—

Largeur maxima du pied

Largeur moyenne: $9^{cm.}$,36 (sur une série de 43). Variations extrêmes: $8^{cm.}$,0 et $10^{cm.}$,5.

Numéros d'ordre	Larg. max. du pied	Numéros d'ordre	Larg. max. du pied
	cm.		cm.
4	8,5	40	9,5
5	10,0	41	8,5
9	10,0	42	10,0
11	9,0	43	10,0
12	9,0	47	9,0
13	9,5	48	9,5
15	9,5	50	9,0
16	8,5	51	9,5
18	9,0	54	9,0
21	9,5	55	9,5
23	10,0	57	9,0
24	9,0	58	8,0
25	9,5	59	8,5
27	10,0	60	10,0
28	10,0	61	10,0
30	10,5	62	9,0
31	9,5	63	9,5
32	9,0	64	9,5
34	10,0	66	9,0
35	10,0	67	8,0
36	8,5	74	10,0
39	10,0	—	—

TABLE DES MENSURATIONS ET INDICES D'ABORIGÈNES DE KŌ-TŌ-SHŌ

	Numéros.	1	2	3	4	5	6	7
Mensurations de la tête et de la face.		mm.	mm.	mm	mm.	mm	mm	mm.
	Diam. ant. post. max. ...	176	184	180	175	170	172	182
	Diam. transv. max.... ...	130	137	137	139	144	137	139
	Long. tot. du visage ...	183	182	185	164	161	171	—
	Long. tot. de la face ...	108	107	103	101	101	111	—
	Larg. tot. de la face ...	137	136	131	127	128	125	—
	Haut. du front	75	75	82	63	60	65	—
	Long. du nez.	36	45	46	46	41	43	—
	Larg. du nez.	41	46	38	35	34	45	—
	Larg. palpébrale...	—	28	31	24	35	28	—
	Larg. bicaroncul...	—	33	37	36	39	36	—
	Larg. buccale	60	60	40	51	49	54	—
	Long. des oreilles ...	62	65	52	59	61	61	—
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm	cm.	cm	cm.
	Taille	161,0	159,0	165,0	154,5	154,5	163,0	155,0
	Gr. enverg.	171,0	165,5	173,0	156,5	156,5	165,5	165,0
	Haut. du cond. audit. ...	—	—	—	141,0	144,0	—	—
	Haut. du menton	—	—	—	132,5	135,0	—	—
	Haut. de l'acrom.	—	—	—	130,5	—	—	—
	Haut. de l'extrémi. du médius	—	—	—	56,5	55,5	—	—
	Haut. de l'ombil...	—	—	—	88.0	92,5	—	—
	Haut. du gr. troch	—	84,5	—	87,5	91,5	—	—
	Haut. du vertex. dans la posit. assise	—	84,0	85,0	86,5	88,5	85,0	—
	Dist. bi-acromiale	—	43,0	—	42,5	38,5	—	—
	Circonf. de la poit.	—	85,5	—	84,0	—	—	—
	Long. du memb. sup. ...	—	—	—	74,0	—	—	—
	Long. du memb. infér. ...	—	—	—	87,5	91,5	—	—
	Circonf. du bras....	—	—	—	26.0	24,5	25,0	—
	Circ. de la cuisse	—	—	—	46,5	46.5	—	—
	Circ. du mollet	—	31,5	—	31,0	32,5	—	—
	Long. tot. du pied	—	—	—	23,0	21,0	—	—
	Larg. max. du pied ...	—	—	—	8.5	10,0	—	—
Indices.	Indice céphal.......	73,9	74,5	76,1	79,4	84,7	79,7	76,4
	Indice du visage...	74.9	74.7	69,3	77.4	79,5	73,1	—
	Indice facial	126,9	127,1	127.2	125,7	126.7	112,6	—
	Indice nasal	113,9	102.2	82.8	76,1	82,9	104.7	—
Rapports.	Rap. entre la gr. enverg. et la taille	106,2	104,1	104,9	101,3	101.3	101,5	106,5
	Rap. de la haut. du cond. audit. à la taille	—	—	—	91,3	93.2	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	85,8	87,4	—	—
	Rap. de la haut. de l'acrom à la taille... ...	—	—	—	84,5	—	—	—
	Rap. de la haut. du méd. à la taille	—	—	—	36,6	35,9	—	—
	Rap. de la haut. de l'omb. a la taille	—	—	—	57,0	59,9	—	—
	Rap. de la haut. du gd. troch. à la taille	—	53,1	—	56,6	59,2	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	52,8	51,5	56.0	57,3	52,2	—
	Rap. de la dist. bi-acrom. à la taille...	—	27,1	—	27,5	24,9	—	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	47,2	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	84,6	—	—	—

	Numéros.	8	9	10	11	12	13	14
Mensurations de la tete et de la face.		mm.	mm.	mm.	mm.	mm.	mm.	mm.
	Diam. ant. post. max. ...	—	169	—	172	180	174	—
	Diam. transv. max.	—	149	—	140	153	150	—
	Long. tot. du visage ...	191	—	—	171	173	—	—
	Long. tot. de la face ...	100	—	—	104	104	—	—
	Larg. tot. de la face ...	125	127	—	127	135	—	—
	Haut. du front	91	—	—	67	69	—	—
	Long. du nez.	42	—	—	42	42	—	—
	Larg. du nez.	40	—	—	41	35	—	—
	Larg. palpébrale	—	29	—	29	32	—	—
	Larg. bicaroncul.	—	40	—	30	34	—	—
	Larg. buccale	47	50	—	55	58	—	—
	Long. des oreilles	60	60	—	62	57	—	—
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm.	cm.	cm	cm.
	Taille	154,0	—	—	160,0	160,0	168,0	—
	Gr. enverg.	—	—	—	165,0	167,0	176,5	—
	Haut. du cond. audit. ...	—	—	—	147,0	149,5	157,5	—
	Haut. du menton	—	—	—	137,5	149,5	149,0	—
	Haut. de l'acrom.	—	—	—	130,5	—	143,5	—
	Haut. de l'extrémi. du médius	—	—	—	58,0	62,0	61,5	—
	Haut. de l'ombil...	—	—	—	94,5	99,5	103,5	—
	Haut. du gr. troch.	—	—	—	83,0	96,5	100,0	—
	Haut. du vertex, dans la posit. assise	—	—	—	85,0	83,0	—	—
	Dist. bi-acromiale	—	39,0	—	43,0	—	48,0	—
	Circonf. de la poit.	—	94,0	—	85,0	—	86,0	—
	Long. du memb. sup. ...	—	—	—	72,5	—	82,0	—
	Long. du memb. infér. ...	—	—	—	83,0	96,5	100,0	—
	Circonf. du. bras...	28,0	27,0	—	26,0	26,5	26,5	—
	Circ. de la cuisse	—	47,0	—	48,5	49,5	—	—
	Circ. du mollet	—	33,0	—	32,5	32,5	32,0	—
	Long. tot. du pied	—	24,5	—	27,0	26,0	26,5	—
	Larg. max. du pied ...	—	10,0	—	9,0	9,0	9,5	—
Indices.	Indice céphal...	—	87,6	—	81,4	85,0	86,2	—
	Indice du visage...	65,4	—	—	74,3	78,0	—	—
	Indice facial	125,0	—	—	122,1	129,8	—	—
	Indice nasal	95,2	—	—	97,6	83,3	—	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	—	—	103,1	104,4	105,1	—
	Rap. de la haut. du cond. audit. à la taille.	—	—	—	91,9	93,4	93,8	—
	Rap. de la haut. du ment. à la taille	—	—	—	85,9	93,4	88,7	—
	Rap. de la haut, de l'acrom à la taille... ...	—	—	—	81,6	—	85,6	—
	Rap. de la haut. du méd, à la taille	—	—	—	36,3	38,8	36,6	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	59,1	62,2	61,6	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	51,9	60,0	59,5	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	53,1	51,9	—	—
	Rap. de la dist bi-acrom à la taille...	—	26,9	—	28,6	—	25,6	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	45,3	—	48,8	—
	Rap. entre ces 2 long. ...	—	—	—	87,4	—	82,0	—

	Numéros.	15	16	17	18	19	20	21
Mensurations de la tête et de la face.		mm	mm	mm	mm.	mm.	mm.	mm.
	Diam. ant. post. max. ...	176	—	174	175	—	—	177
	Diam transv. max.	130	—	145	141	—	—	139
	Long. tot. du visage ...	182	—	176	172	—	—	184
	Long. tot. de la face ...	107	—	104	101	—	—	103
	Larg. tot. de la face ...	121	—	130	124	—	—	116
	Haut. du front	75	—	72	71	—	—	81
	Long. du nez.	34	—	45	50	—	—	41
	Larg. du nez.	33	—	41	39	—	—	41
	Larg. palpébrale	30	—	28	31	—	—	33
	Larg. bicaroncul...	37	—	37	36	—	—	33
	Larg. buccale	59	—	57	54	—	—	52
	Long. des oreilles	69	—	61	60	—	—	57
Mensurations du tronc et des membres.		cm.	cm.	cm	cm	cm	cm.	cm.
	Taille	163,0	—	163,5	156,0	—	172,0	155,0
	Gr. enverg.	165,5	—	173,0	157,0	—	—	157,5
	Haut. du cond. audit. ...	—	—	150,0	143,0	—	—	140,0
	Haut. du menton	142,0	—	141,5	135,5	—	—	132,5
	Haut. de l'acrom.	—	—	137,5	127,5	—	—	131,5
	Haut. de l'extrémi. du médius	58,5	—	61,5	62,0	—	—	55,0
	Haut. de l'ombil...	98,5	—	93,5	89,5	—	—	92,5
	Haut. du gr. troch	93,5	—	—	87,5	—	—	87,5
	Haut. du vertex. dans la posit. assise	86,5	—	88,0	86,5	—	—	85,5
	Dist. bi-acromiale	—	—	—	40,0	—	—	39,0
	Circonf. de la poit	—	—	88,5	81,0	—	—	92,0
	Long. du memb. sup. ...	—	—	75,5	65,0	—	—	76,0
	Long. du memb. infér. ...	93,5	—	—	87.5	—	—	87,5
	Circonf. du bras....	—	—	28,0	25,0	—	—	25,5
	Circ. de la cuisse	45,5	—	—	49,5	—	—	51,0
	Circ. du mollet	—	—	35,5	33,0	—	—	33,0
	Long. tot. du pied	24,5	25,5	—	23,5	—	—	29,5
	Larg. max. du pied	9,5	8,5	—	9,0	—		,5
Indices.	Indice céphal...	73,9	—	83,3	80,6	—	—	78,5
	Indice du visage...	66,5	—	73,9	72,1	—	—	63,0
	Indice facial	113,1	—	125,0	122,8	—	—	112.6
	Indice nasal.	97,1	—	91.1	78,0	—	—	100,0
Rapports.	Rap. entre la gr. enverg. et la taille	101,5	—	106,1	100,6	—	—	101,6
	Rap. de la haut. du cond. audit. à la taille	—	—	91,7	91,7	—	—	90,3
	Rap. de la haut. du ment. à la taille	87,1	—	86,5	86,9	—	—	85,5
	Rap. de la haut. de l'acrom à la taille... ...	—	—	84,1	81,7	—	—	84,8
	Rap. de la haut. du méd. à la taille	35,9	—	37,6	39,7	—	—	35,5
	Rap. de la haut. de l'omb. à la taille	60,4	—	57,0	57,4	—	—	59,7
	Rap. de la haut. du gd. troch. à la taille	57,4	—	—	56,1	—	—	56,5
	Rap. de la haut. du vertex pos. ass. à la taille.	53,1	—	53,8	55,5	—	—	55,2
	Rap. de la dist. bi-acrom. à la taille	—	—	—	25,2	—	—	24,6
	Rap. de la long. du m. sup. à la taille...	—	—	46,2	41,7	—	—	49,0
	Rap. entre ces 2 long. ...	—	—	—	74,4	—	—	86,9

	Numéros.	22	23	24	25	26	27	28
Mensurations de la tête et de la face.		mm.	mm.	mm.	mm.	mm.	mm	mm.
	Diam. ant. post. max. ...	—	179	184	172	—	182	176
	Diam. transv. max.	—	—	—	151	—	161	140
	Long. tot. du visage ...	—	170	181	164	—	189	179
	Long. tot. de la face ...	—	105	106	95	—	109	106
	Larg. tot. de la face ...	—	121	109	125	—	125	129
	Haut. du front	—	65	75	69	—	80	73
	Long. du nez.	—	39	41	39	—	44	42
	Larg. du nez.	—	35	37	32	—	42	41
	Larg. palpébrale	28	32	25	33	—	33	36
	Larg. bicaroncul...	30	35	30	28	—	32	35
	Larg. buccale	—	52	52	51	—	64	56
	Long. des oreilles	—	59	63	46	—	46	56
Mensurations du tronc et des membres		cm.	cm	cm	cm	cm.	cm	cm.
	Taille	—	162,5	156.0	159,0	—	163,5	171,5
	Gr. enverg.	—	173,5	160 0	169,0	—	167,5	176,5
	Haut. du cond. audit. ...	—	145,0	140,5	144,5	—	143,5	153,0
	Haut. du menton	—	139,5	131,5	137,0	—	137,5	145,0
	Haut. de l'acrom.	—	135,0	127,5	130,5	—	134,5	145,0
	Haut. de l'extrémi. du médius	—	—	49,5	62,5	—	60,0	57,0
	Haut. de l'ombil...	—	96,0	92,5	94,5	—	97,5	99,5
	Haut. du gr. troch.	—	95,0	89,5	91,5	—	93,5	98,5
	Haut. du vertex. dans la posit. assise	—	89,5	84,0	85,5	—	85,5	88,5
	Dist. bi-acromiale	—	40,0	39,0	41,0	—	42,0	41,0
	Circonf. de la poit.	—	89,0	85,0	85,0	—	92,0	89,0
	Long. du memb. sup. ...	—	—	78,0	68,0	—	77,5	—
	Long. du memb. infér. ...	—	95,5	89,5	91,5	—	93,5	98,5
	Circonf. du bras	—	26,0	25,0	26,0	—	27,0	29,0
	Circ. de la cuisse...	—	50.0	47,0	47,0	—	50,0	48,5
	Circ. du mollet	—	33.0	29,0	32,0	—	33,0	32,0
	Long. tot. du pied	—	25,5	24,5	24,5	—	25,0	29,0
	Larg. max. du pied	—	10.0	9,0	9 5	—	10.0	10,0
Indices.	Indice céphal...	—	—	—	87,8	—	88,5	79,6
	Indice du visage...	—	71.2	60,2	76,2	—	66,1	72,1
	Indice facial	—	115,2	102,8	131,5	—	114,7	121,7
	Indice nasal	—	89,7	90.2	82.1	—	95.5	97,6
Rapports.	Rap. entre la gr. enverg. et la taille	—	106,8	102,5	106,3	—	102,4	102,9
	Rap. de la haut. du cond. audit. à la taille	—	89,2	90,1	90,9	—	87,8	89,2
	Rap. de la haut. du ment. à la taille	—	85,7	84,3	86,2	—	84,1	84,6
	Rap. de la haut. de l'acrom. à la taille... ...	—	83,1	81,7	82,1	—	82,3	84,6
	Rap. de la haut. du méd. à la taille	—	—	31,7	39,3	—	36,7	33,2
	Rap. de la haut. de l'omb. à la taille	—	59,1	59,3	59,4	—	59,6	58,0
	Rap. de la haut. du gd. troch. à la taille	—	58,5	57,4	57,6	—	57,2	57,4
	Rap. de la haut. du vertex pos. ass. à la taille.	—	55,1	53,9	53,8	—	52,3	51,6
	Rap. de la dist bi-acrom. à la taille	—	25,0	25.8	25,7	—	23,9	25,5
	Rap. de la long. du m. sup. à la taille...	—	—	50 0	42.8	—	47,4	—
	Rap. entre ces 2 long. ...	—	—	87,2	74,3	—	82,9	—

	Numéros.	29	30	31	32	33	34	35
Mensurations de la tete et de la face.		mm	mm.	mm.	mm.	mm.	mm.	mm.
	Diam. ant. post. max. ...	—	175	178	176	175	178	184
	Diam. transv. max.	—	145	145	139	141	140	153
	Long. tot. du visage ...	—	—	165	172	177	167	181
	Long. tot. de la face ...	—	110	103	107	112	104	106
	Larg. tot. de la face ...	—	132	127	122	114	135	139
	Haut. du front	—	—	62	65	65	63	75
	Long. du nez.	—	49	45	41	53	41	42
	Larg. du nez.	—	50	37	38	42	42	50
	Larg. palpébrale	—	—	30	30	36	37	37
	Larg. bicaroncul...	—	—	39	35	44	39	40
	Larg. buccale	—	57	51	46	55	53	59
	Long. des oreilles	55	57	57	65	67	59	68
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm	cm.	cm.	cm.
	Taille	163,5	—	156,5	—	165,5	157,5	169,0
	Gr. enverg.	162,5	—	169,5	—	174.5	163,5	177,0
	Haut. du cond. audit. ...	147,0	—	143,0	151,0	154,0	145,0	156,0
	Haut. du menton	—	—	135,5	141,5	152,5	137,5	147,5
	Haut. de l'acrom.	—	—	123,5	133.5	135,0	138,5	—
	Haut. de l'extrémi. du médius	—	—	56,0	60,5	54,0	57,5	65,0
	Haut. de l'ombil...	—	—	—	94,5	102,5	92,0	101,5
	Haut. du gr. troch	—	—	90,0	93,0	100,0	88,0	98,0
	Haut. du vertex. dans la posit. assise.	—	—	88,5	90,5	92,0	87,0	93,5
	Dist. bi-acromiale	—	39,0	40,0	44,0	—	43,5	43,5
	Circonf. de la poit.	—	93,5	—	83,5	89,0	86,0	91,0
	Long. du memb. sup. ...	—	—	67,5	—	72,5	77,5	73,0
	Long. du memb. infér. ...	—	—	90,0	93,5	100,0	88,0	91,5
	Circonf. du bras	—	28,5	27,0	—	20,5	27,5	26,0
	Circ. de la cuisse	—	49,0	49,0	43,0	47,5	48,0	49,0
	Circ. du mollet	—	35,5	33,0	32,0	35,0	33,0	33,5
	Long. tot. du pied	—	25,5	24.0	26,5	—	24,5	25,0
	Larg. max. du pied	—	10.5	9,5	9.0	—	10,0	10,0
Indices.	Indice céphal...	—	82,9	81,5	79,0	80,6	78,6	83,2
	Indice du visage...	—	—	77,0	70.9	64,4	80.8	76,8
	Indice facial	—	120,0	123,3	114,0	101,8	129,8	131,1
	Indice nasal	—	102.0	82.2	92,7	79.2	102.4	119,0
Rapports.	Rap. entre la gr. enverg. et la taille	93,9	—	108,3	—	105,4	103,8	104,7
	Rap. de la haut. du cond. audit. à la taille	89,9	—	91,4	93,1	92,1	92,3	94,3
	Rap. de la haut. du ment. à la taille	—	—	86,6	92,2	87,3	87,3	86,1
	Rap. de la haut. de l'acrom à la taille	—	—	78,9	85,7	82,0	83,6	—
	Rap. de la haut. du méd. à la taille	—	—	35,8	32.6	36,5	38,5	35,6
	Rap. de la haut. de l'omb. à la taille	—	—	—	61,9	58,4	60.1	57,7
	Rap. de la haut. du gd. troch. à la taille	—	—	57,5	60,4	55.9	58.0	56,8
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	56,6	55,6	55,2	55,3	55,2
	Rap. de la dist. bi-acrom. à la taille	—	27,6	25,7	23,3	—	23,8	26,0
	Rap. de la long. du m. sup. à la taille	—	—	43,1	—	43,8	49,2	43,2
	Rap. entre ces 2 long. ...	—	—	75,0	—	72,5	88,1	79,8

	Numéros.	36	37	38	39	40	41	42
Mensurations de la tête et de la face.		mm.	mm.	mm.	mm	mm	mm	mm.
	Diam. ant. post. max. ...	174	—	—	177	180	182	182
	Diam. transv. max.... ...	140	—	—	146	140	145	138
	Long. tot. du visage ...	172	—	—	176	198	184	191
	Long. tot. de la face ...	103	—	—	107	111	112	111
	Larg. tot. de la face ...	122	-	—	130	128	138	133
	Haut. du front	69	—	—	69	87	72	80
	Long. du nez.	43	—	—	45	43	47	45
	Larg. du nez.	41	—	—	46	40	42	39
	Larg. palpébrale	33	—	—	33	32	31	31
	Larg. bicaroncul...	34	—	—	36	34	38	33
	Larg. buccale	55	—	—	—	41	63	54
	Long. des oreilles	63	—	—	64	59	58	63
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm.	cm	cm.	cm.
	Taille	158,5	—	—	159,5	159,5	—	165,5
	Gr. enverg.	161,0	—	—	162,5	163,0	—	173,5
	Haut. du cond. audit. ...	149,5	—	—	—	—	—	—
	Haut. du menton	136,5	—	—	—	—	—	—
	Haut. de l'acrom.	132,5	—	—	—	—	—	—
	Haut. de l'extrémi. du médius	55,5	—	—	—	—	—	—
	Haut. de l'ombil...	91,5	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit. assise	87,5	—	—	—	—	—	—
	Dist. bi-acromiale	37,0	—	—	38,0	—	—	43,0
	Circonf. de la poit	—	—	—	86,0	—	—	91,0
	Long. du memb. sup. ...	77,5	—	—	—	80,0	—	—
	Long. du memb. infér. ...	—	—	—	—	—	—	—
	Circonf. du bras....	25,0	—	—	27,5	—	25,5	27,5
	Circ. de la cuisse	44,5	—	—	45,5	50,0	46,0	47,5
	Circ. du mollet	30,5	—	—	32,0	31,0	—	33,0
	Long. tot. du pied	25,5	—	—	25,0	25,0	25,5	25,5
	Larg. max. du pied	8,5	—	—	10,0	9,5	8,5	10,0
Indices.	Indice céphal...	80,5	—	—	82,5	77,8	79,7	75,8
	Indice du visage...	70,9	—	—	73,9	64,6	75,0	69,6
	Indice facial	118.4	—	—	121 5	115,3	123,2	119,8
	Indice nasal	95.3	—	—	102,2	93,0	89.4	86,7
Rapports.	Rap. entre la gr. enverg. et la taille	101,6	—	—	101,9	102,2	—	104,8
	Rap. de la haut. du cond. audit. à la taille	90,7	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	85,1	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille... ...	81,1	—	—	—	—	—	—
	Rap. de la haut. du méd. à la taille	31,1	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	57,5	—	—	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	53,4	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	24,5	—	—	24,3	—	—	26,2
	Rap. de la long. du m. sup. à la taille...	48,9	—	—	—	50,2	—	—
	Rap. entre ces 2 long. ...	—	—	—	—	—	—	—

	Numéros.	43	44	45	46	47	48	49
Mensurations de la tête et de la face.		mm	mm.	mm.	mm.	mm	mm.	mm
	Diam. ant. post. max. ...	183	—	—	—	188	174	—
	Diam. transv. max.	140	—	—	—	138	138	—
	Long. tot. du visage ...	182	—	—	—	177	180	—
	Long. tot. de la face ...	113	—	—	—	112	105	—
	Larg. tot. de la face ...	139	—	—	—	136	125	—
	Haut. du front	65	—	—	—	65	75	—
	Long. du nez.	48	—	—	—	44	40	—
	Larg. du nez.	40	—	—	—	34	42	—
	Larg. palpébrale	34	—	—	—	39	29	—
	Larg. bicaroncul...	38	—	—	—	35	31	—
	Larg. buccale.	54	—	—	—	51	53	—
	Long. des oreilles	66	—	—	—	56	56	—
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm.	cm	cm.	cm.
	Taille	—	—	—	—	161,0	158,5	—
	Gr. enverg.	—	—	—	—	170,0	160,5	—
	Haut. du cond. audit. ...	143,5	—	—	—	146,0	141,0	—
	Haut. du menton	135,0	—	—	—	137,0	135,5	—
	Haut. de l'acrom.	130,5	—	—	—	130,5	132,5	—
	Haut. de l'extrémi. du médius	50,0	—	—	—	50,0	52,5	—
	Haut. de l'ombil...	92,5	—	—	—	92,5	95,5	—
	Haut. du gr. troch	92,5	—	—	—	91,5	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—	86,0	85,0	—
	Dist. bi-acromiale	—	43,0	—	—	39,5	38,5	—
	Circonf. de la poit.	90,0	—	—	—	89,5	83,5	—
	Long. du memb. sup. ...	—	—	—	—	82,5	79,5	—
	Long. du memb. infér. ...	—	—	—	—	90,0	90,0	—
	Circonf. du bras	27,5	—	—	—	26,5	23,5	—
	Circ. de la cuisse	50,5	—	—	—	48.5	45,0	—
	Circ. du mollet	36,0	—	—	—	33,0	31,0	—
	Long. tot. du pied	25,5	—	—	—	25,0	24,0	—
	Larg. max. du pied	10,0	—	—	—	9,0	9,5	—
Indices.	Indice céphal...	76 5	—	—	—	73,4	79,3	—
	Indice du visage...	76,5	—	—	—	76,8	69,4	—
	Indice facial	123,0	—	—	—	121,4	119,0	—
	Indice nasal	83,3	—	—	—	77,3	105,0	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	—	—	—	105,6	101,3	—
	Rap. de la haut. du cond. audit. à la taille	89,0	—	—	—	92,3	89,9	—
	Rap. de la haut. du ment. à la taille	85,5	—	—	—	87,1	84,2	—
	Rap. de la haut. de l'acrom à la taille... ...	83,6	—	—	—	83,1	82,0	—
	Rap. de la haut. du méd. à la taille	33,1	—	—	—	36,0	34.8	—
	Rap. de la haut. de l'omb. à la taille	60,3	—	—	—	59,4	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—	54,3	51,7	—
	Rap. de la dist. bi-acrom. à la taille	—	24,9	—	—	23,5	23,8	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	—	51,2	50,2	—
	Rap. entre ces 2 long. ...	—	—	—	—	91,7	88,3	—

	Numéros.	50	51	52	53	54	55	56
Mensurations de la tete et de la face.		mm.	mm	mm.	mm.	mm.	mm	mm.
	Diam. ant. post. max. ...	177	180	—	—	—	185	—
	Diam. transv. max.	—	—	-	—	—	138	—
	Long. tot. du visage ...	183	176	—	—	—	181	—
	Long. tot. de la face ...	107	104	—	—	—	105	—
	Larg. tot. de la face ...	125	137	—	—	134	135	—
	Haut. du front	76	72	—	71	—	75	—
	Long. du nez.	46	45	—	—	51	39	—
	Larg. du nez.	40	43	—	—	41	42	—
	Larg. palpébrale	34	33	29	30	31	34	—
	Larg. bicaroncul...	34	34	32	29	42	33	—
	Larg. buccale	52	55	—	—	54	57	—
	Long. des oreilles ...	62	58	—	59	61	58	—
Mensurations du trone et des membres.		cm.	cm.	cm.	cm.	cm	cm.	cm.
	Taille	162,5	160.5	—	—	162,0	155,5	—
	Gr. enverg.	165,5	167,5	—	—	168 0	157.5	—
	Haut. du cond. audit. ...	150,0	—	—	—	—	—	—
	Haut. du menton	141,5	—	—	—	—	—	-
	Haut. de l'acrom	135,0	—	—	—	—	—	—
	Haut. de l'extrémi. du médius	58,5	—	—	—	—	—	—
	Haut. de l'ombil...	96,5	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit assise	84,0	—	—	—	—	—	—
	Dist. bi-acromiale	42,5	40 0	—	—	38,0	37,0	—
	Circonf. de la poit.	84.0	82,0	—	—	86.0	87.0	—
	Long. du memb. sup. ...	76,5	—	—	—	—	—	—
	Long. du memb. infér....	—	—	—	—	—	—	—
	Circonf. du bras....	24,0	26.5	—	—	26,0	27,0	—
	Circ. de la cuisse	47,0	49.5	—	—	45.0	50,0	—
	Circ. du mollet	31,0	30 0	—	—	31,0	32,0	—
	Long. tot. du pied	24,5	24,5	—	—	25,5	25,5	—
	Larg. max. du pied	9 0	9.5	—	—	9,0	9,5	—
Indices.	Indice céphal...	—	—	—	—	—	74,6	—
	Indice du visage...	68,3	—	—	—	—	—	—
	Indice facial	116,8	131,7	—	—	—	127,4	—
	Indice nasal	87,0	95,6	—	—	80,4	107.7	—
Rapports.	Rap. entre la gr. enverg. et la taille...	101.8	104,4	—	—	103,7	101,3	—
	Rap. de la haut. du cond. audit. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	-	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille... ...	—	—	—	—	—	—	—
	Rap. de la haut. du méd. à la taille	-	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—	—	-	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	-	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	25,0	26,2	—	—	25,5	24,7	—
	Rap. de la long. du m. sup. à la taille...	47,1	—	—	—	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	—	—	—	—

	Numéros.	57	58	59	60	61	62	63
Mensurations de la tête et de la face.		mm.	mm.	mm.	mm	mm	mm.	mm.
	Diam. ant. post. max. ...	172	171	184	184	179	179	170
	Diam. transv. max.	138	132	143	145	130	139	130
	Long. tot. du visage ...	—	174	186	189	171	174	175
	Long. tot. de la face ...	107	101	108	111	107	103	105
	Larg. tot. de la face ...	122	124	127	138	130	128	128
	Haut. du front	—	73	78	78	64	71	70
	Long. du nez.	44	38	41	45	37	42	43
	Larg. du nez.	43	42	38	41	38	44	37
	Larg. palpébrale	31	31	31	33	28	33	34
	Larg. bicaroncul...	35	29	34	35	32	35	32
	Larg. buccale	54	54	47	49	56	56	52
	Long. des oreilles	67	63	61	51	54	65	62
Mensurations du tronc et des membres.		cm	cm	cm.	cm.	cm	cm	cm.
	Taille	154,0	162,0	157,0	162,0	154,0	161,0	151,0
	Gr. enverg.	165,0	170,0	165 0	169 0	160,0	171,0	161,0
	Haut. du cond. audit. ...	—	—	—	—	—	—	—
	Haut. du menton	—	—	—	—	—	—	—
	Haut. de l'acrom	—	—	—	—	—	—	—
	Haut. de l'extrémi. du. médius	—	—	—	—	—	—	—
	Haut. de l'ombil...	—	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—	—	—	—
	Dist. bi-acromiale	38,5	42,5	40,0	—	38,0	38,5	39,5
	Circonf. de la poit	87,0	87,5	88,5	—	78,0	84,5	86,0
	Long. du memb. sup. ...	—	—	—	—	—	—	—
	Long. du memb. infér. ...	—	—	—	—	—	—	—
	Circonf. du bras	25,0	25,0	26,5	27,0	23,5	24,0	26,0
	Circ. de la cuisse	47,0	44,0	46,0	43,0	44,5	49,0	48,0
	Circ. du mollet	33,5	31,0	31,0	31,0	30,0	35,0	33,0
	Long. tot. du pied	24,5	25,0	24,5	25,5	25,5	26 5	24,5
	Larg. max. du pied ...	9,0	8,0	8 5	10 0	10,0	9 0	9,5
Indices.	Indice céphal...	80,6	77,2	77,7	78,8	77,6	77,6	70,6
	Indice du visage...	—	—	—	—	—	—	—
	Indice facial	114,0	122,9	117,6	124,3	121,5	124,3	121,9
	Indice nasal	97,7	110,5	92,7	91 1	102,7	104 8	86,0
Rapports.	Rap. entre la gr. enverg. et la taille	107,1	104,9	105,1	104,3	103,9	105,2	106,6
	Rap. de la haut. du cond. audit. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille... ...	—	—	—	—	—	—	—
	Rap. de la haut, du méd. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille... ...	—	—	—	—	—	—	—
	Rap. de la haut. du vertex. pos. ass. à la taille.	—	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	23,9	26,2	23,5	—	24,3	26,9	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	—	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	—	—	—	—

	Numéros.	64	65	66	67	68	69	70
Mensurations de la tête et de la face.		mm.	mm.	mm	mm.	mm.	mm	mm.
	Diam, ant. post. max. ...	176	172	188	—	—	—	—
	Diam. transv. max.	141	139	144	—	—	—	—
	Long. tot. du visage ...	176	186	191	177	—	—	—
	Long. tot. de la face ...	94	110	116	100	—	—	—
	Larg. tot. de la face ...	124	136	128	136	—	—	—
	Haut. du front	82	76	75	77	—	—	—
	Long. du nez.	37	39	47	40	—	—	—
	Larg. du nez.	40	43	44	41	—	—	—
	Larg. palpébrale	34	32	35	36	—	—	—
	Larg. bicaroncul...	35	35	38	32	—	—	—
	Larg. buccale	46	49	61	52	—	—	—
	Long. des oreilles	59	59	56	59	—	—	—
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm.	cm	cm.	cm.
	Taille	—	170,0	164,5	158,0	—	—	—
	Gr. enverg.	—	178,0	169,5	—	—	—	—
	Haut. du cond. audit. ...	—	—	—	142,0	—	—	—
	Haut. du menton	—	—	—	133,0	—	—	—
	Haut. de l'acrom. ...	—	—	—	129,5	—	—	—
	Haut, de l'extrémi. du médius	—	—	—	55,0	—	—	—
	Haut. de l'ombil...	—	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—	—	—	—
	Dist. bi-acromiale	3,70	40,0	40,0	42,5	—	—	—
	Circonf. de la poit.... ...	8,05	91,0	84,0	—	-	—	—
	Long. du memb. sup. ...	—	—	—	74 5	—	—	—
	Long. du memb. infér. ...	—	—	—	—	—	—	—
	Circonf. du bras....	22.0	26,5	26,0	28,0	—	—	—
	Circ. de la cuisse	39,5	49,0	46,0	48,5	—	—	—
	Circ. du mollet	28 5	32,0	33,0	32,0	—	—	—
	Long. tot. du pied	23,5	—	25,0	25,0	—	—	—
	Larg. max. du pied	9,5	—	9.0	8,0	—	—	—
Indices.	Indice céphal...	80,1	80,8	76,6	—	—	—	—
	Indice du visage...	—	—	—	—	—	—	—
	Indice facial	131,9	123,6	110,3	136.0	—	—	—
	Indice nasal	108.1	110.3	93,6	102,5	—	—	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	104,7	103,0	—	—	—	—
	Rap. de la haut. du cond. audit. à la taille.	—	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille... ...	—	—	—	—	—	—	—
	Rap. de la haut. du méd. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	—	—	—	—	—	—	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	47,1	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	—	—	—	—

	Numéros.	71	72	73	74	75	76	77
		mm.	mm.	mm.	mm.	mm.	mm.	mm.
Mensurations de la tête et de la face.	Diam. ant. post. max. ...	—	—	—	189	—	—	—
	Diam. transv. max.	—	—	—	143	—	—	—
	Long. tot. du visage ...	—	—	—	187	—	—	—
	Long. tot. de la face ...	—	—	—	113	—	—	—
	Larg. tot. de la face ...	—	—	—	129	—	—	—
	Haut. du front	—	—	—	74	—	—	—
	Long. du nez.	—	—	—	42	—	—	—
	Larg. du nez.	—	—	—	36	—	—	—
	Larg. palpébrale	—	—	—	31	—	—	—
	Larg. bicaroncul...	—	—	—	38	—	—	—
	Larg. buccale	—	—	—	51	—	—	—
	Long. des oreilles	—	—	—	61	—	—	—
		cm.	cm.	cm.	cm.	cm.	cm.	cm.
Mensurations du tronc et des membres.	Taille	—	—	—	—	—	—	—
	Gr. enverg.	—	—	—	—	—	—	—
	Haut. du cond. audit. ...	—	—	—	—	—	—	—
	Haut. du menton	—	—	—	—	—	—	—
	Haut. de l'acrom.	—	—	—	—	—	—	—
	Haut. de l'extrémi. du médius	—	—	—	—	—	—	—
	Haut. de l'ombil...	—	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—	—	—	—
	Dist. bi-acromiale	—	—	—	39,0	—	—	—
	Circonf. de la poit.	—	—	—	—	—	—	83,0
	Long. du memb. sup. ...	—	—	—	—	—	—	—
	Long. du memb. infér. ...	—	—	—	—	—	—	—
	Circonf. du bras...	—	—	—	—	—	—	—
	Circ. de la cuisse	—	—	—	48,5	—	—	—
	Circ. du mollet	—	—	—	33,5	—	—	—
	Long. tot. du pied	—	—	—	24,5	—	—	—
	Larg. max. du pied	—	—	—	10,0	—	—	—
Indices.	Indice céphal...	—	—	—	75.7	—	—	—
	Indice du visage	—	—	—	—	—	—	—
	Indice facial	—	—	—	114,2	—	—	—
	Indice nasal	—	—	—	85.7	—	—	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	—	—	—	—	—	—
	Rap. de la haut. du cond. audit. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille ..	—	—	—	—	—	—	—
	Rap. de la haut. du méd. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	—	—	—	—	—	—	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	—	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	—	—	—	—

Numéros.		78	79	80	81	82	83	84
		mm.	mm.	mm.	mm.	mm.	mm.	mm.
Mensurations de la tête et de la face.	Diam. ant. post. max.	—	—	—	—	—	—	—
	Diam. transv. max.	—	—	—	—	—	—	—
	Long. tot. du visage	—	—	—	—	—	—	—
	Long. tot. de la face	—	—	—	—	—	—	—
	Larg. tot. de la face	—	—	—	—	—	—	—
	Haut. du front	—	—	—	—	—	—	—
	Long. du nez.	—	—	—	—	—	—	—
	Larg. du nez.	—	—	—	—	—	—	—
	Larg. palpébrale	—	—	—	—	—	—	—
	Larg. bicaroncul...	—	—	—	—	—	—	—
	Larg. buccale	—	—	—	—	—	—	—
	Long. des oreilles	—	—	—	—	—	—	—
		cm.	cm.	cm.	cm.	cm.	cm.	cm.
Mensurations du tronc et des membres.	Taille	—	—	—	—	—	—	—
	Gr. enverg.	—	—	—	—	—	—	—
	Haut. du cond. audit.	—	—	—	—	—	—	—
	Haut. du menton	—	—	—	—	—	—	—
	Haut. de l'acrom.	—	—	—	—	—	—	—
	Haut. de l'extrémi. du médius	—	—	—	—	—	—	—
	Haut. de l'ombil.	—	—	—	—	—	—	—
	Haut. du gr. troch	—	—	—	—	—	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—	—	—	—
	Dist. bi-acromiale	—	—	—	—	—	—	—
	Circonf. de la poit.	—	—	—	—	—	—	—
	Long. du memb. sup.	—	—	—	—	—	—	—
	Long. du memb. inéfr.	—	—	—	—	—	—	—
	Circonf. du bras.	—	—	—	—	—	—	—
	Circ. de la cuisse	—	—	—	—	—	—	—
	Circ. du mollet	—	—	—	—	—	—	—
	Long. tot. du pied	—	—	—	—	—	—	—
	Larg. max. du pied	—	—	—	—	—	—	—
Indices.	Indice céphal	—	—	—	—	—	—	—
	Indice du visage...	—	—	—	—	—	—	—
	Indice facial...	—	—	—	—	—	—	—
	Indice nasal	—	—	—	—	—	—	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	—	—	—	—	—	—
	Rap. de la haut. du cond. audit. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du méd. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	—	—	—	—	—	—	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	—	—	—	—
	Rap. entre ces 2 long.	—	—	—	—	—	—	—

Numéros.		85	86	87	88
Mensurations de la tête et de la face.		mm.	mm.	mm.	mm.
	Diam. ant. post. max. ...	—	—	—	—
	Diam. transv. max.	—	—	—	—
	Long. tot. du visage ...	—	—	—	—
	Long. tot. de la face ...	—	—	—	—
	Larg. tot. de la face... ...	—	—	—	—
	Haut. du front	—	—	—	—
	Long. du nez.	—	—	—	—
	Larg. du nez.	—	—	—	—
	Larg. palpébrale	—	—	—	—
	Larg. bicaroncul...	—	—	—	—
	Larg. buccale	—	—	—	—
	Long. des oreilles	—	—	—	—
Mensurations du tronc et des membres.		cm.	cm.	cm.	cm.
	Taille	—	—	—	—
	Gr. enverg.	—	—	—	—
	Haut. du cond. audit. ...	—	—	—	—
	Haut. du menton	—	—	—	—
	Haut. de l'acrom.	—	—	—	—
	Haut. de l'extrémi. du médius	—	—	—	—
	Haut. de l'ombil...	—	—	—	—
	Haut. du gr. troch	—	—	—	—
	Haut. du vertex. dans la posit. assise	—	—	—	—
	Dist. bi-acromiale	—	—	—	—
	Circonf. de la poit.	—	—	—	—
	Long. du memb. sup. ...	—	—	—	—
	Long. du memb. infér. ...	—	—	—	—
	Circonf. du bras...	—	—	—	—
	Circ. de la cuisse	—	—	—	—
	Circ. du mollet	—	—	—	—
	Long. tot. du pied	—	—	—	—
	Larg. max. du pied... ...	—	—	—	—
Indices.	Indice céphal	—	—	—	—
	Indice du visage...	—	—	—	—
	Indice facial	—	—	—	—
	Indice nasal	—	—	—	—
Rapports.	Rap. entre la gr. enverg. et la taille	—	—	—	—
	Rap. de la haut. du cond. audit. à la taille	—	—	—	—
	Rap. de la haut. du ment. à la taille	—	—	—	—
	Rap. de la haut. de l'acrom. à la taille... ...	—	—	—	—
	Rap. de la haut. du méd. à la taille	—	—	—	—
	Rap. de la haut. de l'omb. à la taille	—	—	—	—
	Rap. de la haut. du gd. troch. à la taille	—	—	—	—
	Rap. de la haut. du vertex pos. ass. à la taille.	—	—	—	—
	Rap. de la dist. bi-acrom. à la taille	—	—	—	—
	Rap. de la long. du m. sup. à la taille...	—	—	—	—
	Rap. entre ces 2 long. ...	—	—	—	—

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R. TORII.

LES ABORIGÈNES DE FORMOSE.

PLANCHE I.

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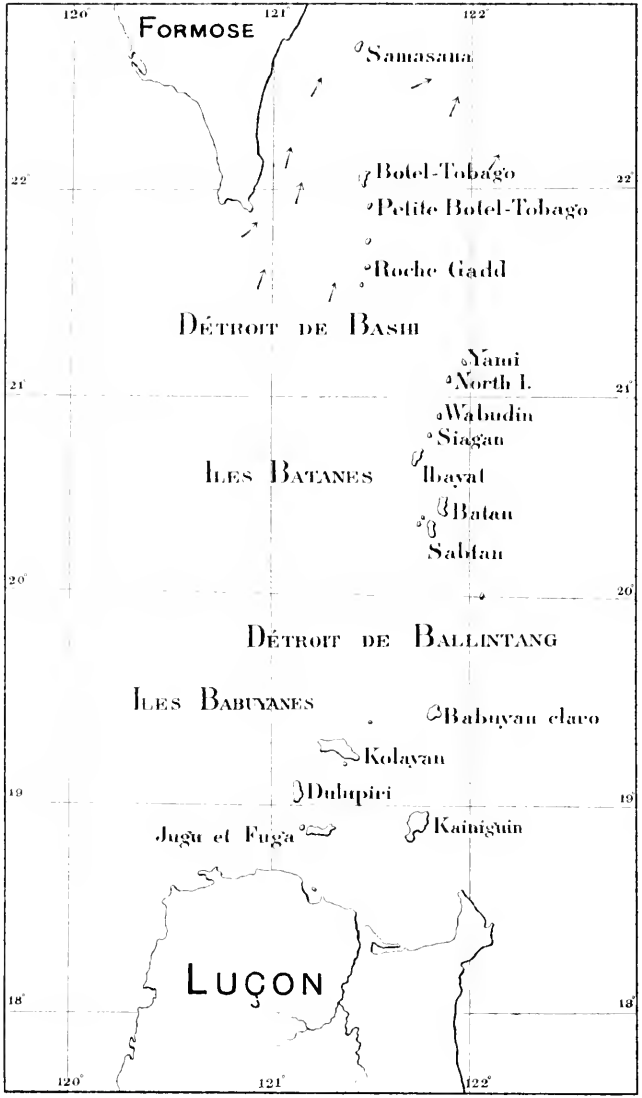
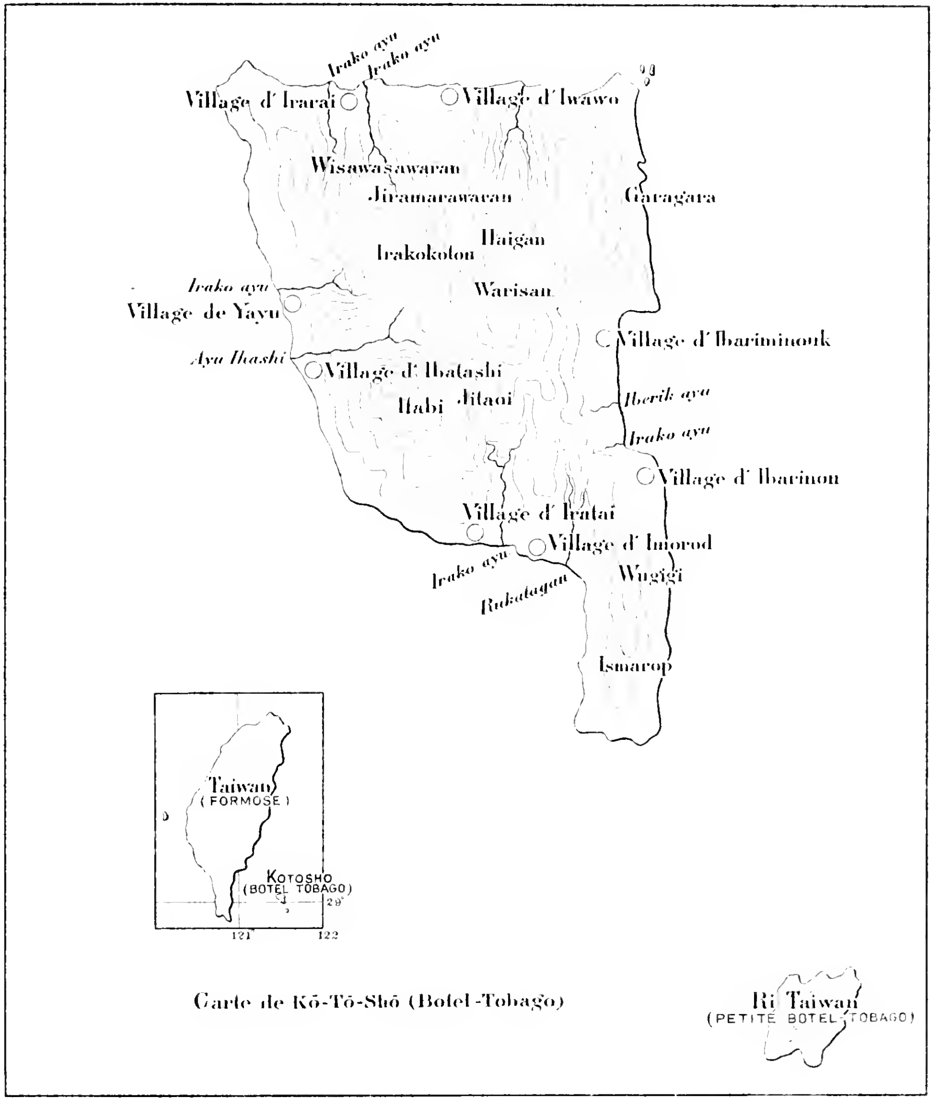
A. Carte montrant les montagnes, les rivières et les villages des Aborigènes de Kō-tō-shō (Botel-Tobago). La petite Carte qui est annexée à la carte de Kō-tō-shō, montre la situation relative de Kō-tō-shō et de Formose.

B. Carte montrant la situation respective de Kō-tō-shō (Botel-Tobago) et des îles qui sont situées au Nord des Philipines.



A



Carte de Kō-Tō-Shō (Botel-Tobago)

B

R. TORII.

LES ABORIGÈNES DE FORMOSE

PLANCHE II.

Explication de la Pl. II.

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B. Le même, de profil.

C. Aborigène de Kō-tō-shō (Botel-Tobago).

D. Le même, de profil.

A

B

C

D

PLANCHE III.

Explication de la Pl. III.

A. Aborigène de Kō-tō-shō (Botel-Tobago).

B. Le même, de profil.

C. Aborigène de Kō-tō-shō (Botel-Tobago).

D. Aborigène de Kō-tō-shō (Botel-Tobago).

A

B

C

D

PLANCHE IV.

Explication de la Pl. IV.

A.	Aborigène de Kō-tō-shō (Botel-Tobago).
B.	Le même, de profil.
C.	Aborigène de Kō-tō-shō (Botel Tobago).
D.	Le même, de profil.
E.	Femme de Kō-tō-shō (Botel Tobago).
F.	La même, de profil.


A


C


E


B


D


F

R. TORII.

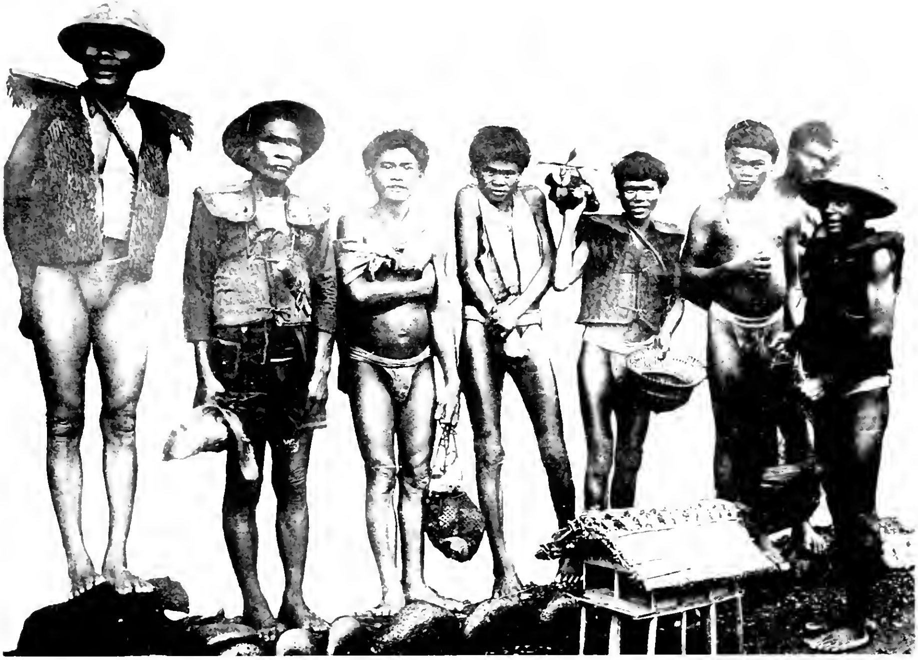
LES ABORIGÈNES DE FORMOSE.

PLANCHE V.

Explication de la Pl. V.

A. Groupe d'Aborigènes (hommes) de Kō-tō-shō-(Botel-Tobago.)—On voit, en bas de la photographie, un modèle des " maisons de travail "—La plupart des aborigènes possédent deux maisons: une où ils habitent et une autre où ils travaillent. Celles-ci sont plus élevées, et ont généralement un étage. Ceux qui sont pauvres, n'ayant pas de " maison de travail," travaillent en plein air, devant leur maison d'habitation.

B. Groupe d'aborigènes. Les 2 individus qui sont accroupis, en bas, au premier rang, sont des hommes. Devant eux, se trouvent 2 spécimens d'une sorte de coiffure en argent, de forme conique, qu'ils mettent à l'occasion des cérémonies religieuses .Le 2^e^ rang est entièrement composé de femmes. À droite, sont de jeunes garçons.



A

B

R. TORII.

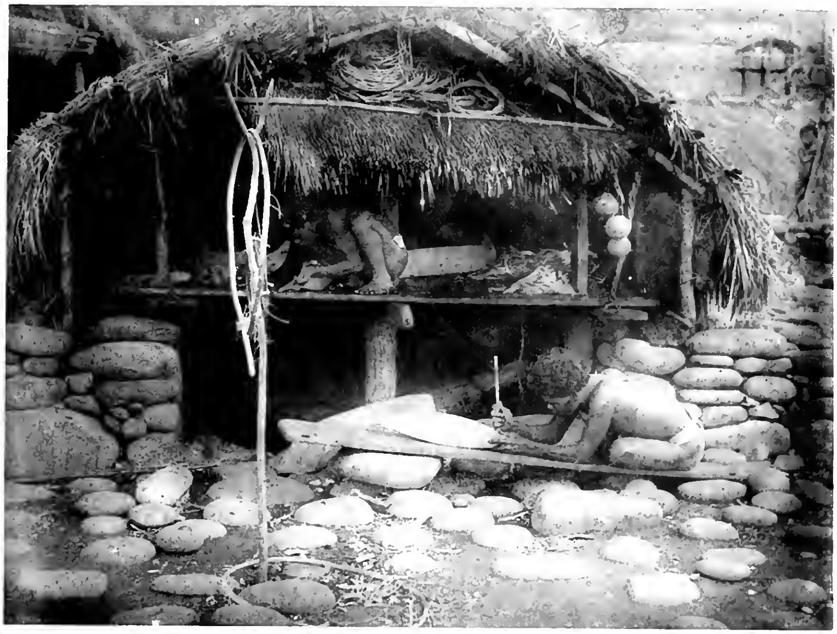
LES ABORIGÈNES DE FORMOSE.

PLANCHE VI.

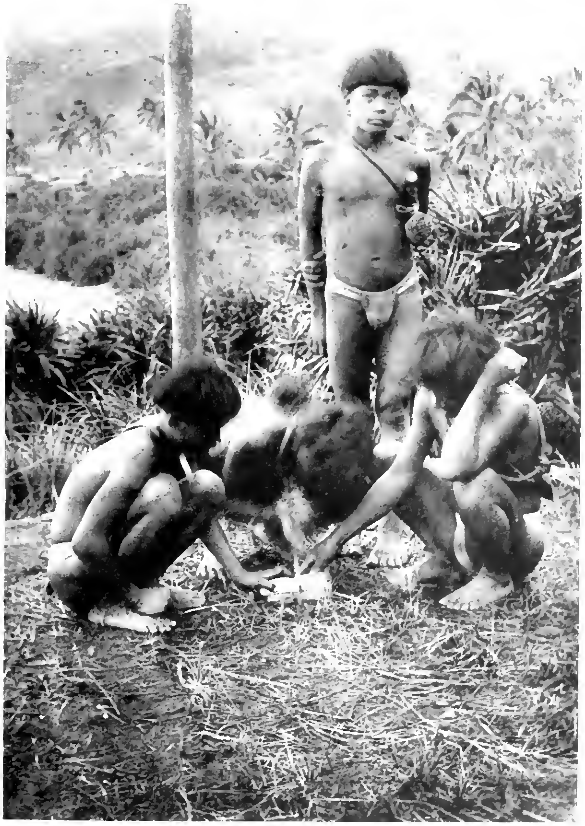
Explication de la Pl. VI.

A. “ Maison de travail.” 2 indigènes sont occupés à fabriquer un modèle de pirogue. Celui du bas qui, se nomme Shikashi, a les cheveux frisés, particularité dont il est parlé au cours de cette étude.

B. Aborigènes occupés à produire du feu par le frottage.



A



B

Explication de la Pl. VII.

A. Un Village de Kō-tō-shō (Botel-Tobago). En bas, à droite de la photographie est une maison d'habitation. Celles qui, dans le village, sont plus élevées que les autres, sont des "maisons de travail." Au premier plan, on voit des femmes et des petites filles.

B. Groupes d'aborigènes (hommes et femmes), devant une "maison de travail."

A

B

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XXXII., ARTICLE 5.

Climatic Changes in Japan since the Pliocene Epoch.

By

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Professor of Palæontology, Imperial University of Tokyo.

With 1 Plate.

As is well known, one of the striking features of the climate of the primæval world was the occasional interruption of a comparatively warm and uniform climate by one of intense cold. The time during which such a cold climate prevailed is called an *ice-age*, because of the enormous quantities of ice which in the form of glaciers covered the land, smoothing, polishing and scratching the rocks over which they moved, and carrying with them erratics and moraines, just as they do to-day in the Alps and in Arctic countries. Geologists have ascertained that such ice-ages have visited the earth at least three times during the past. The first visit was during the Eozoic or Precambrian, the period in which the first dawn of life appeared in the world. Evidences of this age have been discovered in China, Canada and Northern Norway. The second was toward the close of the Palæozoic era, in a period called Permian. This time the ice chiefly invaded the countries around the Indian Ocean—India, Australia and Southern Africa. The so-called *Glossopteris flora*, which resembles that of the succeeding Mesozoic more than that of the Palæozoic and which flourished during the Permian period in the above named countries, is often brought into connection with this second glaciation, on the assumption that it was the result of the transforming power of the cold acting on plants of the Palæozoic which remained unchanged until its close in places where there was no glaciation.

The third and the last ice-age was of a comparatively late date. It was in the Diluvial. During the Tertiary, a period which immediately preceded this age, the climate of Europe and America was very warm, so warm in the beginning that tropical plants grew in Southern England and chelonians and crocodiles inhabited its waters. This great heat, however, gradually diminished as time went on, becoming subtropical in the Miocene and temperate in the Pliocene, the last subdivision of the Tertiary. Within this Pliocene, too, the lowering of temperature still went on from the beginning to the end, a sure indication of the approach of an ice-age. And this is nowhere more clearly mirrored than on the molluscous animals of the so-called *Crag Formation* of England which belongs to the abovesaid Pliocene Epoch. The Mollusca in the lowest division of this Crag, called the *Coralline Crag*, in spite of an admixture of a few northern or boreal forms, still bears in general the stamp of a very genial climate. But in the *Red Crag*, the Crag next above it, the number of boreal forms increases to 10% and in the still higher *Norwich Crag* to still more, until at last in the uppermost Crags,—the *Chillesford* and *Weybourne Crags*—their number is so great that the fauna may be called really Arctic, and there is even a doubt whether these Crags might not be better classed among the deposits of the ice-age itself.

With the dawn of the Diluvial Epoch, the whole aspect of Europe and America was changed. Enormous glaciers were moving everywhere. They formed a continuous sheet of ice several thousands of feet in thickness and covering the greater part of the two continents. They looked very much like those now found in the interior of Greenland or on the Antarctic continent. This ice-age, however, was not one continuous age of ice. There were also times in which the ice partly melted and shrunk and the climate became comparatively mild. Such times are called *Interglacials*, their number varying in different regions but amounting to as many as six, as has been ascertained in America. Thus the ice-age after several fluctuations in the extent of the ice at last disappeared, and in the Alluvial or Modern Epoch we see the once ice-covered Europe and America again covered with meadows and woods, and quite as inviting as in by-gone ages.

Hereupon a thinking mind is naturally led to ask whether this state of things was limited to the above two continents, or was more world-wide in nature, in which case the old remains of erratics and moraines and of polished and scratched rocks should also be found in other parts of the world. And so when Japan was opened to international traffic and geologists, both foreign and native, began to scour the country, they naturally looked for evidences of glaciers. But strange to say, they were nowhere to be found. They were not found in Honshu, nor in the Hokkaido, nor even in the cold island of Sakhalin where even in the southernmost part the mean January temperature falls far below the freezing point, to —13°C, a temperature which we find in Labrador and Southern Greenland. From this negative evidence they were obliged to infer that glaciers had never existed in Japan, probably because the climate had never been cold enough to generate them. But why had it not been cold? There was no one who could answer this question.

Since about a year ago, I have been studying our Pliocene fossils found at a place called Koshiba, some eleven kilometres south of Yokohama and beautifully situated on the shore of the Tokyo Bay. The rock in which the fossils are entombed is a coarse tufaceous sandstone, sometimes so coarse as to look like a conglomerate, thus betraying the shallowness of the sea in which it was deposited. The fossils are chiefly *Molluscs* and *Molluscoids* with some *Echinoderms*, *Tubicolous Annelids*, *Balanids*, *Fish-teeth*, etc. The *Molluscs* seem to be very rich in species, while the case seems to be quite the contrary with the *Molluscoids*, though they are rich in individuals. The number of the species of these two groups of animals which I have been able to distinguish up to this time, amounts to seventy-one,¹⁾ of which the following thirty-nine are living ones:—

1. *Cylichna cylindracea* Pennant.

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1) Detailed descriptions of these fossils will appear in a future number of this journal.

2. *Conus sieboldi* Reeve.
3. *Pleurotoma kamakurana* Pilsbry.
4. *Mangilia robusticostata* Smith.
5. *Admete viridula* Fabricius.
6. *Voluta megaspira* Sowerby.
7. *Mitra ebenus* Lamarck.
8. *Chrysodomus phœniceus* Dall.
9. *Chrysodomus pericochlion* Schrenck.
10. *Trophon clathratus* Linné.
11. *Priene oregonensis* Redfield.
12. *Natica clausa* Broderip et Sowerby.
13. *Leptothyra amussitata* Gould.
14. *Puncturella conica* Orbigny.
15. *Acmæa heroldi* Dunker var. *pygmæa* Dunker.
16. *Patella pallida* Gould.
17. *Dentalium weinkauffi* Dunker.
18. *Corbula venusta* Gould.
19. *Lucina borealis* Linné.
20. *Cardium modestum* Adams et Reeve.
21. *Anomia cytæum* Gray.
22. *Lima goliath* Smith.
23. *Lima smithi* Sowerby.
24. *Lima japonica* A. Adams.
25. *Pecten swiftii* Bernardi.
26. *Pecten yessoensis* Jay.
27. *Pecten vesiculosus* Dunker.
28. *Pecten similis* Lasky.
29. *Pecten irregularis* Sowerby.
30. *Pecten tigerrinus* Müller.
31. *Ostrea gigas* Thunberg.
32. *Arca kobeltiana* Pilsbry.
33. *Arca decussata* Sowerby.
34. *Arca stearnsii* Pilsbry.
35. *Limopsis crenata* A. Adams
36. *Leda ramsayi* Smith.
37. *Nucula insignis* Gould.

38. *Terebratulina crossei* Davidson.
39. *Terebratulina caillcti* Crosse.

I also found three forms which, if not quite identical with, are at least close to, living species. They are

40. *Sipho* cf. *gracilis* Da Costa.
41. *Natica* cf. *pallida* Broderip et Sowerby.
42. *Fissuridea* cf. *tanneri* Verrill.

The remaining twenty-nine species are those which are not yet known to be living, and belong to the genera *Conus*, *Pleurotoma*, *Drillia*, *Mangilia*, *Mitra*, *Trophon*, *Bittium*, *Trichotropis*, *Turritella*, *Solarium*, *Acrilla*, *Scala*, *Dentalium*, *Diplodonta*, *Lucina*, *Astarte*, *Cardita*, *Crassatella*, *Myodora*, *Pecten*, *Ostrea*, *Nemodon*, *Terebratulina*, etc. They amount to about 40% of the whole, and even when reduced by future discoveries, can hardly be imagined as falling below 20%. From this we may safely infer that the fauna can not be younger than the *Middle Pliocene*.

But it is not this high percentage of extinct forms which has struck me most. It is the decidedly boreal character of the entire fauna. The following species are those which point to it:—

1. *Admete viridula.*
2. *Chrysodomus phœniceus.*
3. *Chrysodomus pericochlion.*
4. *Sipho gracilis.*
5. *Trophon clathratus.*
6. *Priene oregonensis.*
7. *Natica clausa.*
8. *Natica pallida.*
9. *Leptothyra amussitata.*
10. *Puncturella conica.*
11. *Corbula venusta.*
12. *Pecten yessoensis.*
13. *Pecten swiftii.*
14. *Leda ramsayi.*
15. *Nucula insignis.*

Trophon clathratus and *Admete viridula* are well known circumboreal species. *Chrysodomus phœniceus* is now found on the coast of British Columbia near 51° N. Lat. and at a depth of 240 fathoms where the temperature of the water is 7°C. *Puncturella conica* is now living only near the Falkland Islands. *Leda ramsayi* is found in New South Wales, but at a depth of 950 fathoms. Also all the others are now living north of Tokyo Bay, and the three species of *Lima* before mentioned, though existing near Central Japan, have never yet been met with in the shallow waters of the coast. Although the boreal forms together with these deep-water ones make up about one-half of the living species, there is not a single one which is limited to the warmer seas. Moreover, the occurrence of such genera as *Trichotropis* and *Astarte* among the new species clearly indicates that the temperature of the waters in which the Koshiba shells had lived must have been a pretty low one.

Now what makes this boreal character of the Koshiba fauna the more important is the less boreal nature of the *Mollusca*[1] of the upper Pliocene found in the immediate neighbourhood of Tokyo, at Oji, Shinagawa, Tabata, etc., which, when compared with the recent, are still boreal enough. From these facts, I am forced to conclude that the climate of Central Japan during the Pliocene Epoch was on the whole *colder than now*, and indeed, *colder in the earlier than in the later part of it.* This is quite in accordance with the conclusion already arrived at by Prof. Nathorst[2] from studying our Pliocene plants. This eminent palæobotanist recognized plants of the said epoch occurring in a rock exposed at the sea-coast near Yokohama and also at Mogi[3] as corresponding to those now growing on our higher mountains and not on the lowlands, as the situation of the fossils would naturally suggest; and although he does not touch the question of the rise of temperature in the course of the Pliocene, he advances the view that the Yokohama plants are probably upper Pliocene and are younger

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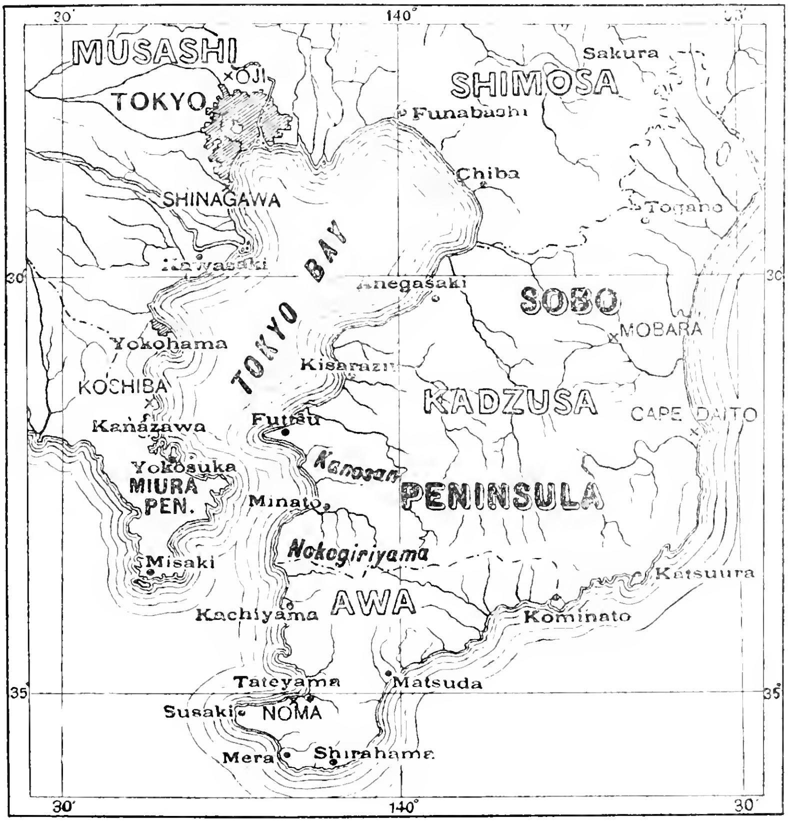
[1] These fossils have been studied by Dr. Tokunaga and the results given in his "Fossils from the Environs of Tokyo," article 2, vol. XXI of this journal. Unfortunately he took them for Diluvial, probably led by the boreal nature of the fossils of the same age in Europe, which can not be, for they contain at least about 10% of extinct forms. Tokunaga himself describes more than 20% of extinct species.

[2] Contribution à la flore fossile du Japon, 1883. Zur fossilen Flora Japans. 1888.

[3] Near Nagasaki.

than those of Mogi, a view which can partly be proved both geologically and palæozoologically.

As soon as I became aware of the above stated increase of temperature, it occurred to me that the so-called *coral-bed* of Noma[1] in the southern part of the Sōbō Peninsula might belong to the succeeding Diluvial age. The bed is a muddy sand filling the valley-bottoms between the hills of the Pliocene rocks and not far from the sea. The fossils consist of large masses of corals mixed with shells and possess a very young looking aspect, on which account they were hitherto supposed—quite vaguely of course—to be Prehistoric. But, as we do not find now such large corals in the neighbouring seas, no one could tell how they happened to be



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[1] Near the town of Tateyama in Awa; latitude 35° N. and Longitude 139° 50′ E.

found there. Therefore I immediately took up the examination of the shells of the bed and was agreeably surprised to find them to be such as can only be interpreted as *Diluvial*, not younger, not older; for, although the thirty-five species[1] which I have been able to distinguish are all living, yet fourteen of them are now living only south of Kyushu—in the China Sea, in the Philippines and the tropical portions of the Pacific and Indian Oceans, etc. Such are

1. *Purpura alveolata* Reeve.
2. *Cuma rugosa* Born.
3. *Triton obscurus* Reeve.
4. *Cypraea carneola* Linné.
5. *Trochus atropurpureus* Gould.
6. *Fissuridea rupellini* Sowerby.
7. *Cytherea tigrina* Lamarck.
8. *Venus lacerata* Hanley.
9. *Venus* cf. *jukesi* Deshayes.
10. *Chama multisquamosa* Gmelin.
11. *Cardita* cf. *gubernaculum* Reeve.
12. *Arca kraussi* Philippi.
13. *Arca fusca* Brugière.
14. *Perna marsupium* Lamarck.

Of the remaining twenty-one species, fourteen are those living in tropical as well as in Japanese seas, while only six are purely Japanese.

As to the corals which are found together with these shells, I have not yet been able to determine their species; but this much is certain that they are true reef-building corals belonging to such genera as *Heliastraea*, *Cyphastraea*, *Prionastraea*, *Mussa*, *Goniophora*, *Stylophora*, *Alveopora*, *Domoseris*, *Madrepora*, several genera of *Fungidae*, etc., all which we do not find now living north of the Ryukyus (the northernmost is 28° 20′ N. Lat.) or of the Bonins (about 27° N. Lat.).

From this we see that we have here a layer which corresponds to the Diluvium of Europe. Just as the latter contains many forms which have since retreated to the north, the Noma

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[1] These will be described in a future number of this journal.

bed contains those which now inhabit tropical seas only. This is an unmistakable sign of the very warm climate which then prevailed in that part of Japan, much warmer than that of to day, for the sea near Noma now cools down to about 10°C, while the minimum temperature of the water in which the reef-corals live is 19°C. Indeed I am quite sure that while the Occident was buried under the heavy burden of ice millions of tons in weight, Central Japan was exposed to the heat of the tropical sun. Beyond in the West, one speaks of the *ice-age;* here in the Far East we can talk only of the *coralline.* Such being the case it is quite natural that geologists should have been unable to find any glacial remains in this part of the world.

It may perhaps be asked whether in Japan there are no beds which are the equivalents of the Interglacials and Postglacials of the West. I think there are. Several years ago I was passing by the town of Mobara in Kazusa situated on the Pacific side of the Sōbō Peninsula and much to the north-east of Noma, when I discovered a sand-layer exposed along the two sides of a stream flowing through a coastal plain at the foot of the Tertiary hills. In this layer I found about sixty species of marine Mollusca all living. Some of these are either tropical or are at least not yet known to exist in the neighbouring seas. Such are *Arca symmetrica* Reeve, *Tapes* cf. *quadriradiata* Deshayes, *Venus* cf. *listeri* Gray, *Eulima solida* Sowerby and *Subemarginula carinata* Reeve. I also examined shells brought from a sand-layer at Cape Daito, somewhat to the south-east of the above mentioned place, and found them to contain, besides one or two tropical forms, a species of *Turritella* which hitherto has been known to occur only in the Koshiba Pliocene. And as these layers contain no such large corals as those found at Noma, they must be considered to be deposits of a time or times in which the climate was much more temperate. This leads us to ask, if they are not *Intercoralline* or *Postcoralline.*[1)]

From all that I have stated above, it follows quite naturally that the temperature in Central Japan has gradually increased

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1) Similar shell-layers seem to occur also on the coast between Noma and Kachiyama.

since the earlier Pliocene, attaining its maximum in the Diluvial and then again decreasing down to the present time. This is, as every one can see, a state of things just the *reverse* of what we find in Europe and America, a singular contrast for which there must surely be a cause.

But before entering into the discussion of this cause, let us go back a little to the Miocene Epoch when Switzerland is said to have enjoyed a climate such as we find now in the southernmost cape of Kyushu (Sata-no-misaki in Osumi with a mean annual temperature of 18°C) and Amami-Oshima (the northenmost of the Ryukyu Islands with 20,8°C). The Japanese fauna of this epoch has not yet been fully studied, but we know something of its plants from the investigations of Nathorst.[1] This palaeobotanist found them to consist of a mixture of the European Miocene and of the so-called Arctic-Tertiary flora, indicating that the climate of Japan, at least between 35° and 40° N. Lat. in which the plants were collected, was not in the least warmer than now. This would naturally lead us to assume that a difference in climate had already at that time existed between Europe and Japan, but that this difference was not so marked as in later epochs. And I think this is quite in accordance with the already known fact that the further back we go into the past, the more uniform the climate becomes throughout the world.

About the Pre-Miocene Tertiary fossils of Japan we do not yet know much. And the few that I myself have lately described[2] are not enough to enable us to draw any conclusion as to the climate of those times.

The phenomena of Nature which have been already set forth as the probable causes of the climatic changes of the past, and especially of the ice-age, are partly astronomical and partly physical. Among the former we may mention the change in the eccentricity of the earth's orbit or in the obliquity of the ecliptic, the precession of the equinoxes, the displacement of the poles and the formation of the smaller planets. Among the latter we may count

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1) Zur fossilen Flora Japans, 1888.

2) Some Tertiary Fossils from the Miike Coal-field; 1911.

the variation of the quantity of carbonic acid gas in the air due to the greater or less frequency of volcanic eruptions and the different distribution of land and water in past times.

Among these supposed causes, those which can be brought into connection with our Coralline Age are only three, viz., the displacement of the poles, the quantity of carbonic acid gas and the distribution of land and water; as for the others, if they were ever real causes, they must have been of a more general character, either affecting the whole earth at once, or at least one-half of it, the Northern or the Southern Hemisphere, and not one-half of the same hemisphere as in our case.

That carbonic acid gas is very effective in keeping the air warm by preventing the too rapid radiation of heat from the ground, is quite true. Therefore, if it is used in explaining the occurrence of our Coralline Age only, it seems to work very well; for we may assume that the volcanic eruptions were quite violent at that time, so many active volcanoes still exist in our country. But then, how can we explain the temperate climate of our Miocene and the cool climate of our Pliocene, when volcanic eruptions were at least equally as violent as in the later times? That such was the case, we know by the profuse occurrence of liparites and andesites and of their respective tuffs containing either Miocene or Pliocene fossils. Have we any evidence that the European Miocene and Pliocene were richer in volcanic eruptions than ours? Can any one prove that the quantity of carbonic acid gas has been increasing in Europe and decreasing in Japan since the Diluvial Epoch? I think this gas, if it ever be used to explain the change of climate in the past, can be more advantageously applied in the case of the Pre-Tertiary or at least the Pre-Miocene period, when the climate of the world was more uniform throughout.

The distribution of land and water also can hardly be said to give a more satisfactory explanation; for the Diluvial was a time in which the configuration of the land was not much different from the present. Looking at our Pacific side, the ocean itself must then have been long in existence, since it is a great geosynclinal, as the geologists call it, whose formation is said to go back at least as far as the Mesozoic. Then the American and the Asiatic coast-regions, Japan, Formosa, the Philippines and even the greater part of the Ryukyu Islands were already in a form very nearly as we see them to-day. And if any one expects to find out any great change in the form of the land, it would be just at the head of the Tokyo Bay. This place is coloured in our geological maps as Diluvial which, if marine, would transform the Sōbō Peninsula at that time into an island. But what is here called Diluvial is a thick layer of subaerial loam evidently derived from a volcanic ash which had fallen on the preexisting land made up of Pliocene strata. From this we know that, in the Diluvial Epoch, the topography of the region surrounding the Tokyo Bay was not much different from what we see at present.

It is a well known fact that ocean-currents exercise a great modifying influence on the climate of a country near which they flow. And as the Kuroshio[1] flows just south of the Sōbō Peninsula, one might think that by a little change of its course, it might come to wash the shores of the Peninsula, thus raising the temperature of the water to a degree sufficient to fit it for the growth of the reef-corals. But such a change in the course of the current can never have been brought about without a marked change in the configuration of the surrounding countries. Those who look only on maps and are not well acquainted with actual meteorological conditions are easily misled by the proximity of the Kuroshio and over-estimate its warming power on our country. One must always bear in mind that in winter in Japan a cold wind sets in from the Asiatic continent either as a north wind or a north-west wind, which not only cools down the land to a temperature quite low in comparison with its latitude, but also prevents the warm air floating over the Kuroshio from ever approaching it and even causes the current itself to deviate a little to the south. Therefore the warming power of this current at this season is reduced to a

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1) Kuroshio means black current or black salt-water, and not black salt as often translated in European books. This mistake is undoubtedly due to our shio 鹽 salt and shio 潮 salt-water being phonetically the same, though different in written characters. Another name for Kuroshio is Kurosegawa which signifies *dark rapid river*.

minimum, and if there is any influence from it, as Prof. Schott rightly remarks,[1] it would be on the Japan Sea side, where flows a branch stream along the coast whose influence, however, is of course much weaker and only limited to that side. As the result of this cooling power of the wind on the land, the waters of the immediate neighbourhood of the coast are also cooled down, often to about 10°C as has been already mentioned. Also we must not forget to mention that, except in midsummer, there is always a counter-current intervening between the coast and the Kuroshio which is taken by Schott for its backset, but which from its comparatively low temperature was formerly even thought to be a southern continuation of the cold *Kurile Current* which comes down at least to the north-eastern shores of Honshū. Under such circumstances it would be impossible to attribute a *specially warming* power to the current just for the Diluvial age. But supposing that we can do it for some reason or other, can we then attribute a great *cooling* power to the Gulf Stream which now exercises such a great influence on the climate of Western Europe, simply because there was an ice-age on that side of our Northern Hemisphere? It goes without saying that such an arbitrary way of explaining things is of no value at all in science.

Accordingly only one cause remains, viz., the displacement of the poles or, as it may perhaps better be expressed, a change in the position of the earth's axis. This is, I believe, the most plausible explanation in a case like ours.

Neumayr[2] in 1887 and Nathorst[3] in 1888 already attempted to explain the curious geographical distribution of the Arctic-Tertiary flora of the Miocene period by this change of the earth's axis. The plants of this flora which betray a rather temperate climate of 8°—10°C in the yearly average, a climate roughly corresponding to that of our Southern Hokkaido, were found in Grinell Land (81° 45′ N.L.), Greenland (70° N.L.), Spitzbergen ($77\frac{1}{2}$ and $77\frac{2}{3}$ N.L.), the Lower Lena (65° N.L.), the Lower Amoor

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[1] Oberflächen-Temperaturen und Strömungen der ostasiatischen Gewässer, p. 45.

[2] Erdgeschichte II. p. 511.

[3] Zur Fossilen Flora Japans, p. 53.

(Bureja), Sakhalin (51° N.L.), Kamtchatka, Alaska, etc., forming so to say a wreath around the present North Pole, but far nearer to it on the Atlantic side than on the Pacific. Neumayr wished to bring the pole ten degrees nearer to the Asiatic side on the meridian of Ferro, while Nathorst increased the displacement to twenty degrees on the meridian of 120° E. long., which would bring the position of the suppósed North Pole in the lower region of the Olenek just west of the Lower Lena. Nathorst also sought to account for the smallness of the leaves of the fossil plants found at Lena by the proximity of the pole and the temperate character of our Miocene plants, which according to him contain not a single element which points to a climate warmer than the present. But Neumayr in the second edition of his Erdgeschichte[1] seems to be inclined to renounce his former assumption, because of the discovery of ordinary Arctic-Tertiary plants in one of the New Siberian Islands which are not far off from the supposed North Pole of Nathorst.

Now, if I may be allowed to express my own opinion on the above subject, I would say that it is not at all necessary to fix the position of the pole so as to make it as equidistant as possible from the various fossil localities. It may as well be taken as lying more to the east, nearer to a meridian passing through the Bering Strait. In saying this, however, I am by no means trying to establish the position of the Miocene pole. On the contrary, I think it is very difficult to locate this, because the distribution of land and water was then very different from what it is to-day. Furthermore, other factors which determined the geographical distribution of plants at that time are utterly unknown to us. Therefore I simply say that the North Pole may have been then in a different position from now, but that the data, now at our disposal, are too scanty to justfy us even in guessing at it.

The case becomes different in the succeeding ages. Here the climatic contrasts in the East and the West are very strong, and always in such a way that when it is cold on one side it is warm

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1) Vol. II, p. 385. 1895.

on the other, and vice versa. This, I think, can only be explained by the movement of the poles to and fro. We may assume that during the earlier Pliocene, the North Pole was more to the Asiatic side. Then it began to move to the Atlantic side until the Diluvial, when that side fell into ice-age and the Asiatic side into coralline age; after that it may be taken as having made a backward movement, that is to say, back again to the Asiatic side. So far as I know, this mode of explanation meets with no serious objection. Therefore, if theories are made to explain a phenomenon whose cause is unknown, and if, among these theories, the one which explains it in the easiest and most unconstrained way is the most plausible, then *the movement of the poles to and fro* must be regarded as the most plausible explanation of the climatic changes of the Northern Hemisphere since the Pliocene Epoch.

It is a singular coincidence that Prof. Simroth of Leipsic, led by a peculiar geographical distribution of the organisms in the present creation, had already tried to explain it also by the so-called "Theory of the Oscillation of the Poles," first propounded by Reibisch to account for the displacement of the beach-line. In this theory,[1] the North and South Poles are made to swing to and fro on the meridian of 10° E.L. which corresponds to 170° W.L. on the Pacific side, a line just passing through the Bering Strait. This meridian has been called by Reibisch the *circle of oscillation*. Now Simroth had recognized a more or less symmetrical distribution of similar or vicarious forms either east or west of this circle or, if under the same circle, north and south of the equator. The first is called by Simroth the *transversal symmetry*, and is said to be caused by the organisms diverting to the east or the west as the quickest means of evasion of the approach of a pole or of the equator. The second is called by him *meridial symmetry*, and is thought to be caused by organisms on the approach of the equator, climbing up high mountains on which they can wander south and even cross the equator beyond which they can again come down to the low-land, where the climate is suited for their existence. As

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[1] Simroth. Die Pendulationstheorie, 1907.

examples of the transversal symmetry he mentions, among others, the occurrence of the *giant salamander* in Japan and of *Menopoma* in the United States, of the genus *Alligator* in China and America, of *Ceratodus* in Queensland and of *Lepidosiren* in South America, etc. Of course it is not my object here to reproduce all the details given by Simroth in his book. I only mention them to show how this eminent naturalist was led to assume the movement of the poles from the distribution of recent organisms, just as I have been led by that of the fossils.

Lastly, it may perhaps be asked: If the poles ever moved, in what position were they during the Japanese Coralline Age? To such a question, I can only say that I have found only enough evidence to suggest the movement of the poles and no more. I even doubt if palaeontologists will ever be able to establish the position of the poles in the past by simply studying the fossils. Therefore, let it suffice for me to say that during our Coralline Age, the poles were in such a position as to cause the sun to shine on the Sōbō Peninsula with about the same intensity as it now shines at least on the Ryukyus or the Bonin Islands.

PLATE I.

Explanation of the Plate (I).

Some of the Noma Fossils.

Fig. 1.	Heliastræa sp. $^1/_5$ nat. size.
Fig. 2.	Do. A fragment in natural size.
Fig. 3.	Madrepora sp. A fragment.
Fig. 4.	Perna marsupium Lam. (Tropical species).
Fig. 5.	Cypræa carneola Linné. (Tropical species).
Fig. 6.	Cytherea tigrina Lam. (Tropical species).
Fig. 7.	Triton obscurus Rve. (Tropical species).
Fig. 8.	Arca fusca Brug. (Tropical species).
Fig. 9.	Triton costatus Born. (Tropical and Japanese species).

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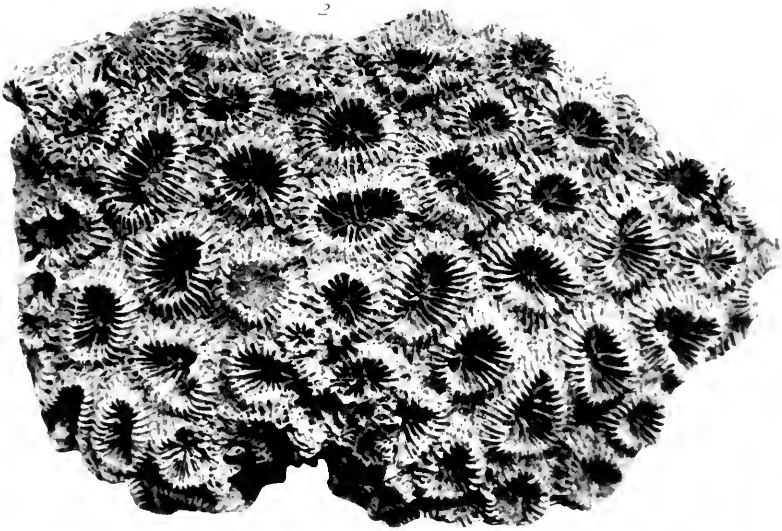

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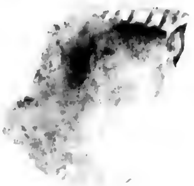

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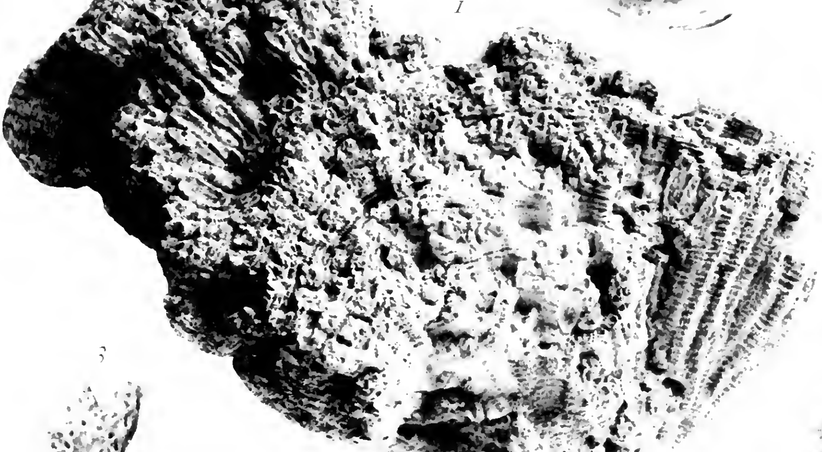

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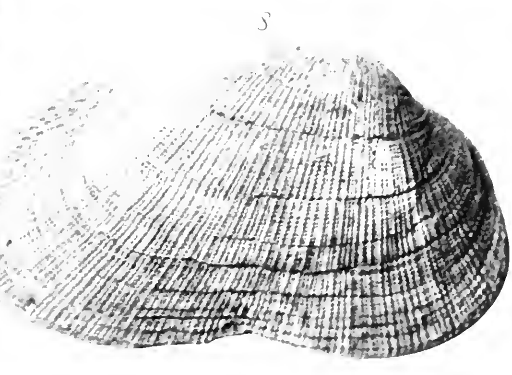

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M. Yokoyama: Noma Fossils.

JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY,
TOKYO, JAPAN.
VOL. XXXII., ARTICLE 6.

On Nepheline-basalt from Yingé-mên, Manchuria

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With 2 Plates

The present short paper deals with the first genuine occurrence, so far as I am aware, of nepheline-basalt in the Koreo-Japanese and Chinese regions. For this reason it may be of some interest to petrologists, who seem at present to attach special importance to any new find of feldspathoid rocks in the subalkaline circum-Pacific region.

It is the current opinion that the "Pacific region" is characterized by the predominance of subalkaline igneous rocks in contrast to the alkaline rocks of the "Atlantic region"[1]; but as there are many exceptions in the latter, so we find alkaline rocks also in the former; and these apparently aberrant forms seem to be increasing in number, as our petrological knowledge of their distribution in the "Pacific region" by degrees accumulates.

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[1] W. Cross in his recent paper seems to discredit broad generalizations concerning the genetic relations and regional distribution of igneous rocks, termed the Atlantic and Pacific kindred. After closely examining the existing analyses of the Hawaiian lavas, he was forced to the conclusion that "the Hawaiian magmas tend to show that the generalizations as to geographic distribution or the genetic relations of the *alkali* and *subalkali* groups included in current definitions of the *Atlantic* and *Pacific branches* or *Sippen* are far from correct. Hence in their present form they can have no place in a petrographic system." Whitman Cross, "The Lavas of Hawaii and Their Relations." *Jour. Washington Acad. Sci.*, vol. 1, No. 3, August, 1911. How far Becke's view on the *Sippe*, endorsed by Harker, can withstand the criticism of age, I cannot tell now. (*Added while in press.*)

Referring mainly to the western Pacific, Wichmann[1] long ago made known a melilite-nepheline basalt from Oahu in the Hawaiian Islands, and Cross[2] has acquainted us with the occurrences of a trachyte (acid phonolite) and a nepheline-basalt from one of the same island group. Alkaline rocks are said to occur in Tahiti, in the Viti Archipelago, and also in Timor[3]; while leucite-basalts are found in Java[4], in the southern Celebes[5], and also in Masbate, one of the Philippine islands[6]. A limburgite is known in the Samoa group, and a nepheline-basalt in the Caroline islands[7].

* * *

As to the alkaline rocks of Japan, I noticed some fifteen years ago[8] an allied rock from the Nemuro headland at the east end of Hokkaidô, where it is said to occur in the terrane of the Cretaceous. In 1907, I found the same kind of rock occurring in the Shirétoko promontory in Japanese Sakhalin, making a sheet or dyke in the coal-bearing Tertiary. Lately I have received dioritic-looking specimens, sent by Déguchi, from Tendai-san, in the islet of Hattaku-tô, in the Pescadores, and from Reisuikô near Taihoku, Formosa. They all proved to be the same kind of rock as that above mentioned. These are doleritic both in mineralogical

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[1] *Neues Jahrbuch f. Min.* etc., 1875, p. 172.

[2] *Jour. Geol.*, vol. xii., 1904, p. 510.

[3] R. Daly, "Origin of the Alkaline Rocks." *Bull. Geol. Soc. Amer.*, vol. xxi., 1910, p. 105.

[4] Verbeek et Fennema, "Description géologique de Java et Madoura," 1896.

[5] Harker, "Natural History of Igneous Rocks," p. 98. Details are given in W. Bücking, "Leucitbasalt aus der Gegend von Pangkadjene in Süd-Celebes." *Berichte d. Naturforsch. Gessel. z. Freiburg i. Br.* Bd. XI. Heft 2, 1899.

[6] Iddings, "The Petrography of Some Igneous Rocks of the Philippines." *Philippine Jour. Sci.*, section A. (1910) 5, p. 164.

[7] Harker, *loc. cit.*, p. 98. M. Weber recently acquainted us with the occurrences in the Samoa group, of an alkali-trachyte, phonolite, trachydolerite, nepheline-basalt and nepheline-basanite besides the usual plagioclase-basalt and andesite. *Abh. k. Bayr. Akad. d. Wiss.* II. Kl. 24. II. Abt. 1909, S. 290–310.

[8] "Notes on the Geology of the Dependent Islands of Taiwan." *Jour. Coll. Sci. Imp. Univ.* Tokyo, vol. xxii., p. 44.

composition and texture, the cuneiform spaces left by fresh, polysynthetic tabular plagioclase being filled up with analcime. They may be analcime-diabase (basalt) or teschenite, and seem to be akin to those of California, described by FAIRBANKS[1], and many others. Since I could not examine the mode of their occurrence, and also as I was unable to find a sure trace of either nepheline or leucite, I have simply left them undescribed. A short description has, however, already been given of the *analcime-basalt* of the Pescadore group (Hôko-tô) in Taiwan[2].

Three years ago, I found in a Geological Survey specimen from the islet of Matsushima, Kyûshû, a rock resembling an aegirine-trachyte on which Kôzu[3] has very recently given a preliminary note. It is a grayish, trachytic-looking laurvikose soda-trachyte with calcium-bearing anorthoclase. The alkali-feldspar-bearing basalts from northern parts of Kyû-shû are also brought to our notice by the same writer[4]. What seem to be barkevikite-bearing rhyolites or andesites, I have several times observed from Kôdzu-shima, one of the Idzu islands, and also from the islet of Kôtô-sho (Botel-Tobago), Taiwan. From the above brief account, which might be multiplied if careful search were made, we see that even alkaline effusives of basic and acid natures are by no means rare in Japanese islands.

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1) "On Analcite-diabase from San Luis Obispo County, California." *Bull. Geol. Depart. Univ. Cal.*, vol. I., p. 273. I am always watching with keen interest the progress on the knowledge of the Miocene analcite-diabase (augite-teschenite or basalt) of California by American writers. If there is any thing which may be called a petrographical province, it is this very rock-group which unites both sides of the North Pacific. There are, as it is already stated, many localities in Japan where the so-called analcime-diabase occurs in dykes or sheets, and one of the allied rocks is the "don" which produced natural cokes by its contact action in many collieries in northern Kyûshû. The most interesting point in the studies of these rocks centers in the presence of analcime which was at one time supposed to be derived from *nepheline*, and at other times from decomposition of labradorite. The latter view is, I think, still entertained by L. Haehl and R. Arnold. (*Proc. Philos. Soc.* vol. XLIII. No. 175.)

2) Kotô, *loc. cit.*, p. 12.

3) Preliminary Notes on Some Igneous Rocks of Japan." I. *Jour. Geol.*, vol. xix. 1911, p. 555.

4) "Preliminary Notes etc." III. *Loc. cit.*, p. 566.

We have as yet scarcely any information respecting the alkaline rocks in China and the lands adjoining that part of the continent. But so far as the writer's knowledge of them goes, the granitic rocks on the southern border of the Mongolian plateau, extending from In-shan to Manchuria (*Iwulü-shan*), are mainly of a reddish, coarse-aplitic, *microcline*-rich variety[†]. The same group which is often mylonitized, forms the foundation of the Koreo-Manchurian highland in contrast to the granodiorites which are prevalent in Japan. A nepheline-syenite is said to occur in southern China[1]. I have a specimen of riebeckite-granite from a quarry near the city of *Foo-chou*, in the province of *Fokien*.

As to *effusives*, lack of knowledge is also deeply felt here. It is well known since the explorations of R. Pumpelly[2] and the late von Richthofen[3] that basalt is widely distributed over the southern Mongolian plateau as the counterpoise of the vast basaltic mesa of the east Koreo-Manchurian landmass. P. Vénukoff[4] gave a description of Mongolian basalts[5] collected at several widely separated localities by the celebrated travellers, M. Potanin, and General Prejevalsky. They all proved to be plagioclase-basalts, and no mention was made of any feldspathoid variety. However, in this connection it may be of special interest to cite from the paper referred to, the occurrences of tachylite and limburgite, with the chemical analyses made of them:

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†) The so-called gneiss that built up the core of the Tsin-ling Shan range, lying to the south of the city Si-nan Fu (西安府), the well-known ancient capital, is found, on microscopic examination, to be a sheared modification of this variety.

1) R. Daly, *loc. cit.*, p. 103.

2) "Geological Researches in China, Mongolia, and Japan." *Smithsonian Contribution Publication*, 1886.

3) "China."

4) "Les roches basaltiques de la Mongolie." *Bulletin de la société Belge de géologie de paléontologie et d'hydrologie*, Bruxelles, tome II., 1888, p. 441.

5) According to V. A. Obrutschew ("Central Asia," I.), there is a large basaltic field, 500 *m* thick near Kalgan. resting on a great thickness of loose conglomerates and sandstones, belonging to the Gobi series—the fresh-water Tertiary with *Rhinoceros*—with trachyte at its base. There is another large basaltic area in Mergen in northern Manchuria.

	Tachylite du lac *Kyry-nor*[1], 41° lat., 83° long.	Limburgite du lac *Dolog-nor*[2], 43° 25′ lat., 86° 30′ long.
SiO_2	49.37	41.69
Al_2O_3	17.67	14.85
Fe_2O_3	6.28	10.39
FeO	4.81	5.43
FeO_2	0.28	——
CaO	9.12	11.20
MgO	5.02	9.84
Na_2O	3.27	3.71
K_2O	1.41	1.05
H_2O	2.15	1.06
	99.38	99.32
Sp. Gr.	2.522	2.851

To mention the only remaining locality, an occurrence of a nepheline-basalt was cited by A. LANICK[3] from *Yang-shan*, which lies to the west of the town of *Wei-hsien* in *Kiau-chau*. It is an amygdaloidal rock in which nepheline is present not in the form of crystals, but as a leptomorphic mesostasis. So much for our present knowledge of the alkaline rocks within the western Pacific territory.

Localities of the Manchurian Nepheline-basalt.—It may not be out of place here to remark briefly on the region in which the present nephline-basalt is found. So far as I know, it is the first occurrence in Manchuria of this kind of rock ever recorded in petrographical literature. As the region is entirely unknown to the

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1) *Kir-nor?* (lake), 2 degrees west of *Kalgan*. The longitude is probably referred to a Russian meridian.

2) *Dalai-nor?* lying to the N.N.E. of *Dolon-nor* (Lama-miau).

3) "Beitrage zur Petrographie von West-Schantung." Inaugural-Dissertation, Leipzig, 1908, S. 32.

outside world, a few lines may be proper to serve as an orientation of the localities of my find.

During my seven months' journey last winter through Manchuria and Korea, I happened to pass over a water-shed (Pl. I. *fig.* 1) of the *Sungari* and the *Hun-ho*, the latter being a tribuary of the well-known *Liau-ho*. I struck the road1) leading southwestwards from the city of Kirin2) to *Mopan-shan*3), and then to the intermontane plain of *Shan-chêng-tzu*4), a fertile and populous flat on one of the upper courses of the *Sungari*, drained by a large tributary, the *Hui-fa*5). Following the river course upstream in flat land and diviating from the high road (Pl. II.) to *Kai-yuan*6), I rode directly south to a very low and lonely snow-clad water-shed, and at the end of December last, came down to the source of the *Hun-ho*7), which I followed downstream southwestwards as far as *Mukden*.

On the south of the above-mentioned granitic water-divide on the low spur of a hill, called the *Nien-yü-ling*3) pass, is located the noted ancient *Gate of Yingé-mên*4) in the long palisade, now ruined, which runs through the heart of the Manchurian hinterland. It is 200 kilometers from *Kirin*, and 140 from *Mukden*.

The "*Yingé-mên area*" with all the surrounding districts is an elevated granite peneplain of 490 *m*., flanked on the east by the overlying volcanic mesa of common basalt 150 *m*. thick, and limited on the west by *hills* of *nepheline-basalt* (Pl. I. *fig*. 1) which poured out probably at the junction of the microcline-granite and the Lower

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1) In Stieler's Hand-Atlas, No. 65, and Debes' Hand-Atlas, No. 44, the region is very imperfectly represented. The best maps ever published in Europe and accessible to general readers are *Karte von Ost-China*, scale 1 : 1,000,000, Berlin, Sheet Mukden, and Paul Langhan's *Neuere Tageskarte von Ost-Asien*, scale 1 : 5,000,000, Gotha.

2) Properly speaking the name is *Chi-lin*, and the people call it *Chuang-chang*. Kirin is the anglicized name, just as Mukden stands for *Fêng-tien*.

3) 磨盤山 4) 山城子 5) 輝發 6) 開原 7) 渾河
8) 年魚嶺 9) 英額門

Cambrian and Tertiary terranes. *The present paper deals with this nepheline-basalt.* It was impossible for me to ascertain exactly the mode of occurrence of the basalt in my hasty journey through the snow-covered region in the cold Manchurian winter with the mercury at −36°C; and moreover the presence of nepheline in the basalt was discovered only after I had reached home and was able to examine slides of the rocks collected during my trip. The age-relation between the more basic, sodic nepheline-basalt on the west and the calcic plagioclase-basalt on the east was not ascertained, but the former is probably older than the latter. This may be conjectured from the incised character of the topography resulting from denudation; while the common basalt on the east builds up a long monotonous mesa (*Chang-kang*[1]) with sharp escarpment. (Pl. I. *fig.* 1.)

One specimen was struck at *Tsao-shih-err*[2] (Pl. II.) in the upper *Shan-shêng-tzu* plain, at the forking of the road to *Kai-yuan* and *Yingé-mên*, and another specimen was picked up quite by chance by H. Murakami in the gravelly bed of the *Hun-ho* river near the already-mentioned *Yingé-mên* gate. The geology of the "*Yingé-mên area*" is roughly indicated in the annexed sketch map (Pl. II.).

The *geologic formations*, cartographically represented, are as follows:

1) The flesh-red, coarse-aplitic, microcline-rich orthogneiss (γ), greatly mylonitized, forming the basement of the overlying complex.

2) Diorite (δ), probably a differentiation-product of an alkaline granitic magma, No. 1. It is a grayish, medium-grained quartz-diorite, composed of short prismoids of deep greenish-brown hornblende, and bent lamellæ of oil-brown biotite, besides plagioclase with the characteristic zonal structure. Quartz fills

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(1 長崗 2) 草市兒 In Plate II. it is erroneously spelled *Tsaoshiêr*.

up angular spaces, or forms myrmekitic bodies with the plagioclase. Locality: Nien-yü-ling.

3) The Middle Cambrian limestone (Ꞓa) and the Lower Cambrian red breccia (Ꞓ). The latter is a rather fine, grayish and reddish variegated breccia, consisting of subangular fragments of microcline and quartz, plagioclase and orthoclase, and lastly, melaphyre, cemented with reddish granitic sand and calcareous matter. The breccia contains slightly pinkish, flattened marly nodules of the size of 4 to 8 *cm.* with a thickness of $1^{1}/_{2}$ *cm.*, with no trace of organic structure. Locality: Hsiao-mai-pu-tzu.

4) The Miocene Tertiary (t) of the type of the Mu-shun colliery, composed of shales and medium-grained gray sandstone with a poor seam of coal.

5) Plagioclase-basalt (β_1).

6) Nepheline-basalt (β_2). Locality: Yingé-mên and Tsaoshiherr.

7) Alluvium (a).

Nepheline-basalt

Composition: Essential: Augite, nepheline, olivine.
Accessory: Magnetite, titanomagnetite, picotite.

Accessory part: Base.

Macrotexture: Compact with minute phenocryst (less than 1 *mm.*) of olivine.

Microtexture: Holocrystalline with a few patches of brown base, microporphyritic.

Macroscopically, the rock appears uniformly grayish-black, and is heavy and aphanitic, though, strictly speaking, finely granular. It is sometimes crumbly, falling into dull, polygonal, incoherent coccolitic clods on a slightly weathered portion, which character seems to be a special feature of this rock. There occur in the general mass glittering flecks (0.9 by 0.3 *mm.*) of olivine with conchoidal fracture and vitreous luster, seen only by reflected light. The rock weathers into an ash-gray earthy mass with brown limonitic spots of decomposed olivine projecting from the general ground.

Macroscopically, the rock is hypocrystalline, varying in degree from percrystalline to docrystalline; and microcrystalline in crystallinity and ranging in size from decimillimeter to micron in granularity; it has inequigranular, prismoid (augite) and equant (nepheline), diverse and seriate (augite, nepheline) fabric. As in all basaltic rocks, the olivine is of a relatively large size as compared with the other constituents of the groundmass. So the fabric may properly be called seriate-porphyritic. On account of the isometric habitus of the microphenocrysts of both the augite[1] and the olivine, the texture of the rock is orthophyric, showing no signs of fluidal arrangement of components. The rock probably crystallized out from an undisturbed magma. (Pl. I. *figs.* 1 and 2.)

Titanaugite is a dominant ingredient occurring in the form of microlite of variable size, the largest being 0.17 *mm.* long and 0.037 broad. The larger ones, rarely seen in slides, are anhedral and tabular with the cleavage-plane toward (011); the smaller ones, on the other hand, are microlitic and euhedral. The extinction of the former on (010) is 43°41′ toward the obtuse angle. The color is yellowish-brown with a tinge of violet-green, and then zonally colored, the interior being of a violet shade; non-pleochroic, the polarization-color being a grayish-yellow of a low order. The crystals are often transversely cracked, and are full of air-pores

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[1] The larger anhedra are *not* seen in the photomicrographs, Pl. I. *figs.* 2 and 3.

and granules of magnetite. Next in abundance is *iron-ore*, which occurs in octahedra or clumps, peripherally changing into leucoxene (titano-magnetite).

Nepheline is the characteristic ingredient occurring in short prisms, the basal section of which is hexagonal and the longitudinal section rectangular. These colorless crystals (the largest being 0.13 by 0.11 *mm.*) occur in large quantities (30% of the volume) and are fresh with a vitreous lustre; they enclose rounded augite-microlites arranged parallel to the contour of the host—a characteristic habitus by which the presence of nepheline can be easily recognized. Through atmospheric decomposition the mineral substance becomes parallel-fibrous by zeolitization along the vertical axis, and in basal section the change is seen advancing from the periphery. Low polarization-colors and other optical behaviors are normal. With HCl and methylviolet the mineral is easily ascertained by the staining method.

Olivine.—The minutely porphyritic or minophyric phenocrysts of olivine of variable size (usually less than 0.8 *mm.* by 0.5) occur abundantly in euhedral or corroded subhedral shape, and occasionally in glomeratic clusters. It often changes into a yellowish or greenish fibrous substance, from which it may be inferred that it is of a variety rich in magnesia. The olivine is colorless in section, and encloses copious octahedra of *brown spinel.* Polarization-colors are indigo-blue, purple, brown, and gray according to the thickness and orientation of given sections.

No sanidine or any other feldspars are present. *Apatite* is also absent. Sporadic patches of a brownish *basaltic base*, granulated and sometimes fibrous, fill up the interspaces left between the idiomorphic nepheline[1], and the overcrowded augite-microlites

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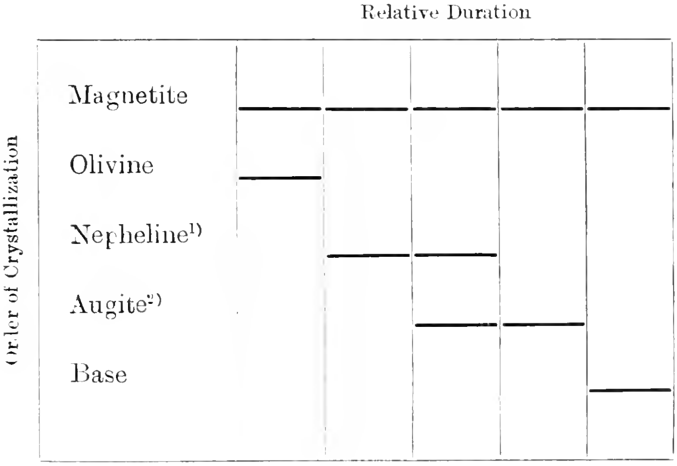
1) For example, around the hexagonal section of nepheline, Pl. I. *fig.* 2.

swim in this scanty base, being rudely arranged tangentially around the nearly isometric crystals (see Pl. I. *fig.* 3) of nepheline, thereby producing the appearance of a leucite-melilite rock.

The rock is nearly holocrystalline, a variety typically rich in nepheline and simple in mineralogical composition. If the nepheline were absent, the mineralogical composition of the rock would correspond to a limburgite, to which the texture has a close resemblance, as may be seen in the photomicrographs, Pl. I. *figs.* 2 and 3. The order of crystallization of the rock-components is shown in the following scheme:



The chemical analysis of the rock from *Tsao-shih-err* was undertaken by Messrs. S. Shimidzu and T. Ohashi, of our Geological Survey, to whom I would acknowledge my indebtedness. The result is given below:

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[1] Two generations.

[2] Two generations (not seen in the photomicrograph). In the older and larger ones crystals of nepheline are poikilitically enclosed in the substance of augite (0.6 *mm* long) which sometimes suffers magmatic corrosion. The augite is so fully stuffed with octahedra of magnetite that the whole presents the appearance of some rhönite crystals, though the substance of the host is here pyroxenic.

SiO_2	44.98%
Al_2O_3	15.56
Fe_2O_3	5.15
FeO	7.30
MgO	3.31
CaO	9.20
Na_2O	5.34
K_2O	1.29
H_2O	3.77
TiO_2	2.89
P_2O_5	0.43
MnO	0.23
S	0.04
Total	99.49

Norms.	
Orthoclase ($K_2OAl_2O_36SiO_2$)	7.8
Albite ($Na_2OAl_2O_36SiO_2$)	23.1
Anorthite ($CaOAl_2O_32SiO_2$)	14.6
Nepheline ($Na_2OAl_2O_32SiO_2$)	11.9
Diopside $\left\{\begin{matrix} CaOSiO_2 \\ MgOSiO_2 \\ FeOSiO_2 \end{matrix}\right\}$	23.0
Olivine $\left\{\begin{matrix} 2MgOSiO_2 \\ 2FeOSiO_2 \end{matrix}\right\}$	1.4
Magnetite ($FeOFe_2O_3$)	7.4
Ilmenite ($FeOTiO_2$)	5.5
Apatite ($3CaOP_2O_5$)	1.0

Sp. Gr. 2.947—2.950.

From the ratios expressed by the above norms, our rock finds its final position in the C.I.P.W. quantitative system, as in the following[1]:

$$\frac{\text{Sal}}{\text{Fem}}=\frac{57.4}{38.3}<\frac{5}{3}>\frac{3}{5}$$ Class III. Salfemane.

$$\frac{\text{L}}{\text{F}}=\frac{11.9}{45.5}<\frac{3}{5}>\frac{1}{7}$$ Order 6. Portugare.

$$\frac{K_2O'+Na_2O'}{CaO'}=\frac{100}{53}<\frac{7}{1}>\frac{5}{3}$$ Rang 2. Monchiquase.

$$\frac{K_2O'}{Na_2O'}=\frac{14}{86}<\frac{3}{5}>\frac{1}{7},\text{or}<\frac{5}{3}>\frac{3}{5}$$ Subrang 3–4. Shonkinose-Monchiquose.

In sampling the material for the chemical analysis, all the necessary precautions were taken by the writer. The analytical result shows near approach to that of the basalt from Franklin Island, Antarctic. The Manchurian rock has, however, a

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[1] Calculations made by Kôzu.

specific peculiarities worthy of note, showing exceptionally high percentages in CaO, and H_2O. Microscopic volumetric analysis made with J. Hirschwald's planimeter-ocular showed 30 per cent of nepheline and nearly 15 per cent of olivine, the latter value being only approximative, due to the phenocrystic habit and irregular distribution of the crystals in the microscopic field (Pl. I. *figs.* 2 and 3).

The presence of large amounts (45.5%) of feldspars, as they are expressed in the above norms, is to my mind a paradox, as basaltic glass is scantily present in the rock in which at least the feldspar molecules must be assumed to exist. Otherwise they must be looked for in the composition of nepheline.

The *chemical composition of nepheline* has long been a problem much discussed among mineralogists. Lately FOOTE and BRADLEY[1] have offered an explanation, namely, that a substance on crystallizing may form "a solid homogeneous solution with foreign matter," and that the mineral nepheline consists of a pure compound, probably $NaAlSiO_4$, with a varying amount of dissolved silica. Very recently, W.T. SCHALLER[2] has proposed still another explanation, *viz.*, that the mineral nepheline is an isomorphous mixture of the compounds crystallizing in the hexagonal modification, which are $AlNaSiO_4$ (essential component), $AlKSiO_4$ (kaliophilite), and $AlNaSi_3O_8$, the last being only in mixture in nepheline, and being best known in its triclinic form as albite. He says "the remarkable fact that the compound $KAlSiO_4$ is always present to the extent of about 20 per cent has as yet received no adequate explanation." The albite molecule in nepheline, however, varies from 5.6 to 10.6 per cent. At all

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[1] "On solid solution in minerals with special reference to nephelite." *Amer. Jour. Sci.*, 4th ser., 31 : 25. 1911.

[2] "The chemical composition of nephelite." *Jour. Washington Acad. Sci.*, Vol. I. No. 4, September, 1911, pp. 109–112.

events, the feldspars in the norms seem to enter largely into the composition of our nepheline. A portion of water may be present in combination with zeolitized products of the nepheline.

The present rock is a simple unique nepheline-basalt in regard to its mineralogical components. As it seems to me the present rock is neither a plutonic nor a dyke-rock, I cannot call it a shonkinite nor a monchiquite. Moreover, the essential attribute of alkali-feldspar is wanting in the Manchurian rock as to be classed among the former, and a brown biotite and barkevikitic amphibole is not present so as to be included among the latter. But I learn from petrological literatures that each of both rocks assumes various phases of crystallinity even within the same mass, extended researches of our Manchurian rock are necessary in regard to its geognostic relation and chemical composition in order to give the final decision as to what species it belongs. Since, however, in mineralogical composition and in appearance, it is most closely related to nepheline-basalts, it is here referred to that group. It is a noteworthy fact, especially in regard to the Sino-Japanese region, that up to the present time no leucite-rocks have ever been recorded from north of the Philippine islands.

My thanks are due to Mr. Swift, of our University, for reading through my English manuscript.

December, 1911.

B. KOTÔ:

NEPHELINE-BASALT FROM MANCHURIA.

PLATE I.

PLATE I.

Fig. 1.—View southwards from Tsaoshiér (Pl. II.) toward the low granitic water-shed of the Nien-yü-lying pass, which separates the waters of two mighty Asiatic rivers; the rivulet running toward us is the upper course of the Hui-fa river, a tributary of the Kirin-ula, which ultimately joins the great Amur; while the valley beyond the water-parting is the source of the Hun-ho, which runs southwestwards to meet the well-known Liao-ho. The plain in the foreground is an elevated granite peneplain of 490 *m*, flanked on the east (left) by an overlying mesa (*Chang-kang*) of common basalt, 150 *m* thick, and bounded on the west by denuded hills of the nepheline-basalt which is the subject of the present paper. (Page 6.)

Fig. 2.—Nepheline-basalt from Tsaoshiér, magnified 260 diameters, set in with a large anhedron of olivine (on the left) and a basal hexagonal section of nepheline with zonally arranged prismoids of augite. The groundmass is a plexus of short prisms of nepheline, prismoids of augite, and minute speck-like crystals and clumps of titanomagnetite, floating on sporadic brown patches (on the left of the hexagonal section of nepheline) of basaltic base. (Pages 9–10.)

Fig. 3.—The same, magnified 130 diameters, showing the general appearance of the diverse, seriate fabric of the rock under weak powers. (Pages 9 and 11.)

Fig. 1.

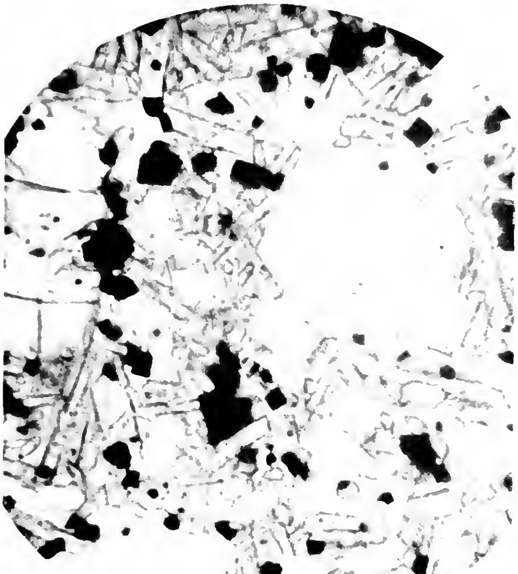


Fig. 2.

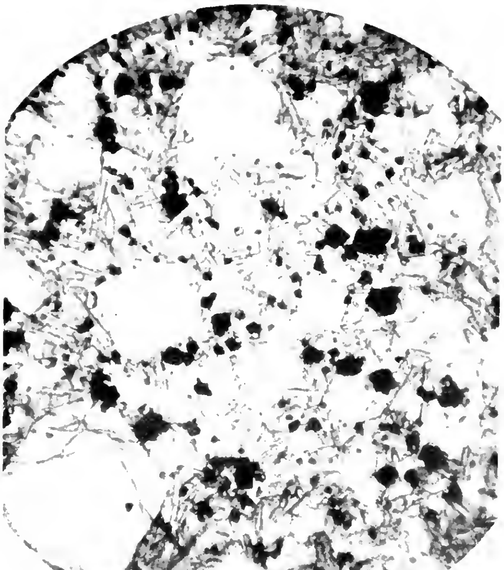


Fig. 3.

Author, Photo.

B. KOTÔ:
NEPHELINE-BASALT FROM MANCHURIA.

PLATE II.

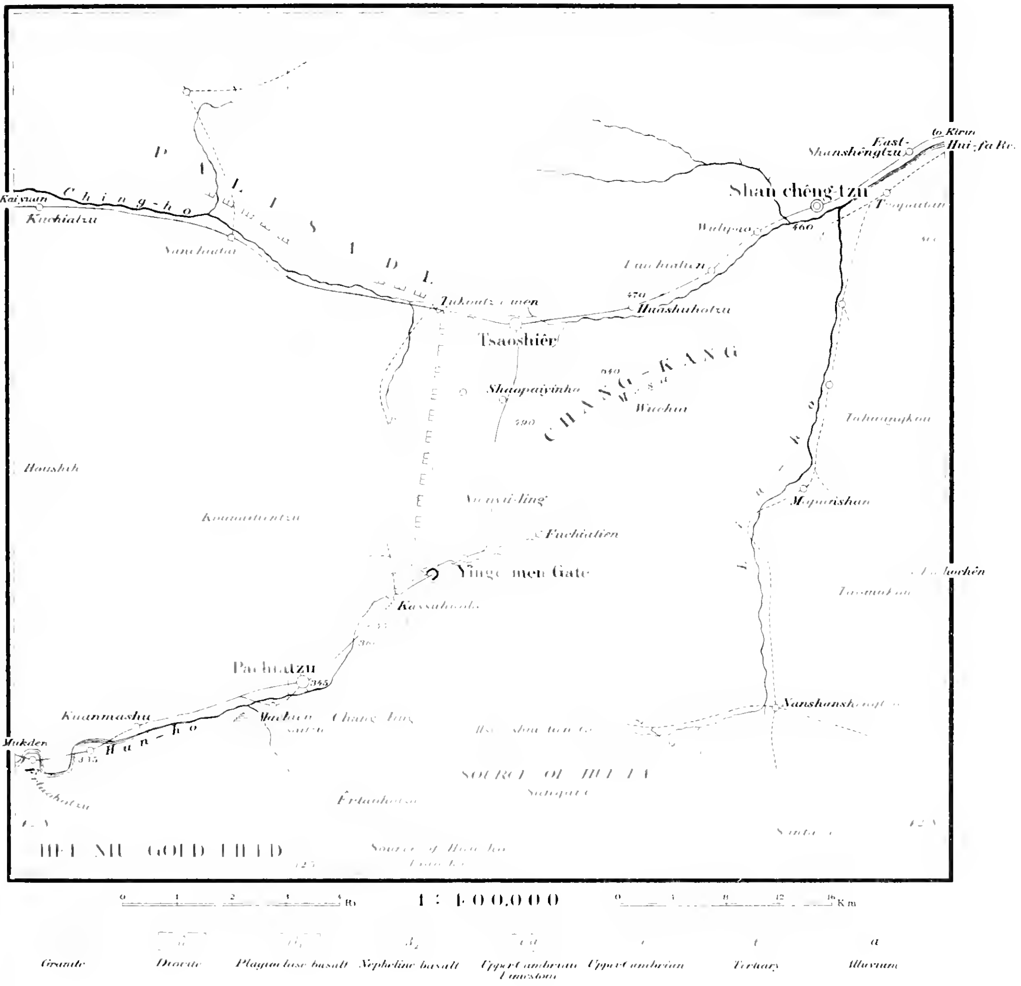
PLATE II.

Map showing the general distribution of the geologic formations represented in the Yingé-mén area (p. 7), the land-feature being seen in Pl. I., fig. 1. As to its petrographic elements the Koreo-Manchurian hinterland is, broadly speaking, built up of the two opposite poles—the pinkish granites and the black basalt; and this is typically exemplified in this small limited area.

The region is also of historical interest, as the Pohais, the Manchus and other ancient highlanders of eastern Manchuria took the road in the intermontane plain of Shan-chéng-tzu (see Map) for their expeditions into the Manchurian plain with bold intent of swollowing gigantic China. With this aim, these peoples marched along the high road from Tsaoshièr (see Map) either westwards through the Tukoutzu-mén gate to Kai-yüan, or southwestwards through the Yingé-mén gate to Mukden. At these two gates the road was cut by the long mound of the ancient palisade (see Map), now ruined, which was built to keep back the swarms of "northern barbarians." The Russians did the very same thing, as the ancient highlanders did. They followed the same track in the Russo-Japanese war on their march from, and retreat to, the secluded and safe city of Kirin.

This region is geologically interesting as well; for besides the occurrence of nepheline-basalt there is a narrow band of the Cambrian with Tertiary beds folded in what is apparently old granite-gneiss in the N.E.-S.W. direction. The Tertiary here is the north end of the well-known coal seam series of Mushun. The above-mentioned trend is the guide-line of the geologic structure that governs the whole Manchurian hinterland. The diorite region marked on the south is probably a differentiation-product of an alkaline granitic magma. This region (the Hei-niu goldfield) is also one of the richest auriferous areas in Manchuria.

GEOLOGIC MAP OF THE YINGÉMÊN AREA



JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY,
TOKYO, JAPAN.
VOL. XXXII., ARTICLE 7.

The Systematic Motions of Sun-spots.

BY

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With 3 plates.

The Systematic Motions of Sun-spots.

1. The object of this paper is to call attention to the possible existence of certain systematic motions of the sun-spots, which has not, so far as I know, been hitherto noticed. It was suggested to me by Mr. and Mrs. Maunder's paper "The Solar Rotation Period from Greenwich Sun-spot Measures," (Monthly Notices, vol. LXV, pp. 813–825) in which they summarized various important results relating to the solar rotation period. Among others, the following statement is made: "The rotation periods given by different spots in the same zone of latitude differ more widely than do the mean rotation periods for different zones of latitude." This is based on their Table II, which shows the number of the spot-groups, arranged in zones of latitude 5° wide, giving different synodic rotation periods. Graphical study of that Table led me to think that there is a tendency in the spot-groups to concentrate upon two particular periods. I was also able to find a similar tendency in Carrington's and Spörer's observations of the sun-spots.

2. To begin with the Greenwich sun-spots observations (1879–1901), I simply took the said Table II prepared by Mr. and Mrs. Maunder, and combined the zones of the same latitudes north

TABLE I.

Greenwich Numbers of Spot-groups, arranged in Zones of Latitudes 5° wide, giving Different Rotation Periods
(1879–1901).

Synodic Rotation Period	0° to 5°	5° to 10°	10° to 15°	15° to 20°	20° to 25°	25° to 30°	30° to 35°	>35°
23$^{\mathrm{d}}$.4			1					
6								
8								
24.0			2	2				
2		3		3				
4	2	2	3	1				
6	3	3	4		1	1		
8	2	4	5	4				
25.0	5	6	5	8	3	1		
2	6	10	11	4	2			
4	3	6	18	8	1	1		
6	4	12	17	12	5	2	1	
8	6	20	25	18	3	1	1	
26.0	12	22	26	15	12	1		
2	6	41	39	23	11	3		
4	16	33	45	29	9	1	1	
6	24	33	49	29	17	5		
8	16	46	61	30	10	6	1	
27.0	14	59	82	48	15	1		
2	5	41	76	63	25	3	1	
4	2	27	52	51	20	6	1	
6	2	5	20	41	26	7	3	1
8	1	8	13	21	24	10	1	
28.0	1	6	8	6	8	11		
2	2	4	5	7	12	4	1	
4	1	2	5	5	10	6		
6		1	4	1	1	2		

Synodic Rotation Period	0° to 5°	5° to 10°	10° to 15°	15° to 20°	20° to 25°	25° to 30°	30° to 35°	> 35°
8			2	6	3	2	1	
29.0			1	1	3	2		
2			1	1		2		
4			1	1	1			
6								1
8			1	1				
30.0			2	1	1			
2								
4								
6					2			
8								
31.0								
2			1					
Mean Rotation Period	^{d}26.36	^{d}25.59	^{d}26.73	^{d}26.89	^{d}27.22	^{d}27.48		

and south. The resulting numbers are given in Table I, which therefore exhibits the distribution of the spot-groups in two ways, the horizontal lines showing the numbers of groups yielding different synodic rotation periods, and the vertical columns the number of groups in each zone of latitude 5° wide. The numbers of Table I are represented graphically in Plate I, a series of curves being drawn, one for each zone. Considering now these curves shown in Plate I, each small circle represents the number of spot-groups corresponding to the given rotation period. They are connected by straight lines, while the heavy continuous lines indicate the smoothed values.

This Plate shows at a glance that, while there are minor differences between the curves for different zones, yet the main features are repeated in a remarkable way in all six series. We may observe that there is a tendency in the spot-groups to concentrate upon one particular period, but each curve is not symmetrical about the ordinate of maximum number. Another important point is the existence of a secondary concentration. At first I thought that if there existed a greater number of recorded observations, then I could get a sort of probability curve, but actually it seems likely that each curve will be a combination of two probability curves. Because of the impossibility of determining rigorously the values of several constants with non-linear equations by the method of least squares, and moreover because of the doubtful nature of the problem, I have endeavoured to determine the positions of the principal and secondary maxima by graphical method. When the maximum is not well pronounced, I have derived the smoothed curves by compounding two symmetrical curves about the directions marked I and II. All doubtful cases (marked ? on the plates) have been excluded. I have thus obtained the following results:

TABLE II.

Angular Velocity corresponding to Maximum I.

Heliographic Latitude	Synodic Rotation Period	Observed Ang. Vel.	Number of Spots in Maximum	Smoothed Ang. Vel. IG	Maunder's Ang. Vel.
2°.5	26ᵈ.60	14°.52	22	14°.45	14°.44
7.5	27.00	14.32	54	14.38	14.41
12.5	27.075	14.28	68	14.29	14.34
17.5	27.25	14.20	51	14.19	14.25
22.5	27.55	14.05	26	14.05	14.13
27.5	27.90	13.88	11	13.88	13.99

TABLE III.

Angular Velocity corresponding to Maximum II.

Heliographic Latitude	Synodic Rotation Period	Observed Angular Velocity	Number of Spots in Maximum	Smoothed Ang. Velocity. IIG
2°.5	?	?	?	(14°.72)
7.5	$26^{\rm d}.225$	14°.71	28	14.71
12.5	26.275	14.69	30	14.69
17.5	26.35	14.65	20	14.65
22.5	26.45	14.60	10	14.59
27.5	26.70	14.47	6	14.49

The value in brackets is one obtained by extrapolation.

Angular Velocities of Maxima I and II for Different Zones of Latitude, deduced from Greenwich Observations.

Fig. 1.

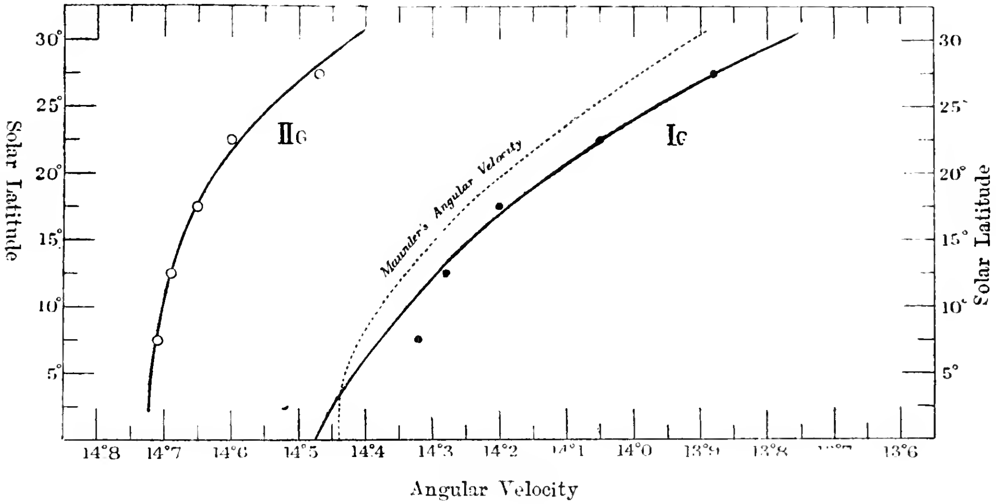


Figure 1 shows diagrammatically the numerical results of Tables II and III.

In the last column of Table II, I have added Maunder's values of daily angular velocity derived from his formula

$\xi=866'.6\pm128'\sin^2\lambda$, where ξ denotes the angular velocity and λ the latitude. These values obtained by his formula are generally greater than my results. That is, they do not correspond exactly to the angular velocities for my Maximum I. As to the second Maximum, I have obtained a pretty good continuous curve by merely connecting the successive positions of Maximum II, corresponding to different zones.

3. Next I pass on to examine Carrington's observations of the spots on the sun so far as they bear on the question of the existence of a secondary maximum. All the materials from which Carrington deduced his formula for the daily motion of the surface of the sun in different solar latitudes are condensed in his "Table of Resulting Diurnal Motions" contained in pp. 213-219 of his work. I have availed myself of the same materials, and deduced Table IV which shows the distribution of the sun-spots observed by him in each zone of latitude 5° wide, with different daily drifts.

Table IV.

Carrington's Numbers of Sun-spots, arranged in Zones of Latitudes 5° wide, giving Different Diurnal Motions (1853–1861).

Daily Drift	0° to 5°	6° to 10°	11° to 15°	16° to 20°	21° to 25°	26° to 30°	31° to 35°
From +80′ to +76′	1						
„ +75 „ +71							
„ +70 „ +66							
„ +65 „ +61							
„ +60 „ +56		1		1			1
„ +55 „ +51					1		
„ +50 „ +46		1					
„ +45 „ +41	1						
„ +40 „ +36	1	2	2				
„ +35 „ +31		2	1	2			
„ +30 „ +26		6	1	1			

Daily Drift	0° to 5°	6° to 10°	11° to 15°	16° to 20°	21° to 25°	26° to 30°	31° to 35°
From +25′ to +21′	3		4	2	1		
„ +20 „ +16	1	6	6				
„ +15 „ +11	1	8	5	4			
„ +10 „ + 6	3	11	7	7	2		
„ + 5 „ + 1	1	15	7			1	
„ 0 „ − 4	2	5	23	6	7	1	
„ − 5 „ − 9		5	9	11	4	2	
„ −10 „ −14		2	6	15	10	2	1
„ −15 „ −19			3	7	7	4	
„ −20 „ −24				5	11	4	
„ −25 „ −29				2	6	2	1
„ −30 „ −34				1	5	10	5
„ −35 „ −39				1	2	4	
„ −40 „ −44					2	4	2
„ −45 „ −49							1
„ −50 „ −54						2	2
„ −55 „ −59						1	
„ −60 „ −64						1	1
„ −65 „ −69							
„ −70 „ −74							
„ −75 „ −79							1
Mean Daily Drift	+17.′7	+10.′8	+3.′3	−3.′9	−1.′6	−29.′1	

The first column of Table IV requires further explanation. It represents Carrington's diurnal motions. According to his words, "The signs prefixed to the diurnal motions are such that + in longitude indicates rotation faster than 14° 11′ per diem (corresponding to the assumed period of 25. 380 days) and − rotation slower than that." The plotted numbers are shown graphically in

Plate II. The method of treatment of the material in Plate II is just the same as before. Here again, as in the previous case, the secondary maximum is clearly brought out in each curve. Graphically determined maxima may be tabulated as follows:

TABLE V.

Angular Velocity corresponding to Maximum I, deduced from Carrington's Observations.

Heliog. Latitude	Observed Angular Velocity.	Number of Spots in Maximum	Heliog. Latitude	Smoothed Ang. Vel. Ic	Carrington's Ang. Vel.
			2°.5	(14.°36)	14.°42
8°	851′+ 5′=856′=14.°27	13	7.5	14.27	14.35
13	„ − 2 849 14.15	19	12.5	14.16	14.21
18	„ −11 840 14.00	13	17.5	14.02	14.06
23	„ −20 831 13.85	9	22.5	13.86	13.90
28	„ −33 818 13.63	8	27.5	13.67	13.73

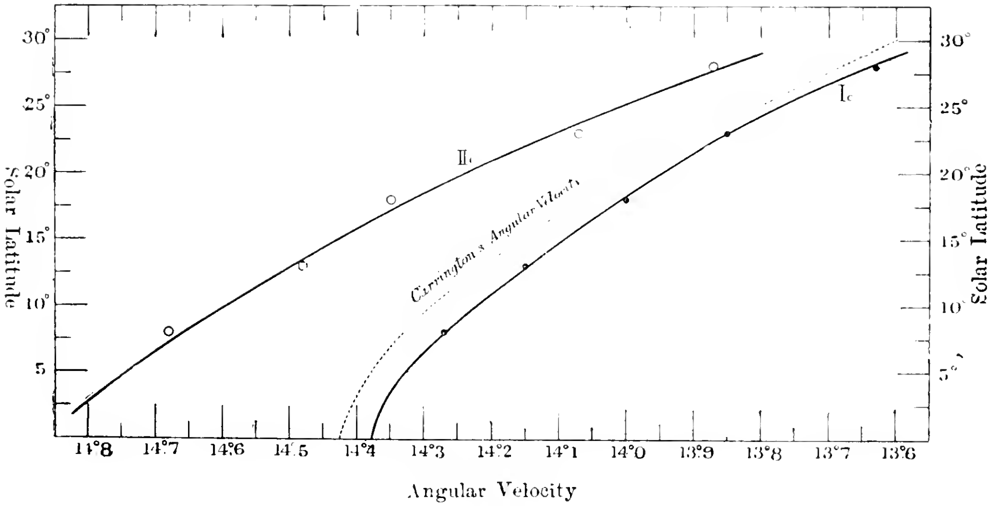
TABLE VI.

Angular Velocity corresponding to Maximum II, deduced from Carrington's Observations.

Heliog. Latitude	Observed Angular Velocity	Number of Spots in Maximum	Heliog. Latitude	Smoothed Ang. Vel. IIc
			2.°5	(14.°81)
8°	851′+30′=881′=14.°68	4	7.5	14.67
13	„ +18 869 14.48	5	12.5	14.51
18	„ +10 861 14.35	6	17.5	14.34
23	„ − 7 844 14.07	2	22.5	14.13
28	„ −19 832 13.87	4	27.5	13.88

Angular Velocities of Maxima I and II for Different Zones of Latitude, deduced from Carrington's Observations.

Fig. 2.



Carrington's angular velocity given in the last column of Table V is derived from his formula for the angular velocity, $\xi=865' \mp 165' \sin^{\frac{7}{4}} \lambda$.

4. Similarly I have examined Spörer's observations. The data for our discussion of the spots as observed by him have been taken from the same source as that from which he deduced his expression, $8^\circ.548+5^\circ.798 \cos \lambda$, for the daily motion of the sun-spots in different solar latitudes, namely his "Beobachtungen der Sonnenflecken zu Anclam."⁽¹⁾ The observations comprise the period 1861–71, the number of the spots whose angular velocities are computed being 264. To increase this number, I have extended the discussion of his observations⁽²⁾ up to the end of the year 1878. So the total number of spots employed became 334. Similarly to the others, Table VII and Plate III were prepared. It is unfortunate that none of the curves in Plate III show so striking a secondary maximum as in the previously considered cases, although there is no doubt that each curve

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(1) Publicationen der Astronomischen Gesellschaft. XIII 1874 pp. 139—146.

(2) Publicationen des Astro-physikalischen Observatoriums zu Potsdam. Nr. 5. p. 66.

TABLE VII.

Spörer's Numbers of Sun-spots, arranged in Zones of Latitudes 5° wide, giving Different Diurnal Motions. (1861-1878)

Daily Motion	0° to 5°	5° to 10°	10° to 15°	15° to 20°	20° to 25°	25° to 30°
13.°4						2
13. 5			1			1
13. 6					5	3
13. 7						7
13. 8				7	9	5
13. 9			4	11	12	1
14. 0	2		17	21	8	2
14. 1	1	16	41	24	4	
14. 2	3	30	35	10	5	
14. 3	5	33	20	7	1	
14. 4	11	10	8	3		
14. 5	6	6	2		1	
14. 6	3	4	3			
14. 7	3	3	1	1		
14. 8	2	2				
14. 9	1	1				
15. 0		2				
15. 1			1			
Mean Daily Motion	14°.43	14.°31	14.°18	14.°07	13.°94	13.°71

is not symmetrical about the ordinate corresponding to Maximum I. In fact, the sun-spots selected by Spörer are best suited for finding Maximum I, but not so favourable for finding Maximum II. However, so far as Plate III shows, I can deduce the following results. Better results would perhaps be reached by discussing the angular velocities of all the spots observed by him.

Table VIII.

Angular Velocity corresponding to Maximum I.

Heliog. Latitude	Observed Ang. Vel.	Number of Spots in Maximum	Smoothed Ang. Vel. Is	Spörer's Ang. Vel.
2.°5	14.°40	10	14.°36	14.°34
7. 5	14. 25	31	14. 28	14. 30
12. 5	14. 14	38	14. 17	14. 21
17. 5	14. 05	23	14. 03	14. 08
22. 5	13. 89	11	13. 90	13. 90
27. 5			(13. 77)	13. 69

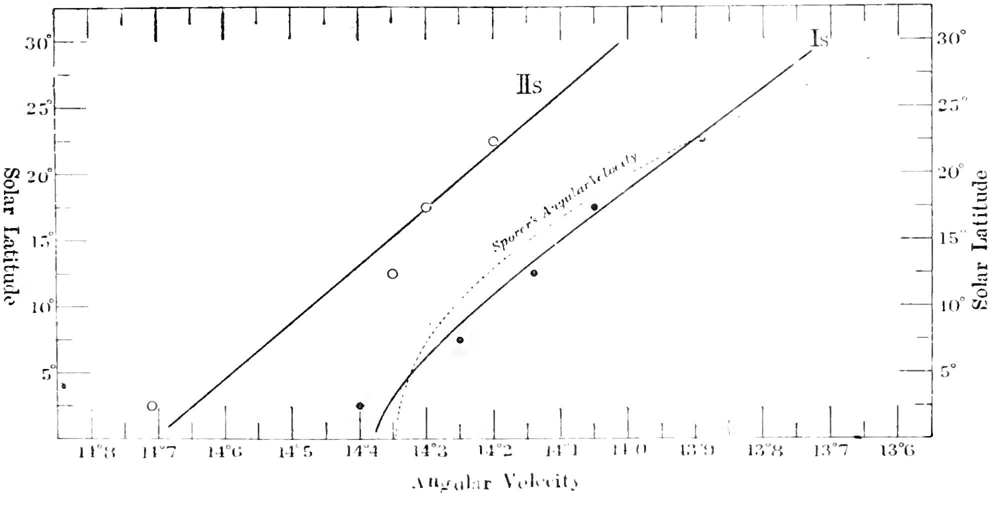
Table IX.

Angular Velocity corresponding to Maxmum II.

Heliog. Latitude	Observed Ang. Vel.	Number of Spots in Maximum	Smoothed Ang. Vel. IIs
2.°5	14.°71	1	14.°65
7. 5	?	?	14. 53
12. 5	14. 35	6	14. 42
17. 5	14. 30	7	14. 30
22. 5	14. 20	4	14. 18
27. 5			(14. 07)

Angular Velocities of Maxima I and II for Different Zones of Latitude, deduced from Spörer's Observation.

Fig. 3.



5. I can now compare the results arrived at from these various observations as follows:

TABLE X.

Angular Velocity corresponding to Maximum I.

Heliog. Latitude	Deduced from Greenwich Observations (1879–1901) IG	Deduced from Spörer's Observations (1861–1878) Is	Deduced from Carrington's Observations (1853–1861) Ic	Simple Mean I	Mean Ang. Vel. computed from Maunder's, Spörer's, and Carrington's Formulae
2.°5	14.°45	14.°36	(14.°36)	14.°39	14.°40
7. 5	14. 38	14. 28	14. 27	14. 31	14. 35
12. 5	14. 29	14. 17	14. 16	14. 21	14. 25
17. 5	14. 19	14. 03	14. 02	14. 08	14. 13
22. 5	14. 05	13. 90	13. 86	13. 94	13. 98
27. 5	13. 88	(13. 77)	13. 67	13. 77	13. 80

TABLE XI.

Angular Velocity corresponding to Maximum II.

Heliog. Latitude	Deduced from Greenwich Observations (1879–1901) IIG	Deduced from Spörer's Observations (1861–1878) IIs	Deduced from Carrington's Observations (1853–1861) IIc	Simple Mean II	Mean Synodic Rotation Period
2.°5	(14.°72)	14.°65	(14.°81)	14.°73	$26.^{d}19$
7. 5	14. 71	14. 53	14. 67	14. 64	26. 37
12. 5	14. 69	14. 42	14. 51	14. 54	26. 56
17. 5	14. 65	14. 30	14. 34	14. 43	26. 78
22. 5	14. 59	14. 18	14. 13	14. 30	27. 04
27. 5	14. 49	(14. 07)	13. 88	14. 15	27. 35

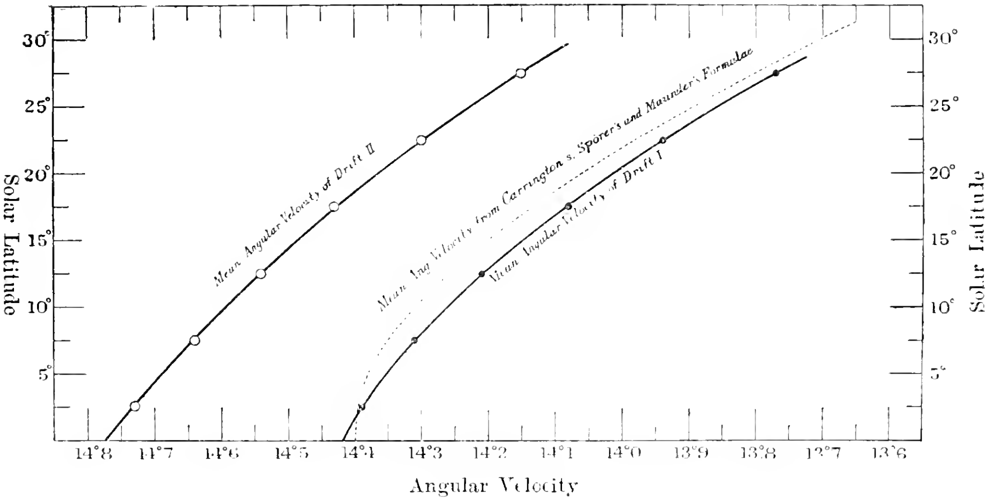
The values in brackets have been obtained by extrapolation.

The mean values corresponding to Maximum I and Maximum II respectively of angular velocities in zones of solar latitude each 5° wide, are shown under the heading 'Simple Mean' of Table

X and Table XI. These velocities are plotted graphically in Fig. 4. The dotted curve in the same figure represents the mean angular velocity, as computed from Maunder's, Spörer's, and Carrington's formulæ. Its numerical values are given in the last column of Table X. For the sake of convenience, the two drifts corresponding to Maximum I and Maximum II will in the remainder of this article be called Drift I and Drift II respectively.

Angular Velocities of Drift I and Drift II.

Fig. 4.



6. On the whole, the angular velocities of Drift I, as represented in Table X, accord very well with the mean values as computed from the formulæ of the three investigators, though there is a small systematic difference of about 0°.04 on the average. In fact, the values obtained by these authors do not exactly represent the angular velocities of spot-groups of maximum occurrence.

7. As to Drift II, it will be noticed from Table XI that there is a rather considerable discrepancy in the values derived from the Greenwich observations and from the other two, although there is no great difference between the results deduced from Spörer's and Carrington's observations. It is evident that the values at latitudes 2°.5 and 27°.5 are of low weights, the first being based

upon only a single determination, and the second upon but two. A comparison of Table X and Table XI shows a faster rate of daily angular motion for Drift II than for Drift I. The mean acceleration of the angular velocities is about 0°.35, within the limits of observation, the corresponding acceleration in the rotation period being $0.^{d}71$. For the lower latitudes, the rotation periods of the spots belonging to Drift II agree approximately with the recent spectroscopic results obtained by Messrs. Storey and Wilson.(1) Perhaps certain groups of spots by a proper motion of their own come to the same level as the reversing layer and attain its angular velocity.

As to the peculiar motions of sun-spots Prof. Spörer says: "Die Beobachtungen haben ergeben, dass im östlichen Theile einer Gruppe niemals übergrosse Rotationswinkel vorkommen. Man findet daselbst Verkleinerung der Rotationswinkel, aber selten mit bedeutenden Betrage. Uebergrosse Rotationswinkel kommen vor an der Westgrenze der Gruppen und bei neu entstandenen Flecken." He then mentions 66 cases of great angular velocities during the period 1880-84. This excess comes out to be about 0°.5 on the average. Perhaps such spots and those of short duration may greatly contribute to the existence of Drift II.

8. Since the ratio of the amplitudes of the two drifts depends on the choice of spots by each investigator, it is difficult to find the true ratio from the investigations hitherto made. By examining the tables in this article, it will be found that it is actually different for different investigators. It also varies irregularly in different zones. The mean ratio of the amplitudes of the two drifts is about $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{5}$ in Maunder's, Carrington's and Spörer's observations respectively. The researches of Mr. and Mrs. Maunder were made on spots in general. They say: "There has been no selection of spots because they seemed to be steady in motion or regular in shape, no rejection because of unsteadiness or irregularity. The only criterion for the inclusion of a group in the discussion has been that it lasted for six consecutive days". This

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(1) Storey and Wilson, Spectroscopic Observations of the Sun's Rotation, etc. Monthly Notices LXXI p. 674.

fact has led me to assume that the sun-spots belonging to Drift II are about $\frac{1}{2}$ of the whole.

9. If we adopt Faye's empirical formula for solar motion, then our results may be expressed as follows:

$$\xi=14^\circ.37-2^\circ.97\ \sin\lambda. \quad \text{for Drift I.}$$
$$\xi=14^\circ.69-2^\circ.65\ \sin\lambda. \quad \text{for Drift II.}$$

In order to exhibit how these formulæ satisfy the observations, I give the following table.

TABLE XII.

Comparison of Computed with Observed Angular Velocities.

	Drift I.				Drift II.			
λ	ξ Observed	Weight	ξ Computed	O−C	ξ Observed	Weight	ξ Computed	O−C
2.°5	14.°39	$\frac{2}{3}$	14.°36	+0.°03	14.°73	$\frac{1}{3}$	14.°68	+0.°05
7.5	14.31	1	14.32	− 1	14.64	1	14.64	0
12.5	14.21	1	14.23	− 2	14.54	1	14.57	− 3
17.5	14.08	1	14.11	− 3	14.43	1	14.45	− 2
22.5	13.94	1	13.94	0	14.30	1	14.30	0
27.5	13.77	$\frac{2}{3}$	13.75	+ 2	14.15	$\frac{2}{3}$	14.13	+ 2

It will be noticed that the above formula for Drift I nearly coincides with the expression, $\xi=14^\circ.37-3^\circ.10\ \sin^2\lambda$ deduced by Faye.

10. By examining all the spots which lasted for more than six consecutive days, Mr. and Mrs. Maunder (loc. cit. p. 818) have deduced another formula, $\xi=875'.7\mp164'\ \sin^2\lambda$, which nearly corresponds to the mean values in the last line of Table I. This formula may be analysed as follows:

$\frac{1}{4}$(ξ of Drift I)+$\frac{3}{4}$(ξ of Drift II)

$$=\tfrac{1}{4}(14^\circ.37-2^\circ.97\ \sin^2\lambda)+\tfrac{3}{4}(14^\circ 69-2^\circ.65\ \sin^2\lambda)$$
$$=14^\circ.61-2^\circ.73\ \sin^2\lambda=876'.6-163'.8\ \sin^2\lambda$$

That the last expression practically coincides with their formula shows that the latter is greatly influenced by Drift II.

The mean value of ξ, (column 6 of Table X), as computed from Carrington's, Spörer's, and Maunder's formulæ, is nearly expressed by the formula, $\xi=14°.40-2°.83 \sin^2\lambda$, which may also be analysed as follows:

$$\tfrac{9}{10}(\xi \text{ of Drift I})+\tfrac{1}{10}(\xi \text{ of Drift II})$$
$$=\tfrac{9}{10}(14°.37-2°.97 \sin^2\lambda)+\tfrac{1}{10}(14°.69-2°.65 \sin^2\lambda)$$
$$= \quad 14°.40-2°.94 \sin^2\lambda.$$

11. The present investigation, though cursory, leads me to conclude that there are two apparent drifts in the motions of the sun-spots. The angular velocity of Drift I is represented by

$$\xi=14°{\cdot}37-2°.97 \sin^2\lambda$$

and that of Drift II by

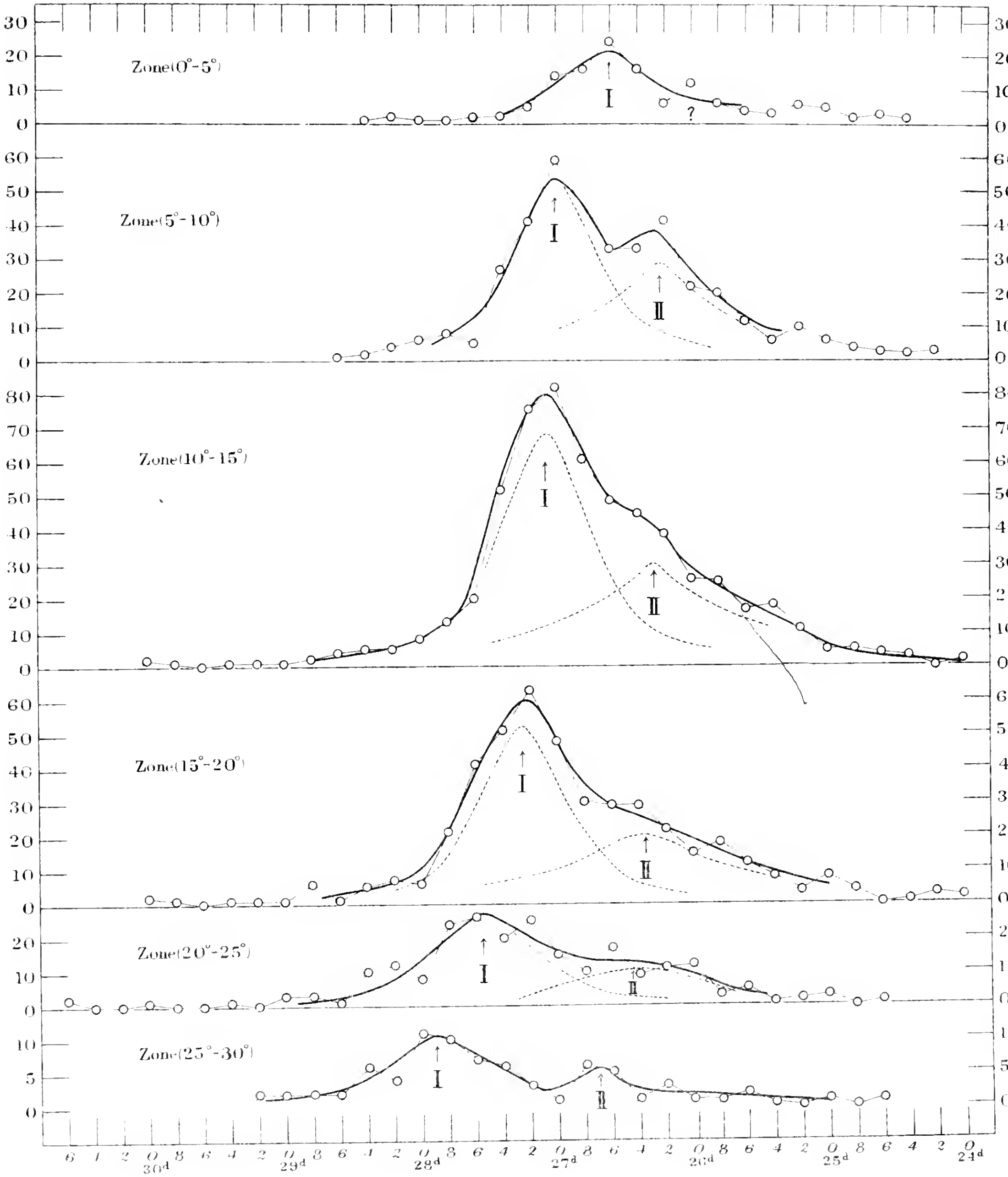
$$\xi=14°.69- 2°.65 \sin^2\lambda,$$

showing a mean rate of about 0°.35 greater than that indicated by Drift I. The mean ratio of the number of sun-spots in Maximum II to those in Maximum I is 1: 2. This hypothesis of assuming the existence of a secondary drift may be considered a tentative explanation of the phenomena of the distribution of sun-spots with different rotation periods in any particular zone of latitude, and I do not claim that the conclusion I have arrived at do more than approximate to quantitative precision.

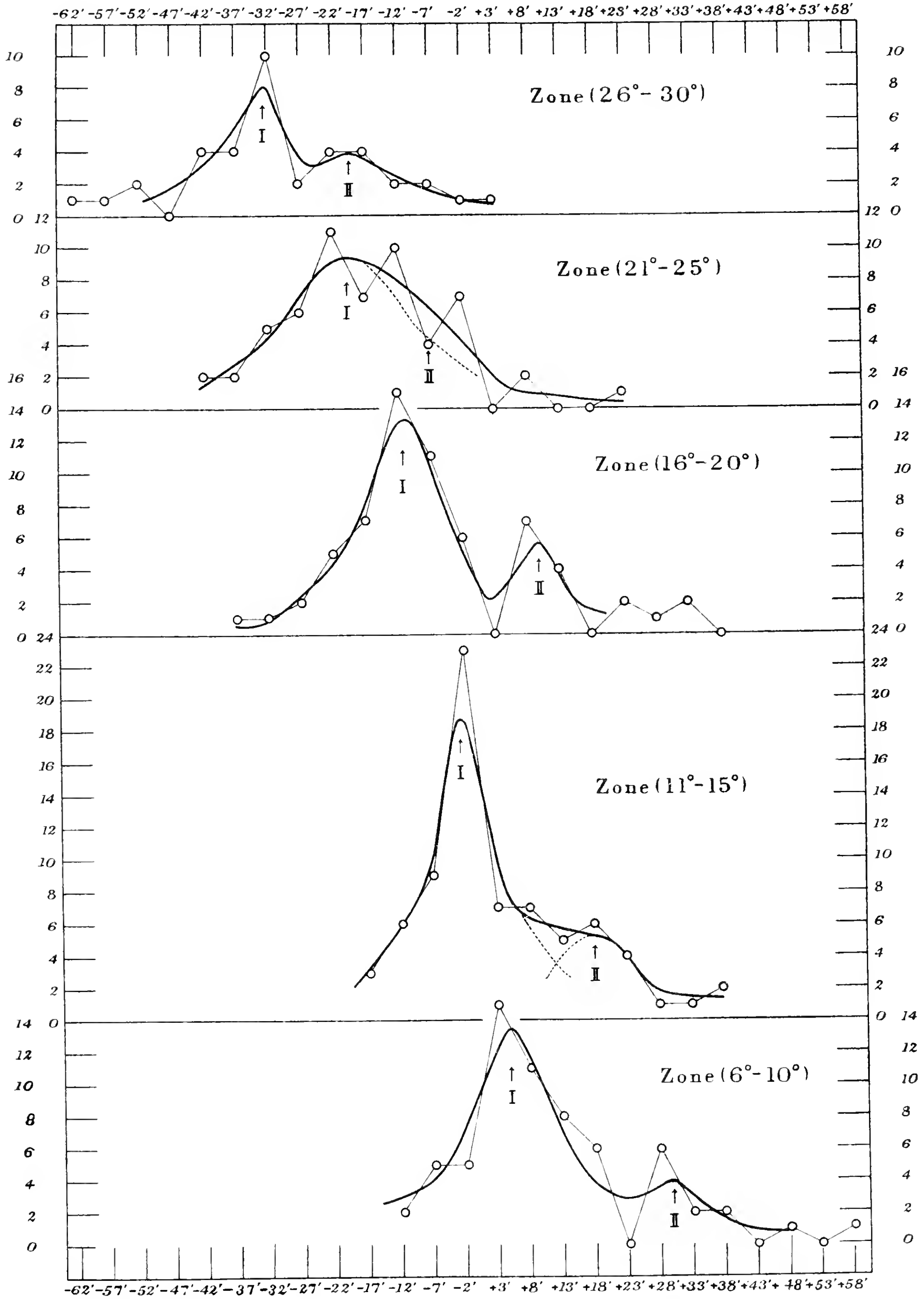
Tokyo:
1912, January 20.

Publ. June 7th, 1912.

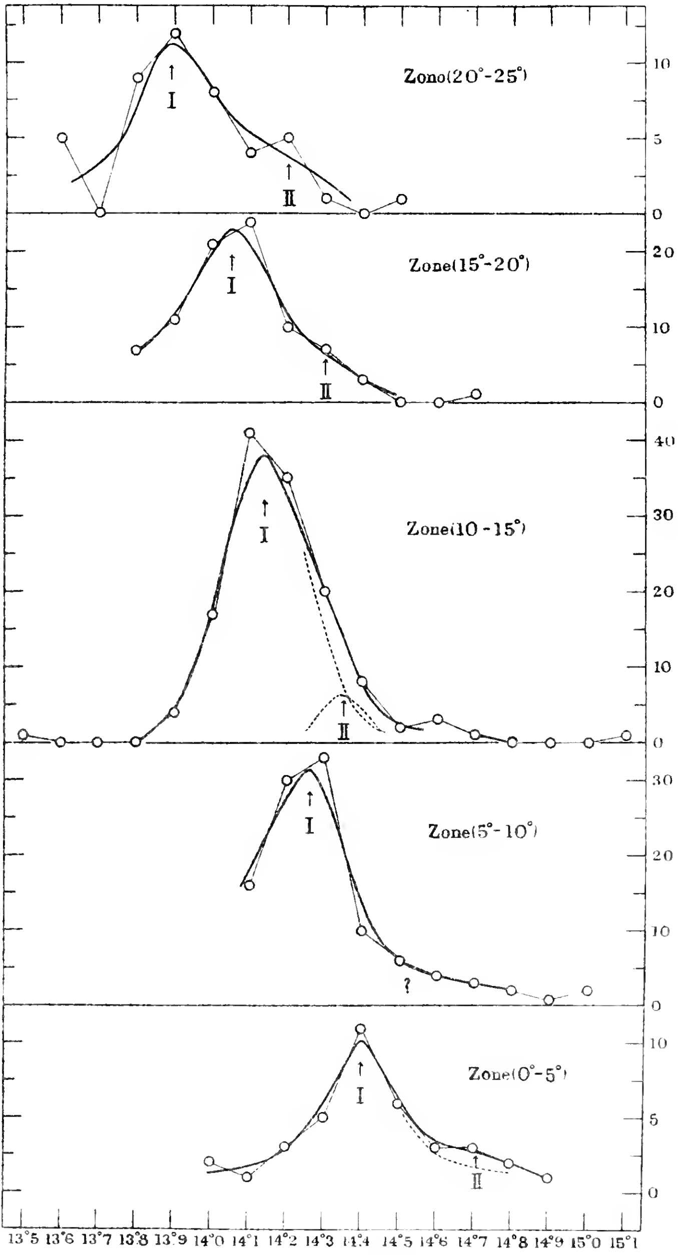
Greenwich Number of Spot-groups with Different Rotation Periods in Zones of Latitude 5° wide.



Carrington's Number of Sun-spots, arranged in Zones of Latitude 5° wide, giving Different Diurnal Motions.



Spörer's Number of Sun-spots with Different Angular Velocities in Zones of Latitude 5° wide.



JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XXXII., ARTICLE 8.

The Metallogeny of the Japanese Islands.

By

C. Iwasaki, *Rigakushi.*

With 1 Map.

1. Magmatic Emanations and their Petrification.

Since SVANTE ARRHENIUS[1] made public the results of his studies on the chemical properties of water in high temperatures, the world's geologists have been more or less influenced by him, their views on metallogeny changing gradually from the hydrothermal to the magmatic theory. Heavy metals were formerly supposed to have been brought up by hot springs in the form of mineral solution. But at present ore-deposits are believed to have been deposited by gas, or by a mixture of gas and liquid, or by liquid only, emitted from magma while cooling. This is asserted by J. H. L. VOGT,[2] who calls this "eruptive after-action." This view naturally leads us to believe that where ore-deposits exist, there must be found igneous rocks, near or distant, from which the materials of the ore-deposits were emitted. Prof. KOTÔ,[3] in his recent paper entitled "*Geology and Ore-deposits of the Holgol Mine,*" 1910, calls these rocks "ore-bringers."

It had already been recognized by MATTEUCCI, LACROIX,[4] GAUTIER,[5] and others that a great many elements always exist in emanations. When the latter cool, these elements form different kinds of minerals. It is in this way that petrification of emanations takes place.

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1) Svante Arrhenius: "Zur Physik des Vulkanisms," Stockholm, 1900.
2) The Genesis of Ore Deposits," p. 642.
3) B. Kotô: *Jour. Coll. Sci. Imp. Univ. Tokyo*, Vol. XXVII., Art. 12, 1910.
4) Matteucci and Lacroix: The Digest in *Economic Geology*, Vol II., No. 3, p. 258, 1907.
5) Gautier: *Economic Geology*, Vol. I., p. 690, 1906.

The petrification may often be seen distinctly in recent lavas. As an example, let me explain here the occurrence of tridymite in Ishigami-yama, a hillock in the environs of the city of Kumamoto. This hill is a part of a lava flow extruded from Kibô-san, a now extinct volcano, and is composed of amphibole-pyroxene andesite. The rock is fresh in composition, whitish in color, with conspicuous phenocrysts of amphibole converted into the pseudomorphs of magnetite and augite grains by the resorption of the original crystals. In the miarolitic fissures and cavities formed during the consolidation of the lava, several minerals are found, such as tridymite, phlogopite, breislakite,[1] specular iron, and *calcite*, all forming very fine crystals. The tridymite is in hexagonal plates, sometimes attaining 5 mm. in diameter. The mineral, when picked out of the rock cavities, is transparent, but very soon becomes whitish and translucent on exposure to the air. The change of color may be clearly explained by microscopic study. The tridymite occurs in the form of a pile of thin laminæ, and has, when it is picked out of the rock cavities, a light-brownish liquid in the interspaces between the plates. When exposed to the air, the liquid immediately evaporates and the tridymite becomes whitish by total reflection of light. The liquid contained in the tridymite is supposed to be what is left of juvenile water extruded from the cooling lava.

The presence of calcite as an emanation-product in recent lava is, so far as known, extremely rare. The other minerals in the miarolitic cavities are also supposed to be all of juvenile origin, and not of the vadose formation; in other words, all belong to the so-called fossil emanations of Lincoln.[2] To prove it, I shall give here the following three data: (1) the side-wall of the miarolitic cavities and fissures presents the slaggy aspect usually seen on the surface of lava, (2) the cavities and fissures are perfectly closed as if to prevent the infiltration of vadose water, (3) the andesite in which the cavities and fissures are found is quite fresh, showing that the minerals in question are not decomposition-products.

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[1] It was so determined by B. Kotô.

[2] Lincoln : " Economic Geology," Vol II., No. 3, p. 258,1907.

2. Classification of Ore-deposits.

VON WALDENSTEIN[1] and VON COTTA[2] were the first geologists to try (in 1824 and in 1859) to classify ore-deposits. Since then, many methods of classification have been proposed from time to time. GRODDECK's system,[3] which takes as the basis of classification the origin of the deposits, is perhaps the best of all. He divided ore-deposits into two groups, *viz.*, original and fragmentary deposits.

VAN HISE[4] a little later classified them into three groups, namely, those of igneous origin, those which are the direct result of sedimentation, and those which have been deposited by underground water. A classification based on the magmatic theory is perhaps the best for us, when looked at from the standpoint of the theory. The greater part of the ore-deposits in the case of the heavy metals is of igneous origin, and also since there are, in my opinion, hardly any other deposits of heavy metals found in Japan. Accordingly I shall here classify them into five categories, based on the magmatic theory:

a) Magmatic segregations.
b) Contact deposits.
c) Mineral veins.
d) Replacement deposits.
e) Impregnation deposits.

This classification has been made quite independently by me for the special treatment of Japanese ore-deposits. I am, however, very glad to notice its close resemblance to that of RICHARD BECK, made public in the third edition of his "Lehre von den Erzlagerstaetten," 1909.

Magmatic segregations are heavy metals accumulated in a magmatic body. Contact deposits are the so-called fossil ema-

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[1] von Waldenstein: " Die besonderen Lagerstätten der nützbaren Mineralien," 1824.

[2] von Cotta: " Lehre von den Erzlagerstätten," 1859.

[3] von Groddeck: " Die Lehre von den Lagerstätten der Erze " 1869.

[4] Van Hise: " The Genesis of Ore Deposits," pp. 282—432.

[5] Lincoln: *Loc. cit.*

nations of LINCOLN,[1] deposited between the ore-bringers and the preëxisting rocks, the latter of which obstructed the passage of the emanations from the former. When the emanations force themselves into the fissures of the rocks and deposit heavy metals there, we have mineral veins. When the magmatic emanations, by their strong rush and chemical action, dissolve part of rocks, make cavities of various forms, and deposit heavy metals therein, then we have replacement deposits. Impregnations are the ore-bodies disseminated in the rock-masses.

3. The Order of Petrification of Emanations.

LINCOLN[2] has classified emanations into four groups, i. e., actual, fossil, repressed, and potential emanations. "Actual emanations may be observed as gases and vapours from lava streams expelled from volcanic vents." "Fossil emanations are the more or less well-preserved remains and traces of actual emanations. The complete preservation of past emanations is often seen as inclusions in minerals, while partial preservation is common in druses and in lithophyses, at contacts and in veins." "It is well to remember in this connection that the mineral veins and contacts frequently appear to be in whole or in part of magmatic origin."

As the emanations begin to get cool, the minerals begin to be formed, and petrification occurs. From frequent observations, I have come to the conclusion that the order of petrification of emanations is similar to that of the formation of rock-forming minerals in magma; for in both cases, the falling of temperature is the chief agent in forming minerals from liquids or gases at high temperature. The following list shows the order of petrification of emanations observed in Japanese ore-deposits:—1. magnetite, 2. chromite, 3. hematite, 4. garnet, 5. augite and hornblende, 6. scheelite, 7. pyrite, 8. cobaltite, 9. chalcopyrite, 10. barite, 11. argentite, 12. gold, 13. quartz, 14. tetrahedrite and enargite, 15. calcite. The minerals at the head of the series are those

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1) Lincoln: *Economic Geology*, Vol. II., No. 3, p. 258, 1907.

2) *Loc. cit.*

formed at high temperature, and, as we go downwards, the temperature of their formation is lower. Minerals having a high position in the petrification order are spoken of as "of the higher order of petrification." Not only does the order indicate the order of the formation of the minerals, but also their position in certain deposits. The higher the order of petrification, the lower is the position of the minerals in the ore-deposits, for it is natural that the temperature of emanations in rock fissures should become higher the lower we go. The reason of the constant association of quartz with gold, and the transition of quartzose gold ores into sulphides in the bottom of mineral veins may be readily understood in the order of petrification of emanations above cited. LINDGREN[1] enumerated persistent minerals according to their positions, ranging from the contact metamorphic or igneous condition to the surface of the earth, as shown in the following list, *viz*:—pyrite, chalcopyrite, bornite, arsenopyrite, galena, zincblende, molybdenite, gold, quartz, calcite, etc. The reader will easily recognize the essential coincidence between my petrification order and the above list.

In magmatic segregations found in Japan, only the first two minerals in my petrification order occur, of which chromite in serpentine is the only one workable. Contacts constitute the best reservoirs for all the magmatic emanations, and therefore various minerals are found there. Of these minerals, magnetite, chalcopyrite, cobaltite, and sometimes gold are being worked. In mineral veins which are located far from the source of the ore-bringer, the temperature must be lower than in magmatic segregations and contacts, and initial products such as magnetite and chromite can not journey through so long a passage. Accordingly there occur only pyrite and such minerals as are of a lower order than it, of which the copper and gold ores are chiefly being worked. Ores occurring as impregnations and replacements do not present many points of difference from those in veins, but are very complex in their composition; for all elements of the emanations are shut up in them as in the case of contacts. This is especially true of replacements, such as those in the Kosaka Mine.

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1) Lindgren: *Economic Geology*, Vol. II., p. 122, 1907.

4. Metallogenetic Provinces.

In Japan, there are several kinds of ore-bringers, such as granite, diorite-porphyrite, liparite, and andesite; serpentine is also supposed sometimes to have a genetic relation to ore-deposits. All these rocks occupy their own areas, which we call here metallogenetic provinces, after A. M. FINLAYSON,[1] who made similar divisions of the British Isles. Granite is very extensively exposed in Japan, but it is not always associated with ore-deposits. As an ore-bringer it is most frequent in Korea, and also in many places in northern Kyûshû as well as in western Honshû (the Main Island). Quartz-porphyry associated with ore-deposits in central Japan is also asserted to be the marginal facies of this particular province including Korea and other regions. These localities therefore may be called the *Korean Province*.

Diorite is not scanty in Japan, and a noteworthy fact is that diorite-porphyrite is rather better suited to be an ore-bringer than diorite proper. The ore-deposits formed by emanations from diorite-porphyrite are chiefly found in the Paleozoic formation in the outer zone of North Japan, with their center in the *Kitakami* Mountain-land, which, possessing most numerous deposits of this sort, may give the name to this *Province*. Liparite lava is not very often met with in this country, but the rock doing the function of an ore-bringer is found more frequently in the form of dykes or necks, nearly always in the inner zones of North and South Japan, which are put together under the name of the *Kosaka Province*, the Kosaka Mine being its exponent. Besides liparite, propylite is sometimes found doing the work of an ore-bringer in this province. Andesite is the volcanic rock of widest occurrence in Japan, but it is not always associated with ore-deposits. The rock which serves as an ore-bringer is rather the older rock of this kind, recent andesite lava being always barren of the useful heavy metals. The greater part of the andesite that acts as an ore-bringer is supposed to have erupted in the later period of the Tertiary and the earlier portion of the Diluvial, and intrudes Tertiary sediments, forming dykes, necks, or denuded volcanoes.

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[1] Finlayson: *Quart. Jour. Geol. Soc. London*, p. 281, 1910.

The andesite of this kind is chiefly found in the inner zone of the Ryûkyû (Loo-choo) arc, where gold mines are very hopeful, especially in Satsuma, and to this metallogenetic province the name *Satsuma* is given. The Sado island, famous on account of the rich Sado gold mine, is also supposed to belong to this province, judging from the properties of the ores from the mine.

Pyrite beds in Japan have for a long time been supposed to be of aqueous origin, but at present they are treated as bedded veins. Their ore-bringer is not yet definitely known, but the author believes that it may be serpentine or a like rock, just as VOGT[1] explains the origin of the pyrite deposits of Norway as related to gabbro. Such beds occur in the outer zones of South Japan and the Ryû-Kyû arc. The largest of the kind is in the Besshi mine, for which reason the author calls these regions the *Besshi Province.*

5. The Korean Province.

The mineral resources of the Korean Province are gold and copper, sometimes with cobalt, zinc, lead, arsenic, and tungsten. The origin of the deposits in the Korean Province is most clearly explained in "The Geology and Ore-deposits of the Holgol Mine," an instructive paper by Prof. KOTÔ.[2] The Holgol mine is situated in the northeastern portion of Hoan-haidô in Korea. The geology of Holgol and its neighborhood is composed of highly metamorphosed argillite, calcareo-siliceous slate, limestone, porphyritic granite, and basalt. Prof. KOTÔ describes these rocks in a most elaborate manner; and, from various facts obtained by this study, he comes to "the conclusion that the gold is juvenile, and must have come from deep in the interior as an exudation from the eutectic mixture of the granitic magma."

Ores of the Korean Province occur in veins, or in contacts. The gold ores in mineral veins are always quartzose. The quartz is hard and translucent, generally being very poor in gold content, except when sulphide minerals such as pyrite, galena, or zinc-

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[1] Vogt: The Digest in "The Genesis of Ore Deposits," p. 652.

[2] Kotô: *Loc. cit.*, p. 2.

blende are present. It is a question whether the gold was deposited with sulphide minerals as a primary product, or has been accumulated around the sulphides by secondary enrichment in process of time.

Copper ores in this province are often found in contacts, as at Kapsan in Korea, and Naganobori and other places in Japan proper, where gold veins of the Korean type are very scanty. The author studied contacts in the Naganobori Copper Mine in the prefecture of Yamaguchi. This mine is thirteen miles distant from the Ogôri railway station, near the western extremities of Honshû. There is an extensive '*karst*', called Akiyoshi-dai. Through the limestone a small granite boss 3,000 feet long and 1,700 feet wide, is exposed forming a hillock named Hanano-yama. All around the boss, contacts are found, Naganobori being one of them.

The deposits of the Naganobori Mine are 30 feet thick, the hanging-wall being limestone and the foot-wall granite. The greater part of the ores consist of radially aggregated augite, which is either mixed with garnet crystals, or planted upon garnet nodules. The ground-mass of the ore is a mixture of quartz and calcite, in which cobaltite crystals and chalcopyrite masses are imbedded. The chalcopyrite is always amorphous, but the cobaltite crystallizes in pentagonal dodecahedrons, showing cubical cleavage. Throughout the ore body, mineral veins with symmetrical structure are frequently met with. These consist of quartz in the salband, calcite in the middle, and tetrahedrite on both sides. Branching out from the main body of the contact deposit, veinlets of chalcopyrite traverse the limestone. In my opinion, the ore of the deposit was petrified from the emanations emitted from the granite magma. First, ferromagnesian silicates have crystallized out as garnet and augite, then cobaltite, chalcopyrite, quartz, tetrahedrite and calcite were formed one after the other.

6. The Kitakami Province.

This province gets its name from the fact that the metal mines in it are most flourishing in the Kitakami Mountain-land, situated between the Kitakami Valley and the Pacific Ocean. The mines are nearly always in the Paleozoic formation and are associated with such ore-bringers as diorite, diorite-porphyrite, and sometimes granite. The diorite-porphyrite, green and compact, with phenocrysts not very distinct to the naked eye, is the most favorable rock for ore-deposits. Under the microscope, the felspar is seen to be kaolinized or to form epidote in combination with the decomposition-products of hornblende turned into chloritic matter. Magnetite is always present, being particularly abundant toward the margin of the eruptive masses. I observed a very interesting phenomenon between the diorite-porphyrite and the limestone in the Kamaishi Iron Mine. This mine is the most hopeful one in this province, and is well known as the only private iron-smelting work in Japan. The deposits belong either to the contact of the diorite-porphyrite with paleozoic limestone, or to that of the diorite-porphyrite with granite, or else the magnetite is wholly enclosed in granite masses. Where the diorite-porphyrite is in

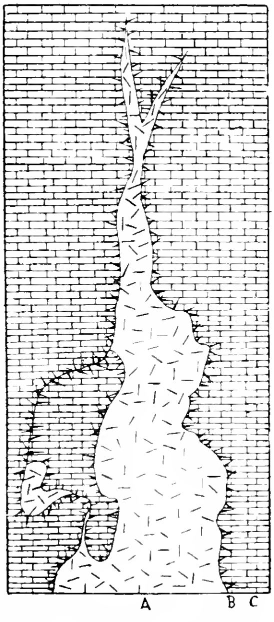

Fig. 1.—Intrusion of diorite-porphyrite into limestone, in Kamaishi Mine A, Diorite-porphyrite. B, Magnetite crystals. C, Limestone.

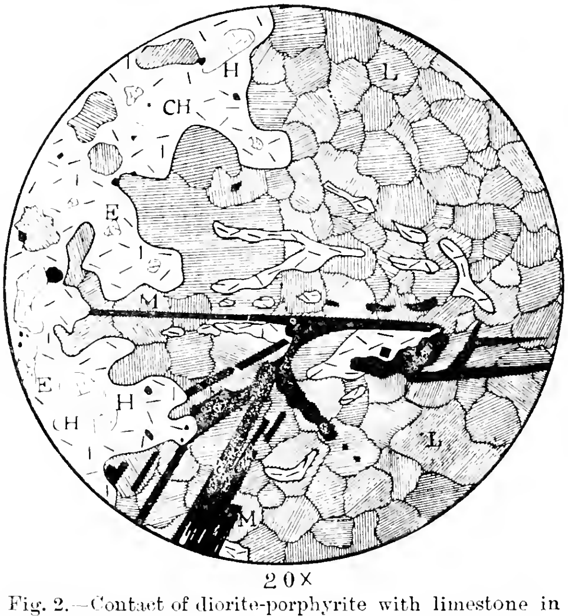

Fig. 2.—Contact of diorite-porphyrite with limestone in the Kamaishi Mine. H, Hornblende. E, Epidote. CH, Chlorite. L, Limestone. M, Magnetite.

contact with limestone, magnetite lamellæ, perhaps flattened rhombic dodecahedrons, are seen projecting from the porphyrite into the limestone (Fig. 1 and Fig. 2). While the porphyrite was in the deep as fused magma at high temperature, it was a eutectic compound with the iron content uniformly diffused throughout. But when the magma was erupted and came into contact with the limestone, its temperature fell and its chemical properties became entirely different from those it had in the deep. Magmatic differentiation took place at the margin of the magma. Magnetite was driven out of it to form the thick deposit between it and the limestone, which finally attained a thickness of 30 feet.

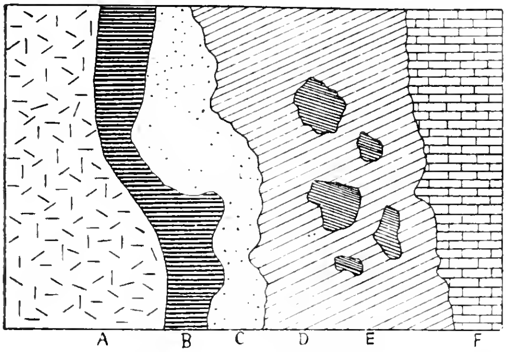

Fig. 3—Arrangement of minerals in the contact deposit of the Kamaishi Mine. A, Diorite-porpyrite. B, Magnetite. C, Garnet. D, Quartz. E, Calcite with gold. F, Limestone.

The arrangement of minerals in this contact deposit is highly instructive as to the order of the petrification of emanations (Fig. 3). Magnetite is found on the side of the diorite-porphyrite, garnet constituting the central zone comes next, and quartz on the side of the limestone. In the quartz, calcite masses are scattered about, and in them the gold is remarkably rich. The gold grains are usually microscopic, being sometimes as large as 1 cm. in length, and 0.2 cm. in diameter. They are of two kinds. One is like granulated zinc in form, and is supposed to have been solidified from the fused drops of gold in the liquid emanations exuded from the diorite magma. The colour of the gold is very fine being almost like that of pure gold. The other kind of gold is always in long prismatic crystals, acutely pointed at both ends. These are perhaps rhombic dodecahedrons, elongated on an axis. They are paler in colour, are found in the cleavage of calcite, and are supposed to be of secondary origin in contrast with the former, which are of primary origin.

Arguing from the arrangement of the minerals in the ore-deposit, I have come to the conclusion that the order of the petrification of emanations in the Kamaishi Mine must have been as follows: magnetite, garnet, quartz, gold, and calcite.

As a typical example of the mineral veins in the Kitakami Province, I shall here choose the Shikaori Mine, not very far from the Kamaishi Mine. The deposits of this mine are bedded veins running S. 5° W. along the stratification of the Paleozoic formation. As in the case of the Korean Province, the ores are composed of the hard translucent quartz of a whitish colour, which is characteristic of the so-called old vein of Prof. Vogt. The gold content in the ore is very variable. As a whole the ore is not very rich, but big nuggets have sometimes been found in the veins. A nugget called "monster"[1] consists of thick plates of gold in the cracks of the quartz ore. The fineness of the gold is estimated at 882.844 and the nuggets 910 grammes in weight. From the specific gravities of the quartz, the gold, and the nugget, I have estimated its value at 950 yen. This is one of the largest nuggets ever got from mineral veins in Japan, and is considered to be one of the best specimens of the kind in the world. Gold veins containing coarse grains of gold disposed in an irregular manner are also often found in this province, and constitute the source of gold placers.

7. The Besshi Province.

This metallogenetic province comprises the entire outer zones of South Japan and the Ryûkyû Arc, and the southern part of the outer zone of North Japan. In this province, the pyrite beds are most important—stibnite and gold veins as well as manganese beds being of rather subordinate value. The Besshi Copper Mine contains the best of the pyrite beds in this province, and for this reason it is called the Besshi Province in this paper.

The pyrite beds are chiefly found in the so-called crystalline

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[1] The description of "Monster" is given in detail in my work "Gold," p. 284, Tôkyô, 1910. (*Japanese*)

schists, the Sambagawan Series of Prof. KOTÔ.[1] They are also sometimes met with in the Paleozoic formation. As mother rocks, basic rocks such as chlorite schist[2] and graphite schist are the most favorable; serpentine is often found near the beds. Pyrite beds occur in the crystalline schists in nearly concordant stratified form, cutting them crosswise in a few instances. The pyrite beds consist of an intimate admixture of pyrite and chalcopyrite. They are so compact that these two minerals can only be distinguished from each other under the microscope after polishing, or in a few cases by the naked eye. According to SAKAWA,[3] the pyrite in the ore is usually in rounded grains, but sometimes it is crystallized, when it attains 0.7 cm. in diameter. The interspaces between the pyrite grains are filled with massive chalcopyrite, which often enters even into the cracks of the former.

Pyrite beds sometimes form lenticular bodies or rounded nodules. When they are found in the decidedly younger formation, i. e., the Paleozoic, they are usually roundish. The structure of the pyrite beds in the so-called crystalline schists is often very complex. In the central portion, there are very rich copper ores containing rock fragments, the outline of which is either rounded or indented. On one or both sides of the rich zone of the pyrite beds, there are found highly contorted ores, with regularly stratified schists on their outer sides. These contorted ores constitute the "shear zone" of Sakawa.

From the facts above stated, and after very careful examination of a great many pyrite beds in Japan, he comes to the conclusion that they are bedded veins of epigenetic origin. In my opinion, however, the original form of the pyrite beds must have been that of replacements brought up in different successive periods. After their deposition, a strong mountain-making force flattened them

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1) Kotô "On the so-called Crystalline Schists of Chichibu." *Jour. Sci. Coll. Imp. Univ. Tokyo*, Vol. II.

2) It is said that greater part of the so-called chlorite schist near the pyrite beds is amphibole-schist.

3) Sakawa: "Report on Cupriferous Pyrite Beds." *Bull. Imp. Geol. Surv. Japan*, Vol, XXII., No. 1. (Japanese).

into the form of beds, at the same time causing regional metamorphism of the country rocks. After such a geological change, a fissure was formed along the middle line of the bed, and the side-rock masses slipped down, producing the shear zone on the exterior part of the bed. Finally, a secondary enrichment took place around the faulted rocks, filling up the interspaces of the fissure. Thus the rock fragments in the beds are rounded or indented on their exterior by the dissolving action of the vadose water. This explanation will, I think, solve the varied structures of the pyrite beds in a very natural way. S. ISHIKAWA,[1] a Mining Inspector, enumerates 59 copper mines of this species in Japan, namely, 27 in crystalline schists, and 32 in the Paleozoic formation.

Quite recently very interesting gold deposits have been discovered in *central Kyûshû*, which, upon investigation, seem to be an isolated block from the Besshi Province. The region is hilly with an altitude of about 400 to 2000 ft. above sea level, and is geologically composed of a thick complex of amphibolite and phyllite belonging to the Lower Paleozoic. The amphibolite is a pale green homogeneous rock. The phyllite is a highly contorted lamellar rock, gray to black in colour, showing pearly luster by the presence of the abundant quantity of mica. The latter rock sometimes contains very conspicuous cubic phenocrysts of pyrite, which measure up to 0.5 cm. in diameter, and is usually converted into limonite pseudomorph. Examined under the microscope, the amphibolite consists of elongated green crystals of amphibole and greenish-yellow grains of epidote, cemented by a transparent quartz matrix. Phyllite shows beautiful contortion, microscopically as well as macroscopically, forming alternate layers of quartz, mica and graphite. It is a very noticeable feature that, so much gold exists throughout the rocks for several miles, that sometimes they practically become gold ore themselves. Now, it is a question whether the gold is a primary constituent of rocks, or it had been carried into them at the time of the formation of quartz

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[1] Ishikawa: "Geology and Ore-deposits of Ôshima." *Jour. Geogr. Soc. Tokyo*, No. 260, 1910 (Japanese).

veins, which traverse the rocks everywhere. The quartz veins sometimes produce very rich gold, but it is most hopeful when the gold forms placers. The placers may be divided into two distinct kinds, original and alluvial. The former is seen on the surface of the mountain region, forming the primary soil. The latter forms the placer beds in the valley. The bedded deposits are found in the form of successive river terraces, the highest and most promising measuring about 200 ft. in height; the next is on a hillside and is about 80 ft. high; while the lowest is only 6 ft. from the valley level and forms part of valley ground. These terraces cover more than several hundred acres, and form horizontal strata of gravels composed of pebbles of amphibolite, phyllite, quartz and andesite cemented by reddish clay, sand of the above stated rocks, and limonite pseudomorph after pyrite. The conglomerate bed rarely contains gold in the high proportion of from 3/1,000,000 to 9/100,000 or 1/100,000 on the average and measures from 6 to 120 ft. in thickness. The gold grains are similar in form to those from old veins, and may be classified into two groups, granular and crystallized. The colour of the granular gold is very fine, being like pure gold, and is much larger in size usually measuring as much as 3 mm. in diameter. Gold nuggets weighing 131 gr. and 67 gr. were once found in the valley. The peculiarity of this granular gold is that it is of a flattened form with cracks in it. The crystallized gold thought to be of a secondary origin is inferior in grade, and usually smaller in size, being not quite 0.5 mm. in diameter. The comparatively large size and flattened form of the granular gold is explained by the fact that the gold was formed in amphibolite or other crystalline schists in old time and subjected to intense mountain-making force during the metamorphosis of these rocks. The ore-bringer of this gold is not yet definitely known; but it is probable that the amphibolite is a rock metamorphosed from the diabase or like rocks which brought up the gold from the interior of the earth, thus doing the work of the ore-bringer itself.

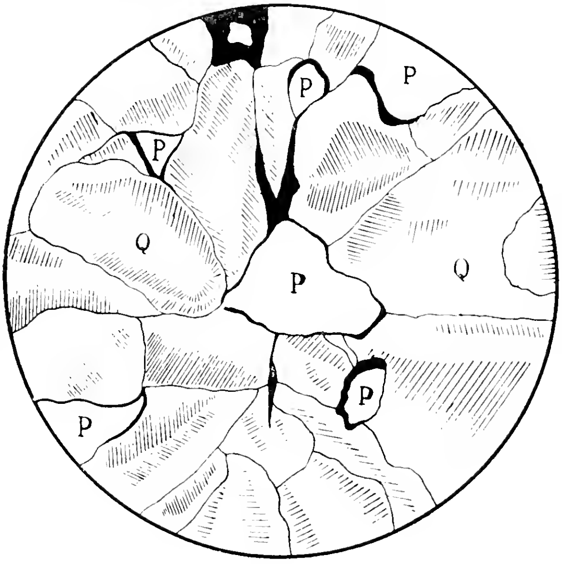
8. The Kosaka Province.

This is the region containing plagioliparite and propylite as ore-bringers, and has Kosaka as its largest and most important mine. The ore-deposits found in this province are chiefly replacements, bearing the so-called "black sulphide ore"; but there are also famous veins of various other kinds. It is a characteristic of this province that abundant sulphide minerals are always present in the ores. The presence of this character may be due to the strong acidity, or high fusing point of the ore-bringer. Even where andesite is the ore-bringer, the emanations emitted from the rocks must have been at a high temperature, and thus andesite itself was changed into propylite. Such a high temperature compels the formation of sulphide minerals, which belong to the higher order of petrification of emanations; in other words, sulphides were formed only in a temperature higher than that in which gold, quartz and calcite (all common minerals in the Satsuma Province) must be formed.

The deposits in the Kosaka Province belong to the younger veins, formed in the later period of the Tertiary or the earlier part of the Diluvium. They are most frequent in the Tertiary sediments or in the ore-bringer itself, forming replacements or veins. The province includes nearly the whole of the inner zone of North Japan, as well as isolated points in the inner zones of South Japan and the Ryûkyû Arc. The deposits in the Kosaka Province may be classified into mineral veins, black sulphide ores, and disseminations.

Mineral Veins:—These veins are of several kinds. They always bear a greater or less quantity of sulphides, but some are composed of auriferous quartz, some of quartzose copper ore, and some rich in lead or zinc. Generally speaking, the deposits in the province are the sulphide-rich, "younger" veins of Vogt.

As a type of the auriferous quartz veins, let me describe the Hasami Gold Mine, for I know it better than any other of these veins. It is situated about five miles to the south of the Arita Station on the Nagasaki line of the Kyûshû Railway. The mine was discovered only fifteen years ago, but at present it is one of the most important and hopeful gold mines in Japan. The deposit is of the true fissure-vein type traversing the Tertiary



80 ×

Fig. 4.—Quartzose gold ore of the Hasami Mine. Q, Quartz containing liquid enclosures, in parallel or radial arrangement. P, Pores connected by passages with a lining of siderite.

80×

Fig. 5.—Colony of gold in the quartzose gold ore of the Hasami Mine.

sandstone and shale, the former being the more important of the country-rocks. Quartz-trachyte is found in this concession, and is supposed to be the ore-bringer of the gold veins. Several veins are met with running N. 45° W., and dipping 70°–80° SW. They are mostly simple veins, about 5 feet thick, but sometimes assembled together, attaining even 100 feet in thickness. Usually the simple veins are regular in extent, with distinctly banded or brecciated structure. The ores now being worked are stained by limonite, for they belong to the weathered zone. When the working proceeds deeper, much sulphide is expected.

Under the microscope, the quartz in the gold ore shows a granular or hypidiomorphic structure. (Fig.4.) The outline of the quartz is always smooth, in contrast with the indented grains in the old veins. Roundish pores with narrow connecting passages are very noticeable. Both the pores and passages are lined with brown siderite. These phenomena show that, during the formation of the veins, the emanations from the quartz-trachyte (liparite) contained very large quantities of gases which were for the greater part carbonic acid remaining as siderite in some interspaces between quartz grains. This is surely one of the most important properties of the ores.

The gold grains from this mine may be divided into two classes, granular and crystallized. The former is covered with siderite, while the surface of the latter is fresh and brilliant. The gold grains are grouped together in colonies (Fig. 5).

Black sulphide ores: —Ores of this kind are found in the inner zone of North Japan. They were not investigated until late years, and HIRABAYASHI,[1] Geologist to the Mining Bureau, was the first to treat their origin and characteristics in detail. According to him, the black sulphide ore is an intimate admixture of galena, zincblende, and barite. It occurs most frequently in the form of replacements, but, in a few cases, as mineral veins or impregnations. The ore-bringers are quartz-trachyte or andesite, the latter being generally altered into propylite. Hirabayashi gave a single example of *basalt* taking the place of an ore-bringer, but I believe it was only an eruptive succeeding the formation of the deposits, as in the case of the Hol-gol Gold Mine, described by Prof. KOTÔ.[2]

The occurrence of the black sulphide ores furnishes us with materials for making clear the magmatic theory. According to Hirabayashi, there are 43 mines in Japan, in which these ores are worked. They are all in Tertiary beds, and always associated with younger volcanic rocks. In 14 mines, quartz-trachyte is found, in 10 mines andesite or propylite, and in 14 mines both these rocks together. Basalt has been found only in

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[1] Hirabayashi: "Report on Black Sulphide Ore-deposits," I. and II., Mining Bureau, Tokyo, 1908 and 1910.

[2] Loc. cit.

one mine. In the remaining three, their existence was doubtful. When the ore-deposit is in contact with the volcanic rocks, the deposit becomes thinner and thinner as we descend changing at last into a network or dissemination, and passing by imperceptible changes into the volcanic rock itself.

Impregnations:—One of the characteristics of the ore-deposits in the Kosaka Province is the abundance of impregnations. This type of ores is perhaps evidence of the intense pressure and the high temperature of the emanations. The emanations form massive deposits by impregnation in the igneous rocks such as quartz-trachyte or andesite; and sometimes they produce bedded deposits by dissemination in sandstone. When the rocks are traversed by numerous veinlets, the result of emanation is embodied in networks. Sometimes whole masses of igneous rock are changed into metasomatic ores. From these deposits gold is usually worked; copper and iron also are sometimes got from such ores. The vein-stuffs are chiefly quartz and clay; besides, pyrite, hematite, chalcopyrite and barite are found as accessory components. I shall take the Washinosu Gold Mine as an example of impregnation in the Kosaka Province.

The Washinosu Gold Mine[1] is situated in the prefecture of Iwaté in the inner zone of North Japan. The largest part of the deposits in this mine consists of impregnations in quartz-trachyte (plagioliparite) erupted through the Tertiary beds; only a small portion belongs to the Tertiary formation. The hill of quartz-trachyte is about 900 feet above the lowest water level in the concession. Veinlets traversing the eruptive are usually 1 or 2 inches thick, but sometimes they become as much as one foot in thickness, and 300 feet in length. Where the veinlets are very densely crowded, the impregnations are very rich. In the veinlets, quartz and chalcopyrite are most abundant, while barite and micaceous iron exist in small amounts. Gold is rich in the pyritic quartzose ore, but very poor in the chalcopyrite.

There are numerous gold deposits like those of Washinosu in the environs of the mine. They are also developed in the

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[1] Nishiwada: The Digest of "Report on Gold and Silver Deposits," 1907. (Japanese)

southern extremity of the Satsuma Peninsula in Kyûshû, where there is an extensive lava plain of loose andesite, through which nine independent rocky hills project, rising from 500 to 900 feet above the sea level. They are composed of a hard compact rock of a whitish colour, the petrographical properties of which are not definitely known. One geologist says it is a quartz-trachyte, but others treat it as an andesite silicified. Although all of the rocks are not quartz-trachyte, at least a part of the hills belongs to it; besides, the properties of the ore-deposits are like those of the Washinosu Mine. Nearly all the silicified rock masses of the hills contain a trace of gold. In the Kasuga Gold Mine, which has one of these deposits, the whole rock mass contains 0.0002% gold, but in the clayey veins running through it the gold content is richest going up to 0.02% and even more. In this ore-deposit, I recently discovered barite, which is always present in black sulphide ores, but as yet has not been found in other gold mines in the Satsuma Province.

9. The Satsuma Province.

The ore-deposits belonging to this province are associated with andesite as their ore-bringer. In contrast to the Kosaka Province, they are characterized by a scantiness of sulphides. The ores are chiefly composed of auriferous quartz and calcite, both belonging to the *lowest*[1] order of petrification and are generally worked for gold. Transition is seen, however, between the Satsuma and the Kosaka Province. For example, in the Sado Gold Mine, which is supposed to belong to the Satsuma Province, quartzose gold ores are associated with some sulphides, and in the Kinkwaseki Gold Mine in Taiwan (Formosa), auriferous enargite masses occur in the form of chimneys, while the Tasei Lode in the Ikuno Mine, which is supposed to belong to the Kosaka Province, is a true quartz vein. Generally speaking, the deposits in the Satsuma Province are true veins, with banded, ring or brecciated ores. The ring ores are most beautifully developed in the

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[1] Perhaps gold and quartz are of colloidal origin.

Serigano and other gold mines.

First of all, after the formation of fissures, gold, argentite and pyrite were deposited around andesite horses, at the same time that the quartz veins were formed, after that, secondary enrichment took place, and gold together with other minerals was formed upon the andesite nucleus in the inner side of the first ring. Thus double rings were produced there. Together with the above-described processes, silicification also took place in the andesite horses, which were all or nearly all changed into quartz. Although such ring ores are also found in the Kosaka Province, they are most frequent in the Satsuma Province. This is perhaps due to the greater basic property of andesite, compared with quartz-trachyte, shale, and sandstone, which are the most important mother rocks in the Kosaka Province.

The so-called replacement veins of LINDGREN[1] are also often found in the Satsuma Province, and are, as EMMONS[2] stated, distinguished by their unsymmetrical structure, variable size, complex arrangement of minerals, and the preservation in the ore of the microscopical structure of the original rocks. I have studied the replacement veins in the Ôkuchi and Kushigino Gold Mines, in the Satsuma Peninsula, southern Kyû-syû, and therefore will state here the results of my observations.

The andesite, which is the mother rock of the mines, seems to have erupted in the Tertiary or the Diluvial epoch, usually forming low undulating hills due to erosion. The rock is grey and compact, with augite and felspar phenocrysts. The former is conspicuous to the naked eye, but the felspar is not so distinct. Under the microscope, the felspar is seen to be very large, usually twinned in the Carlsbad type, enclosing augite and magnetite. The augite is monoclinic, its pleochroism being very strong. Magnetite is so abundant that the ground-mass often seems black and opaque. Brown coloured glass is abundant in the ground-mass containing microlites of felspar and augite in the fluidal-arrangement. The andesite is the pyroxene-andesite, very com-

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[1] "The Genesis of Ore Deposits," p. 517.

[2] *Loc. cit.*, p. 517.

mon in Japan, but in the Satsuma Province it is frequently rich in the precious metals, notwithstanding the fact that the andesite of other provinces is generally barren of these metals. I made a microscopic study of the ores in the replacement vein in the andesite of the Ôkuchi Gold Mine.

This andesite is generally fresh, but the felspar phenocrysts are decomposed from the central portion into brownish chloritic matter. By the penetration of a mineral solution into the fissures of the rock, felspar is kaolinized, and augite and a part of the felspar are chloritized. The groundmass is at the same time transformed into a mixture of chlorite, kaolin, and quartz. Then silica, separated from the constitution of the rock-forming minerals, is deposited in the rock masses in the shape of veinlets or rounded masses. Magnetite is dissolved, and its iron together with that secreted from the other components is deposited again as pyrite by the chemical action due to the introduction of hydrogen sulphide. The auriferous solution is reduced by the ferrous oxide formed during the decomposition of the felspar and augite, and is deposited in colonies around the chlorite pseudomorph after the augite and felspar, or is imbedded in the kaolin-silica mixture. Thus gold in rich ores exists in colonies, as in the case of the Hasami Gold Mine already referred to. In ores in the replacement veins, gold is never found in the chlorite pseudomorphs or in the quartz veinlets running through the decomposition-products of the mother-rock. It will be seen, therefore, that the introduction of gold began after the chloritization of the rock-forming minerals, and finished before the formation of the veinlets. It is, however, not well established whether the metasomatic change took place at the same time as the formation of the mineral veins, or after the completion of the vein-making and during the period of its secondary enrichment. I am of opinion that the latter is the more probable theory.

10. Summary.

The above statements may be summarized as follows:—

a. During the consolidation of magma, various magmatic emanations are exuded, by the petrification of which ore-deposits are formed.

b. A definite process of deposition of emanations determines the order of petrification, as stated in Section 3, p. 4.

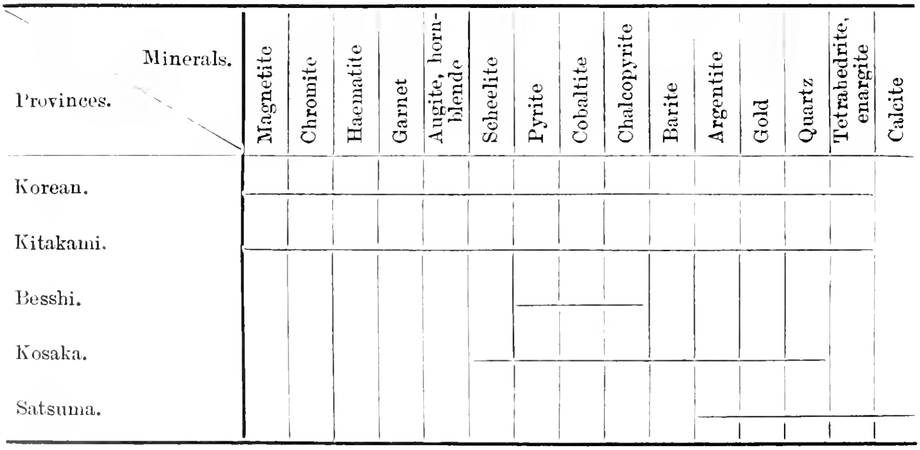
c. The ore-deposits of igneous origin may be classified into five divisions; magmatic segregations, contacts, replacements, mineral veins and impregnations.

d. There are several kinds of igneous rocks called ore-bringers, which produced the ore-deposits by their "eruptive after-action."

e. The Japanese empire is divided from the metallogenetic point of view into five provinces, according to the difference of the ore-bringers. They are as follows:—

Provinces.	*Ore-deposits.*	*Ore-bringers.*
Korean.	Contacts, veins.	Granite.
Kitakami.	Contacts, veins.	Diorite-porphyrite.
Besshi.	Beds.	Serpentine?
Kosaka.	Replacements, veins.	Quartz-trachyte, and propylite.
Satsuma.	Veins, impregnations.	Andesite.

f. The minerals in the ore-deposits in the different provinces are distributed in the order of petrification as in the following table:—



As the reader will see, in the pertrification order all the minerals except calcite are found in the Provinces of Korea and Kitakami. This is because they all belong to the older veins, which means that the formation of the minerals took place in the deep, where the temperature of the emanations was very high, the petrification continuing until the emanations got entirely cool. The pyrite beds in the Besshi Province are supposed to have been emitted from the most basic rocks such as serpentine or gabbro, and therefore only the minerals of the lower position in the petrification order are deposited there. The scantiness of quartz in the pyritic beds is explained by the basic character of the supposed ore-bringers. In the Provinces of Kosaka and Satsuma only the ore-deposits of younger formation are distributed and therefore such minerals as iron oxides or ferromagnesian silicates are never found there. Sulphides are more abundant in the Kosaka Province than in the Satsuma Province, for the fusing point of quartz-trachyte is higher than that of andesite. In the gold veins in the Satsuma Province, sulphides are very scanty, but if we go deep down we shall find much more of the sulphides which are of a higher petrification order than quartz and calcite, the two predominating vein-stuffs of the Satsuma Province.

Tokyo:
1912, October 20.

Publ. Nov. 3rd, 1912.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.

Vol. XXXII., Art. 9.

Oogonium Liberation
and
the Embryogeny of Some Fucaceous Algae.

By

M. Tahara, *Rigakushi.*

With 3 Plates and 5 Text Figures.

It had long been my wish to make some biological as well as cytological observations on the representative members of Japanese Fucaceae, as our knowledge of this family especially in respect of these points is still very imperfect.

Taking the opportunity of a short stay at the Misaki Marine Biological Station of the Tokyo Imperial University in the winter of 1908–1909, I made some observations on *Sargassum*, especially on the liberation phenomena of oogonia. The results were published in a preliminary note in the Botanical Magazine, Tokyo, Vol. XXIII. 1909.

To carry out more extensive studies, I made a second visit to the station at the end of December, 1909 and stayed there for about three months. The present paper presents the results of that visit. The substance of it was reported on the 28th of April, 1910, before a meeting of the Tokyo Botanical Society[1]; and briefer accounts were given in Japanese in the Bot. Mag. Tokyo. Vol. XXV. 1911.

According to Yendo's well known monograph on Japanese Fucaceae[2] there are eight genera of this family in Japan, namely, *Fucus*, *Pelvetia**, *Ishige**, *Cystoseira*, *Cystophyllum*, *Coccophora*, *Turbi-*

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[1] Proceedings of the Tokyo Bot. Society. Bot. Mag. Vol. XXIV., P. (246).

[2] Yendo, The Fucaceae of Japan. Journ. Coll. Sci., Imp. Univ. Tokyo. Vol. XXI., Art. 12.

*naria** and *Sargassum**; but only the four with asterisk are found at Misaki. Of these genera only a few species were available for my studies, as the other species did not come to maturity during my stay there. *Sargassum enerve, Sargassum Horneri* and *Cystophyllum sisymbrioides* furnished the principal materials of my investigation. All these three species are dioeceous. At Misaki *Sargassum enerve* grows in such profusion as often to present a serious obstacle to the navigation of smaller craft. The liberation of oogonia begins usually at the end of December.

Sargassum Horneri is also common at Misaki. The receptacle of this species are very large and well-suited for investigation. The liberation of oogonia begins at the end of December.

Cystophyllum sisymbrioides is not so common at Misaki as the former two, but it is by no means rare. The liberation of oogonia begins at about the middle of February.

First let me give my observations on oogonium liberation.

I. Oogonium Liberation.

In the preliminary paper mentioned above, I gave the following acount of my observations on the oogonium liberation of *Sargassum*.—At that time I used the term 'Oosphere liberation' intead of 'Oogonium liberation.' But strictly speaking, the products liberated from the female receptacle on the day of the so-called 'Oosphere liberation' are not oospheres but oogonia containing in their bodies one oosphere initial.

"On the 24th of December 1908, the next day after the full moon, almost all individuals of *Sargassum enerve* of the coast discharged their oospheres simultaneously. The discharged oospheres stayed on the receptacle for about three days and then dropped off also simultaneously, so that on the 28th there was not a single stock that bore the sporelings on the receptacle.

"After a fortnight, i. e. on the day of new moon, the next general liberation of oospheres occurred."

These facts reminded me of the periodical liberation of sexual products in *Dictyota dichotoma* and led me to the conclusion that, "The liberation of oospheres in *Sargassum* takes place simultaneously, not only for a given plant, but also for all plants of the same locality. This simultaneous liberation proceeds in fortnightly crops on a particular day with a fixed interval after the highest spring tide, the interval varing however in different species."

As this conclusion was based on observations made during a relatively short time, naturally entire confidence could not be put in its validity. My second visit to Misaki was made mainly to determine this point.

I arrived at Misaki on the 27th of December, 1909, which was just the day before the highest spring tide. To my disappointment I found that most of the *Sargassum* growing in that locality had not yet attained their maturity and for some time no general oogonium liberation could be observed.

The first general oogonium liberation of *Sargassum enerve* occurred in fact on the 12th of January, the next day after the highest spring tide. Three days later, on the 15th of January, the first general oogonium liberation of *Sargassum Horneri* also took place.

So far these observations confirmed in the main the record of the preceding year. But the liberation went on thereafter quite irregularly, without showing any fixed relation to the highest spring tide. The actual state of things is shown in the following table.

Species	Jan.	Feb.
S. enerve	12* 21 31	11* 16
S. Horneri	15 23	2 14 21

The numbers in the table denote the dates of general oogonium liberations. The intervals between two successsive liberations is quite irregular, for example, the intervals in *Sargassum enerve* are 5, 6, 9, 10 or 11 days. But the intervals between the two corresponding liberations in *Sargassum enerve* and *Sargassum Horneri* are, as is seen from the table, tolerably constant; namely, two or three days after the liberation of *Sargassum enerve* occurs almost always the liberation of *Sargassum Horneri*. The same relation is given in my record of the previous year.

The highest spring tides occurred on the 11th and 25th of January and on the 10th and 24th of February. The dates with asterisk in the table correspond to the days next after the highest spring tides.

I have also observed such oogonium liberation in *Sargassum Kjellmanianum*, *Sargassum tortil*, and *Cystophyllum sisymbrioides*. In these algae too, the successive liberations do not seem to show a fixed relation to the highest spring tide; for example, in *S. Kjellmanianum* the liberations took place on the 7th, 15th and 23rd of February and in *Cyst. sisymbrioides* on the 17th of February and the 3rd and 20th of March.

All these facts led me to the conclusion that the liberation of oogonia in *Sargassum* and *Cystophyllum* takes place periodically and simultaneously among individuals of the same species growing in the same locality; but the intervals between two successive liberation vary in an irregular manner, without having at least any fixed relation to the highest spring tide. Thus the liberation phenomena in our plants are somewhat different from those in *Dictyota dichotoma*, the periodicity of which was studied first by WILLIAMS[1] and recently by HOYT[2] and LEWIS.[3] Probably owing to differences in local conditions, the result of the observations of these authors do not agree in details, but all of them agree that the liberation phenomena of this alga have a certain relation to the highest spring tide.

To ascertain how the liberation of oogonia proceeds under artificial conditions, I kept some branches of *S. Horneri* and *Cyst. sisymbrioides* in a glass vessel filled with sea-water. To prevent contamination the culture water was renewed almost every day. The liberation did not occur as in nature at all; but after about a

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1) WILLIAMS, Studies in the Dictyotaceae. Ann. Bot., XIX. 1905.

2) HOYT, Periodicity in the production of the sexual cells of *Dictyota dichotoma*. Bot. Gaz., XLIII. 1907.

3) LEWIS, Periodicity in *Dictyota* at Naples. Bot. Gaz. L. 1910.

month's culture the branches liberated the oogonia in a very feeble manner.

I often observed the actual mode of oogonium liberation in *Sargassum* and *Cystophyllum* in common sea-water under the microscope. But when I collected some small branches on the day before the day of an oogonium liberation and put them into a mixture of sea-water and fresh water (one volume of sea-water to four of fresh water proved to be the best proportion). I could quite easily observe the mode of the oogonium liberation. I studied the mode of oogonium liberation in *S. Horneri* more minutely than in other species, and the following description refer to this plant.

Generally speaking, the paraphyses of *Sargassum* do not protrude from the conceptacle as they do in *Fucus*. In *S. Horneri* they compose a disklike plug at the opening of the conceptacle. In a few seconds after immersion in the mixture medium above mentioned, the plug comes out slowly, with some broken pieces of paraphyses on its inner surface (Text. Fig. 1); and then the conceptacle commences to discharge its oogonia one after another. The discharged oogonium has a thick outer layer of gelatinons substance, which trails out a tail fastened to the interior of the conceptacle (Text Fig. 1). In one or two days the gelatinous substance becomes less rigid and the tail can no more be recognized with certainty, but still for a time the discharged oogonium remains attached to the receptacle.

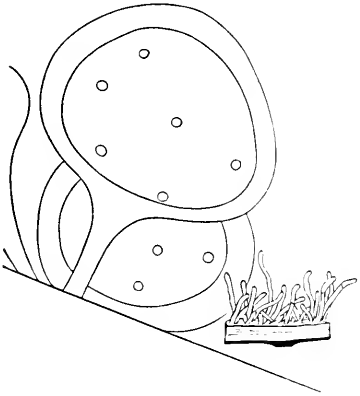

Fig. I. ×140

As already stated in my preliminary note, the oogonia in one receptacle are not liberated at one time, but in succession, one zone after another in acropetal order. Fig. 1 of Plate I shows the receptacle in its first oogonium liberation: the black spots on the receptacle are oogonia. The area in which the discharged oogonia have already dropped off shows a remarkable contrast to the area in which the oogonia are in situ in the conceptacle (Fig. 2, PL. I). Fig. 3, PL. I shows the second oogonium liberation. The older part of the receptacle becomes more slender and the surface has the appearance of a young pine cone (Figs. 2, 3, 4, PL. I).

The mode of oogonium liberation in *Cystophyllum sisymbrioides* differs considerably from that of *S. Horneri* and deserves special mention. The receptacle of *Cyst. sisymbrioides* is rather small and slender and what is remarkable is that it shows no trace of the conceptacle opening on its outer surface. As above stated *S. Horneri* has something like a plug at the conceptacle opening, but the outline of the conceptacle opening on its outer surface can be seen under the microscope without any difficulty; this however, is not the case with *Cyst. sisymbrioides.*

On the day before the oogonium liberation, paraphyses in this alga begin to grow very rapidly. As there is no opening, paraphyses must make their way through the outer wall of the conceptacle. The tips of paraphyses peeping out through the cracks on the outer surface of the receptacle are disposed quite regularly in a line parallel to the main axis of the receptacle. And in the mean time, the oogonium liberation takes place in the same way as in *Sargassum*; paraphyses continue to grow and entangle with one another about the oogonia, giving an appearance of a mycelium growing on a nutritive substratum (Fig. 1, PL. III). As in the case of *Sargassum*, the liberation at one time is always restricted to a zone of receptacle, the liberation proceeding acropetally. The discharged oogonia remain attached to the surface of the receptacle for about five days and then drop off, when the paraphyses protruded from the conceptacle and entangled about the oogonia are also cleared away from the surface of the receptacle.*

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* The protruded paraphyses are at first relatively stiff, but become gradually slushy.

I often came across some detached branches of *Cyst. Turneri*, floating on the sea near the Marine Biological Station; and the receptacle on the branches bore many discharged oogonia within the mass of entangled paraphyses. Thus the rapid growth of paraphyses at the time of the oogonium liberation appears to be a characteristic of the genus *Cystophyllum*.

II. Early Stages of Embryogeny.

Since the appearance of OLTMANNS' classical work on Fucaceae[1], it has been generally believed that in the Fucaceae in general the three successive nuclear divisions in the oogonium take place before the formation of oospheres, no matter how many oospheres come to function in one oogonium.

At this stage of the discussion Miss E. B. SIMONS' paper on *Sargassum filipendula*[2] attracted the attetion of plant morphologists. According to her, in this alga the three successive nuclear divisions before the oosphere formation are entirely suppressed and the one nucleus of the oogonium initial remains in a resting condition throughout the entire period of growth of the oogonium and becomes directly the nucleus of the single oosphere,

During my stay at Misaki, I paid special attention to this point and was so fortunate as to be able to observe the successive developmental stages of the oosphere in the oogonium of *Sargassum* and *Cystophyllum*. The result of my observations differs, however, remarkabley from that of Miss SIMONS; namely the oogonium development in these algae is quite normal, showing the usual three successive nuclear divisions in the oogonium.

As a matter of course, the periodical oogonium liberation is accompanied by the periodical development of the oogonium. All the oogonia in one conceptacle are liberated at one time, so the developmental stage of all the oogonia in one conceptacle is always the same. In other words, differing from the other cases

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1) OLTMANNS, Beiträge zur Kenntnis der Fucaceen. Bibl. Bot. Cassel. 1898.

2) SIMONS, A morphological study of *Sargassum filipendula*. Bot. Gaz. XVIX. 1906.

in Fucaceae[1], in *Sargassum* and *Cystophyllum* one can not observe several developmental stages of the oogonium in the same conceptacle. Not only the same conceptacle, but also all the materials collected on the same place, on the same day, do not show in general the several developmental stages of the oogonium.

After the occurrence of an oogonium liberation, the single nucleus of the oogonium, which is to be liberated for the next period, remains in a resting condition for a time and for the first time on the day before the day of the next oogonium liberation, the nucleus begins to divide to form the nuclei of oospheres, and the oogonium attains the di- or tetra-nucleate condition. On the day of the liberation, the oogonium contains eight nuclei evenly distributed in its substance; the dense mass of chromatophores assembled around each nucleus facilitates the counting of the number of the nuclei. Fig. 1, PL. II, Fig. 3, PL. III show this condition of the oogonium in *S. Horneri* and *Cyst. sisymbrioides* respectively. NIENBURG's recently published paper on *Cystoseira* and *Sargassum*[2] states also that three successive nuclear divisions take place in the oogonium before the formation of oospheres. While the result of my observations is based on living materials, NIENBURG made his study on the microtome-sections of fixed materials. At any rate the occurrence of the three successive nuclear divisions in the oogonium development seems to be general in Fucaceae. The eight nuclei formed in one oogonium have at first the same appearance. But *Sargassum* and *Cystophyllum* develop only one egg in one oogonium, so only one of the eight nuclei becomes the functional nucleus of the oospheres and the others are destined to degenerate in the course of future development. Fig. 4, PL III shows a stage in which some of the eight nuclei are about to degenerate. The degeneration of the seven nuclei does not proceed simultaneouly.

In other Fucaceae the superfluous nuclei are regularly thrown out into the space between the oogonium wall and the oosphere. But it seems to me that this is not the case in *Sargassum* and

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[1] OLTMANNS, Beiträge zur Kenntnis der Fucaceae, Bibl, Bot. 1889. p. 84.

[2] NIENBURG, Die Oogonentwicklung bei *Cystoseira* und *Sargassum*. Flora Bd. I. 1910.

Cystophyllum, for in living materials I have very often had the chances to observe the stage of oogonium development, in which such cast off plasma-masses would likely be found, had they ever been present, but I failed to find any trace of such a body.

It is rather a curious fact that none of the foregoing observers have succeeded in observing not only the fertilization but even the moving spermatozoids in *Sargassum* and *Cystophyllum*. Miss SIMONS writes in her paper already cited that, "A study of fertilization in *Sargassum* is surrounded by serious technical difficulties, because both eggs and sperms develop upon the same plant, thus making it difficult to isolate the sexual cells." As above described, the common species of *Sargassum* and *Cystophyllum* in our coast are all dioeceous, so the difficulty pointed out by Miss SIMONS does not occur in our materials. Nevertheless the study of the fertilization of these algae, both in living and fixed materials, is not an easy task. I have never succeeded in observing even the spermatozoid itself. From the phenomena of the periodical development of the oospheres, one naturally presupposes the periodical development of spermatozoids, but I could find no sign of such a phenomena in the antheridia of these plants.

Now let me give my observations on the development of the sporelings of *Sargassum* and *Cystophyllum*. The early development of these algae goes on within the oogonia which after having been discharged from the conceptacle, are attached to the surface of the receptacle: this condition fascilitates the investigation in no small degree. The later development may also be studied easily in materials cultured in a glass basin. The method is very simple. I collected some small branches of these algae which carried many hundreds of attached sporelings on their receptacles and cultured them in natural sea-water, some of the sporelings may in the course of development fall to the bottom of the glass basin but many remain attached to surface of the receptacle for a long time and still persue the normal course of development. The detached sporelings become fastened to the bottom of glass basin and may also be used for investigation.

Generally speaking, the oospheres of *S. Horneri*, *S. enerve* and *Cyst. sisymbrioides* are equally oval or elliptical and common to all of them the first segmentation wall runs perpendicular and about midway to the long axis of the oosphere (Fig. 2, PL. III; Fig. 5, PL. III): the second wall runs parallel to the first, cutting off a small lens-shaped cell at one end of the sporeling. NIENBURG states in his paper, "Die erste Wand steht senkrecht zur Längsachse. Die zweite steht senkrecht auf der ersten und teilt das Vorderende in zwei gleiche Hälften. Darauf wird von der unteren Spitze durch eine Wand, die der ersten parallel ist, eine schmale Rhizoidzelle abgeschnitten." Thus his observations do not agree with mine.

Further development differs in *Sargassum* and *Cystophyllum*, and would better be described separately.

Sargassum.

The lens-shaped cell, cut off by the cecond segmentation wall will hereafter be called for the sake of convenience the 'Rhizoid cell.' This cell divides simultaneously with the segmentations of the other cells, until the eight-celled stage is reached. The segmentations of the rhizoid cell are quite regular and the segmentation wall are all perpendicular to the outer surface of the sporelings. (Figs. 5, 8, 9, PL. II) clearly show this regularity. While the segmentation of the other cells proceeds further, the rhizoidal portion remains in the eight-celled stage, and in the mean time the rhizoid formation begins. At the outset, we see the papilla-like protuberances, eight in number (Fig. 11, PL. II). These protuberances grow gradually and become a group of rhizoids arranged in a circle. But later there arises in the central region another group of rhizoids which elongate with greater rapidity so that they become longer than those of the first and outer group (Figs. 13 and 14, PL. II). This difference in length becomes, however, obscure in the further development of the rhizoids, the outer group of rhizoids also growing rapidly (Fig. 15, PL. II).

To ascertain, if possible, the origin of this central group of rhizoid I made some microtome-sections of the sporelings in this stage. Text-Fig. 2 was drawn from one of such sections. The two rhizoids in shade are the descendants of the rhizoid cell formed by the second segmentation wall. Other rhizoids situated in the central portion seem to have been derived from the body cells, without having any direct relation to the above mentioned rhizoid cell. In the later development the number of rhizoids gradually increases. The rhizoids are at first unicellular but later we find several partitions here and there (Fig. 16, PL. II). Under a strong magnification we see peculiar thickenings on the cell walls of the rhizoids, which remind us of the spiral thickenings of tracheids of higher plants (Fig. 16 b, PL. II). The cells contain small granules of what seems to be a fat-like substance, so far as can be seen by the reactions of osmic acid and Sudan III. The same substance is found not only in the rhizoids but also very abundantly in the body cells in general.

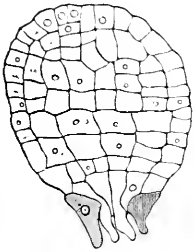
Fig. 2. ×140

For a long time, the shape of the sporelings remains oval or elliptical, but later becomes like a flask and at last at the boundary between the slender and the swollen part of the sporeling, there grows a new branch (Figs. 17–20, PL. II). This is the last stage that I observed at Misaki.

Cystophyllum.

The segmentation process in the rhizoid cell of this plant differs considerably from that above described; that is, in this plant before the rhizoid formation begins, the rhizoid cell is already divided into about 30 small cells. Text-fig. 3 is the surface view of the rhizoidal potion of the sporeling and text-fig. 4 presents a median longitudinal section of the same. In the latter figure, we can see the two-storied arrangement, a

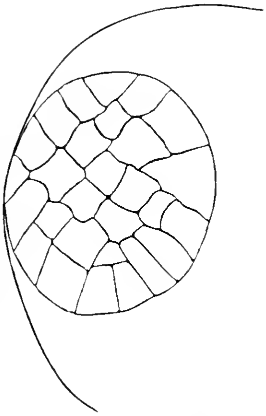
Fig. 3. ×240

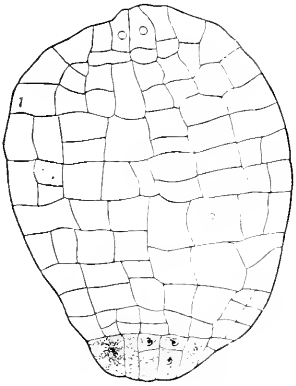

Fig. 4. ×140

state which is never found in *Sargassum*. The rhizoid cells elongate to form a numebr of rhizoids; similar to what has been described in the case of *Sargassum*, the rhizoids originating from the central region grow more rapidly than those originating from the outer region (Fig. 8, PL. III). But in this case the central group of rhizoids are also derived from the rhizoid cell formed by the second segmentation wall, although in later development there may be some rhizoids derived from body cells as in *Sargassum*.

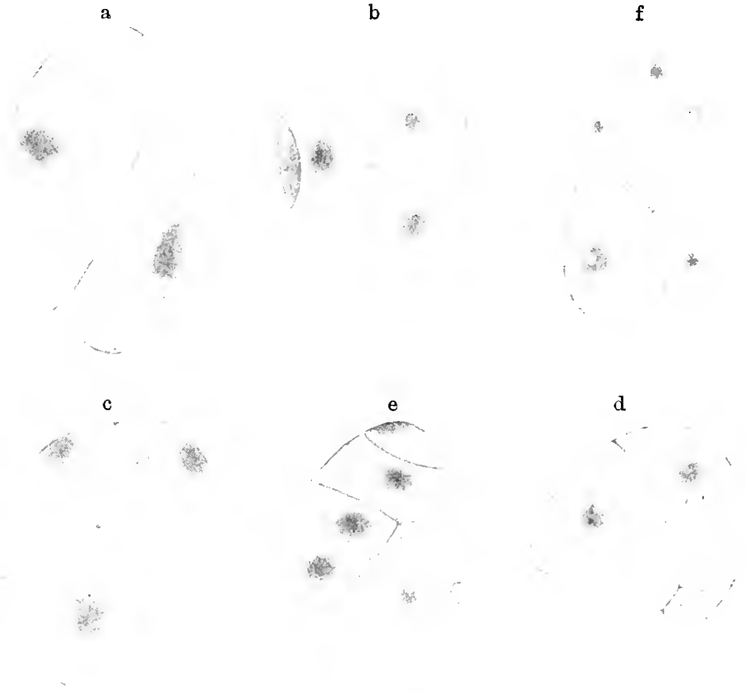

Fig. 5. ×175

As already stated, the early development of sporelings, both in *Sargassum* and *Cystophyllum*, is carried out while they are enveloped in the oogonium wall. But in the course of development the wall ruptures at one end by the pressure of the growing rhizoids (Fig. 14, PL. II) and the sporeling becomes free thereafter.

During the study of the sporeling-development I often met with different abnormities and some which are interesing are shown in text-fig. 5. These abnormities are often found, especially in *S. enerve*, and all these figures were sketched from the sporelings of this alga. Fig. 5, *a* represents an abnormity in which the first segmentation wall is oblique to the long axis, fig. 5, *b* is the later stage of this abnormity, *c* and *d* of the same figure show something like 'Simultan-dreier' and 'Simultan-vierer.' Superfluous nuclei in the oogonium often fail to degenerate, and this results in the formation of a curious abnormity in the later development (Fig. 5, *f*).

In conclusion I wish to express my hearty thanks to Professor K. FUJII for his valuable suggestions and assistance given me during the progress of this work and to Professor IIJIMA, the director of the Misaki Marine Biological Station through whose kindness many facilities were afforded me in the course of my investigations.

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Publ. March. 31st, 1913.

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OOGONIUM LIBERATION AND THE EMBRYOGENY OF SOME FUCACEOUS ALGAE.

Plate I.

Explanation of Pl. I.

Female receptacle of *Sargassum Horneri.* All figures were drawn with the aid of camera lucida from living materials. Magnification: ca. 10 times.

Fig. 1. First oogonium liberation.

Fig. 2. After the oogonia discharged in the first liberation had dropped off.

Fig. 3. The second oogonium liberation.

Fig. 4. After the oogonia discharged in the first and second liberations had dropped off.

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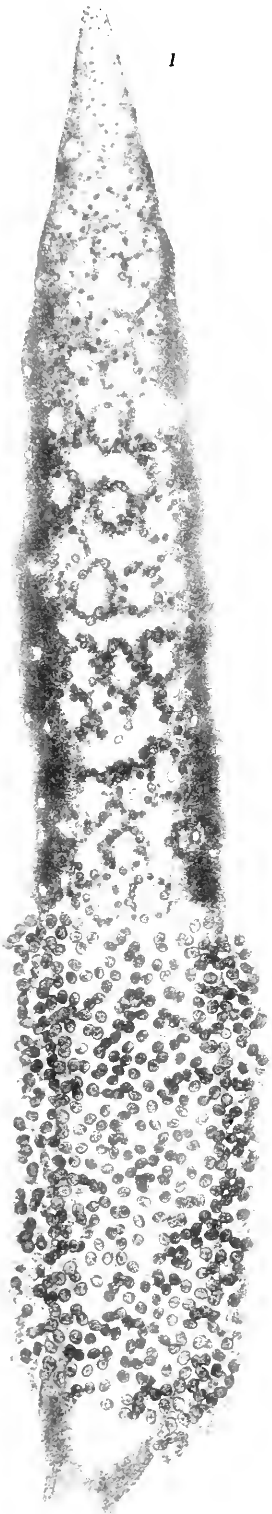

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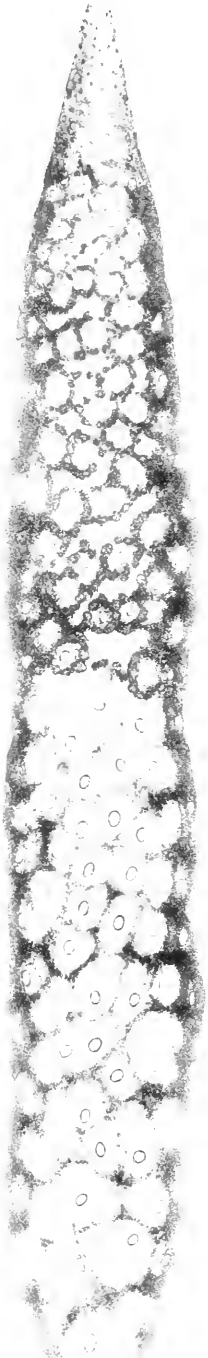

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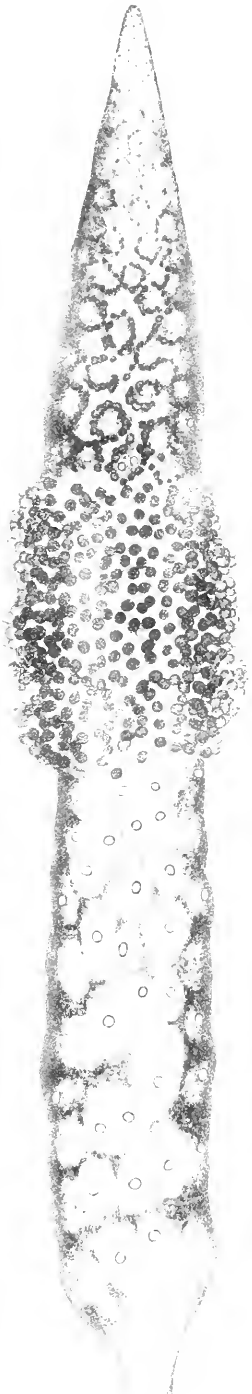

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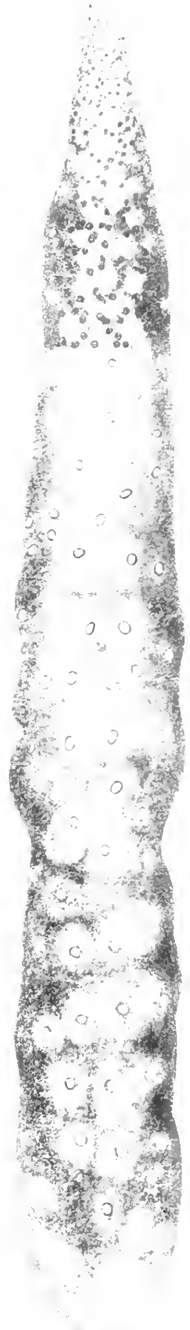

M. Tahara del.

M. TAHARA.

OOGONIUM LIBERATION AND THE EMBRYOGENY OF SOME FUCACEOUS ALGAE.

Plate II.

Explanation of Pl. II.

Sporeling-development of *Sargassum Horneri.* All Figures were drawn with the aid of camera lucida from living materials. Magnifications: fiigs. 1–16a ca. 140 times; figs. 17–20 ca. 50 times; fig. 16b ca. 500 times.

Fig. 1. Oogonium with eight nuclei, chromatophores grouped around the nuclei.

Fig. 2. First segmentation.

Fig. 3. Second segmentation, forming the rhizoid cell at one end.

Fig. 4. Beginning of the third segmentation.

Fig. 5. Completion of the third segmentation.

Fig. 6, a. Side view at the beginning of the 4th segmentation.

Fig. 6, b. Polar view of the same.

Fig. 7. First segmentation of the rhizoid cell.

Fig. 8. Second segmentation of the same.

Fig. 9. Rhizoid cell in the eight-celled stage.

Fig. 10. Further segmentation of body cells. Rhizoid cell remains in the eight-celled stage, a, side view; b, polar view.

Fig. 11. Beginning of rhizoid-formation.

Fig. 12. Rhizoids somewhat elongated.

Figs. 13–16 a. Further development of rhizoids.

Fig. 16 b. The terminal portion of a rhizoid.

Figs. 17–20. Development of the body of a sporeling.

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M. TAHARA.

OOGONIUM LIBERATION AND THE EMBRYOGENY OF SOME FUCACEOUS ALGAE.

Plate III.

Explanation of Pl. III.

Female receptacles and sporeling development of *Cystophyllum sisymbrioides*. All figures were drawn with the aid of camera lucida from living materials. Magnifications: figs. 1 and 2. ca. 10 times; figs. 2–9 ca. 170 times.

Fig. 1. Female receptacle in the first oogonium liberations. Paraphyses protruding from the conceptacle and forming a mass resembling a mycelium.

Fig. 2. After the oogonia discharged in the first liberation had dropped off.

Fig. 3. Oogonium with eight nuclei.

Fig. 4. Some of the eight nuclei in the oogonium about to degenerate.

Fig. 5. The first segmentation.

Fig. 6. The second segmentation.

Figs. 7–9. Later stages of the sporeling development.

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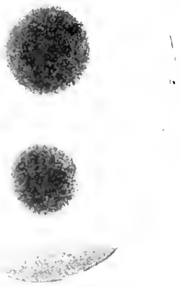

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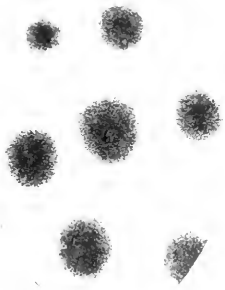

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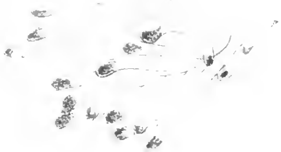

M. Tahara del.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XXXII., ART. 10.

Beiträge zur Kenntnis der Morphologie und Stammesgeschichte der Gorgoniden.

Von

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Mit 13 Textfiguren.

I. Einleitung.

Die Gorgoniden waren früher für eine ganz natürliche Gruppe gehalten worden. Heutzutage werden sie jedoch auf Grund der Forschungen von v. Koch, Studer und vielen anderen allgemein als diphyletisch angesehen. Sie zerfallen nämlich in die Ordnung Gorgonacea, Axifera v. Koch oder Holaxonia Studer, bei welchen die Skeletachse, wie bei *Primnoa*, *Isis*, *Gorgonia*, etc., lamellöse Struktur zeigt, und in die Ordnung Pseudaxonia v. Koch oder Scleraxonia Studer, bei welchen das Innere der Kolonie zur Skeletachse, die in sich spikuläre Struktur erkennen lässt, differenziert ist.

Während die Trennung in diese zwei Gruppen fast allgemeine Anerkennung gefunden zu haben scheint, ist doch die morphologische Bedeutung der Kolonie von den verschiedenen Forschern ungleichartig angedeutet, und infolge dessen sind die Ausgangspunkte dieser beiden Gruppen bei verschiedenen Formen gesucht worden. Und es dürfte wohl klar sein, wenn man einmal die Litteratur durchsieht, dass diese Verhältnisse noch von niemand ganz endgültig aufgeklärt worden sind.

In dieser Abhandlung nun beabsichtige ich also einige Tatsachen zu schildern, welche geeignet sein dürften auf diese

Fragen Antwort zu geben. Hier möchte ich mir erlauben, auch an dieser Stelle, den Herren Professoren IJIMA und GOTO für ihre vielfachen Ratschläge und ihr stetiges Interesse während der Ausführung dieser Arbeit, meinen herzlichsten Dank auszusprechen.

MILNE-EDWARDS (**1**) 1857 schloss in der Familie Gorgonidae diejenigen festsitzenden Alcyonarien zusammen, bei denen das Innere der Kolonie durch die Skeletachse, welche entweder homogene oder lamellöse Struktur zeigt, eingenommen ist. Als ein anderes Hauptmerkmal der Familie hob er besonders hervor, dass alle Polypen kurze Magenhöhlen besitzen, wodurch sie sich von denjenigen der Alcyonaceen, welche stark verlängert und nach der Basis der Kolonie allmählich verschmälert sind, deutlich auszeichnen.

Diese Familie teilte MILNE-EDWARDS in drei Unterfamilien, Gorgoninae, Isidinae und Corallinae, ein.

Die Skeletachse der Gorgonaceen nun hielt er, ebenso wie LAMARCK (**1**), EHRENBERG (**1**) und DANA (**1**,**2**), für ein Sekret des Ektoderms der Basis. Dieselbe tritt nun nach ihm anfänglich an der Kontaktfläche des Ektoderms mit dem Substratum in der Form einer dünnen Lamelle auf; sie wird jedoch durch wiederholte Ansätze neuer Lamellen allmählich erhoben, sodass endlich eine einfache oder verzweigte Skeletachse zustande kommt.

Neben den typischen Formen, welche die Skeletachse eben erwähnter Art besitzen, führte er in die Familie Gorgonidae auch diejenigen Formen ein, deren Skeletachse suberöse Struktur erkennen lässt (*Briareum*, *Solanderia*, *Paragorgia*), und dazu auch noch eine solche Form, bei welcher Stamm und Zweige von einer zentralen weiten Höhlung durchsetzt sind (*Coelogorgia*). Alle diese einbezogenen Formen gruppierte er in "Briarées," welche eine "Agèle" der Gorgoninae bildeten. Nun, wenn man nach seiner Bemerkung über die Gattung *Paragorgia* schliesst, welche ich folgends anführe, scheint er diese Gruppe als die primitivste der Gorgoniden betrachtet zu haben.

"Ce genre établit le passage entre les Gorgoniens et les Alcyoniens. Il tient de ces derniers par la texture de son axe qui paraît être formé par un coenenchyme trés developpé, et non par un tissu sclérobasique, comme chez les Gorgones, le Corail, etc.; mais il se rattache à ceux-ci par la conformation des polypes, dont la cavité viscérale ne se prolonge pas inferieurement dans le coenenchyme, et se termine brusquement en forme de cul-de-sac arrondi.''

Lacaze-Duthiers (**1**) 1863 wies nach, dass die Skeletachse von *Corallium rubrum* nicht durch die Ausscheidung eines Epithels, sondern durch die Aggregation der Skleriten im Innern des Coenenchyms gebildet wird.

Eine ähnliche Entwicklungsweise der Skeletachse wurde von Kölliker (**1**) 1866 bei der Skeletachse der *Sclerogorgia* und bei den harten Achsengliedern von *Melithaea* und *Mopsea* mit aller Bestimmtheit bewiesen. Weiter wandte derselbe Autor die Idee, dass die Skeletachse bei diesen Gorgoniden im Innern des Coenenchyms entsteht, auch auf diejenigen Formen der Gorgoniden an, bei welchen die Skeletachse eine einfach lamellöse Struktur erkennen lässt. Kölliker betrachtete also die Gorgoniden ganz als eine einheitliche Gruppe.

Er klassifizierte die Alcyonarien folgendermassen:

Ordo: Alcyonaria M. E.

Fam. I. Alcyonidae M. E. Festsitzende Alcyonarien mit langen Leibeshöhlen.

Subfam. I. Cornularidae M. E.

Subfam. II. Alcyonidae.

Fam. II. Pennatulidae M. E. Freie Alcyonarien mit langen Leibeshöhlen.

Fam. III. Gorgonidae M. E. Festsitzende Alcyonarien mit kurzen Leibeshöhlen.

Subfam. I. Gorgonidae M. E. Mit ungegliederter horniger oder verkalkter Axe, die eine Ausscheidung des Parenchyms ist.

Subfam. II. Isidinae. Axe gegliedert, aus hornigen und verkalkten Stücken zusammengesetzt, von denen die letzteren einen lamellösen Bau besitzen und nach dem Ausziehen der Salze in ihrer Form sich erhalten.

Subfam. III. Briareaceae M. E. Gorgoniden, deren Inneres aus verschmolzenen Spicula besteht, die zum Theil eine ziemlich gut begrenzte Axe bilden.

Subfam. IV. Sclerogorgiaceae Köll. Gorgoniden mit ungegliederter Axe, die aus Hornsubstanz und verschmolzenen Kalkkörpern besteht. Coenenchym wie bei Gorgonia.

Subfam. V. Melithaeaceae. Axe gegliedert. Die weichen Glieder bestehen aus getrennten Kalknadeln, umgeben von Hornsubstanz und Bindegewebe, die harten Glieder aus verschmolzenen Kalkkörpern.

Subfam. VI. Corallinae M. E. Axe ungegliedert aus krystallinischer Kalkmasse und mit derselben verschmolzenen Kalkkörpern gebildet, die beim Auflösen der Erdsalze in der Form sich nicht erhält.

In dieser Klassifikation ist besonders zu beachten, dass Kölliker unter den Charakteristiken der Familie Gorgonidae den grössten Wert darauf legte, dass die Polypen alle kurze Magenhöhlen besitzen, und auch dass er in die Unterfamilie Briareaceae die kriechenden Formen wie *Sympodium* und *Erythropodium*, welche sonst in die Familie Alcyonidae gestellt worden waren, hineinbrachte.[1] Dies scheint die Ansicht Kölliker's über die Abstammung der Gorgoniden anzuzeigen, dass die baumförmigen Briareaceae direkt von den kriechenden Briareaceae ohne irgend eine Zwischenform in der Alcyonidae abgestammt seien.

Später jedoch beschrieb Kölliker (3) 1870 seine neue Gattung *Siphonogorgia*, die er, seiner früheren Meinung widersprechend, für eine Zwischenform zwischen den Gorgoniden und Alcyoniden hielt. Darüber sagt Kölliker Seite 22 folgendes:

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1) Vergl. auch Kölliker (2).

"Erwägen wir nun nach der Beschreibung von *Siphonogorgia* ihre Stellung im Systeme und ihre Verwandtschaften, so ergibt sich, dass dieselbe weder den Gorgoniden, noch auch den Alcyoniden eingereiht werden kann, vielmehr eine Zwischenform zwischen diesen beiden grossen Abtheilungen der achtarmigen Polypen oder Alcyonarien darstellt. Mit den Gorgoniden und zwar mit der Unterfamilie der Briareaceen stimmt dieselbe durch den Gesammthabitus so überein, dass sicherlich jeder, der *Siphonogorgia* zuerst sieht, diese Form den Gattungen *Paragorgia* oder *Semperina* Köll. anreihen und selbst im Zweifel sein wird, ob sie nicht zu der einen oder andern dieser Gattungen gehört. Wie bei den Gorgoniden ist auch das Sarcosoma von *Siphonogorgia* durch Kalknadeln sehr hart und zerfällt wie bei den Paragorgiaceae mihi in eine Rinden- und in eine Kernsubstanz. Ganz abweichend von den Gorgoniden ist auf der anderen Seite, dass die Darmhöhlen (Leibeshöhlen der Aelteren) der Polypen von *Siphonogorgia* nicht kurz sind, sondern wie bei den Alcyoniden in lange Kanäle, die von mir sogenannten Darmröhren auslaufen, die durch den ganzen Stock sich erstrecken, und kommt dieser Thatsache die grösste Wichtigkeit zu, die nur in etwas dadurch abgeschwächt wird, dass von den acht Septa der Polypen nur 4 in dieses Röhrensystem übergehen, und nicht alle acht, wie bei den Alcyoniden. Ausserdem ist der grosse Reichthum des Sarcosoma an Ernährungsgefässen und an Bindesubstanzzellen auch etwas, das bei den Gorgoniden selten sich findet (bei einigen Briareaceen), bei den Alcyoniden dagegen sehr häufig ist."

Auf diese Gattung errichtete Kölliker eine besondere Unterfamilie, Siphonogorgiaceae, welche er in die Familie Gorgonidae, und zwar neben die Briareaceae stellte.

Klunzinger (**1**) 1877 schloss sich über die Ableitung der Gorgoniden gänzlich Kölliker an. Auch er meinte nämlich dass die Gattung *Siphonogorgia* den Uebergang von den Alcyoniden zu den Gorgoniden, und zwar spezieller von den *Spongodes* zu den Briareaceen, bilde. Die Briareaceen soll Klunzinger nur auf die Paragorgiaceae Köll. (Köll. **2**, S. 11) beschränkt haben, da er

Sympodium[1] aus den Briareaceen ausschied und in die Cornulariden stellte.

Die bis jetzt angeführten Forscher betrachten die Gorgoniden als eine einheitliche Gruppe, indem sie diese Formen nach den Beschaffenheiten der Skeletachse, welche sie bei allen Gorgoniden für morphologisch homolog hielten, wenn sie auch dieselbe als mesogloeales oder ektodermales Sekret ansahen, nur in einige Untergruppen teilten.

v. Koch (**2**) 1878 wies jedoch bei *Gorgonia verrucosa* zwischen dem Coenenchym und der Skeletachse eine Epithelschicht nach, die er Achsenepithel nannte und für eine solche hielt, welche zweifellos die Skeletachse ausgeschieden hatte, da die Bindesubstanz überhaupt gar nicht mit der Skeletachse in Berührung stand.

Die Existenz einer solchen Epithelschicht konnte er (**3**) auch später in demselben Jahre noch bei einigen anderen Gorgoniden konstatieren. Da er sich nun durch diese Untersuchung davon überzeugte, dass die Skeletachse bei diesen Gorgoniden von derselben bei *Melithodes*, *Corallium*, etc., welch letztere spikuläre Struktur zeigt, morphologisch gründlich verschieden ist, so nahm er die Gorgoniden als eine diphyletische Gruppe an, und demgemäss teilte er dieselbe in zwei Familien ein: namentlich Axifera und Pseudaxonia, von welchen die erstere den Unterfamilien Gorgonidae und Isidinae, die letztere den Unterfamilien Sclerogorgiaceae, Melithaeaceae und Corallina in der Klassifikation von Köllker (**1**) entspricht. Ueber die Ableitung der Pseudaxonia schloss sich v. Koch den Ansichten von Kölliker (**3**) und Klunzinger (**1**) an. Die Axifera aber wollte er von den Cornulariden oder von den Alcyoniden ableiten. Darüber sagt er Seite 476 folgendermassen:

"VIII. Die Berechtigung dieser Familie (Axifera) lässt sich wohl nach der vorhergegangenen Auseinandersetzungen nicht mehr bezweifeln. Ihre näheren Verwandtschaftsverhältnisse zu den übrigen Gruppen lassen sich vor der Hand nicht mit Genauigkeit angeben, doch ist zu vermuthen, dass sich entweder

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[1] *Erythropodium* ist hier von Klunzinger nicht behandelt.

bei den Cornularien oder bei den Alcyoniden (im letzteren Falle wohl in Verbindung mit den Pennatuliden) Anknüpfungspunkte finden lassen.''

v. Koch (**5**) 1882 berichtete vorläufigerweise die Resultate seiner Untersuchung über die Entwicklung von *Gorgonia cavolini*, die er (**6**) später 1887 in einer Monographie der Zoologischen Station zu Neapel ausführlich beschrieb.

In derselben Untersuchung konnte er feststellen, dass das Achsenepithel, welches er vormals bei den verschiedenen Gorgoniden nachgewiesen hatte, in den früheren Stadien der Entwicklung sich von dem Ektoderm der Fussscheibe des Primärpolypen ableitet. Unter den übrigen Resultaten, welche v. Koch in dieser Untersuchung erlangte, ist auch besonders zu beachten, dass die Skeletachse bei ihrem Wachstum in die Magenhöhle des Primärpolypen hineintritt, und dass der Stamm selbst eine modifizierte aborale Hälfte des so von der Skeletachse durchgezogenen Primärpolypen darstellt. Was die Verhältnisse des Polypen und der Skeletachse anbelangt, so fasse ich hier aus den Schilderungen v. Koch's folgendes zusammen:

Das Ektoderm der Fussscheibe des fertig gebildeten Primärpolypen scheidet die Hornlamellen wiederholt aufeinander aus, welche allmählich einen kleinen Höcker, den Anfang der Skeletachse, bilden. Der letztere dringt in die Magenhöhle des Primärpolypen ein, indem er die drei primären Gewebsschichten vor sich treibt. Der so entstandene Hügel liegt immer exzentrisch in der Polypenhöhle und verschmilzt teilweise mit der Körperwand, teilweise mit den benachbarten Mesenterien. Ob die Lage der Skeletachse in Bezug auf die Mesenterien eine konstante ist, wurde nicht festgestellt, doch fiel sie nicht in die Sagittalachse. Ehe der Hügel die Höhe der Mundscheibe des Polypen erreicht, beginnen die um ihn liegenden Teile der ursprünglichen Polypenhöhle mehr Selbständigkeit zu zeigen und sich als Anfänge der späteren Ernährungskanäle zu dokumentieren. Im Verlaufe des weiteren Wachstums werden die Ernährungskanäle noch selbständiger und erhalten auf der dem Schlundrohr entgegengesetzten Seite der Skeletachse schon nahezu die Anordnung wie an einem älteren Busche. Später grenzt sich der Polyp von dem die Skeletachse umschliessenden Teile durch eine Furche ab, und wird, da er bald im Wachstum hinter dieser zurückbleibt, und diese geradeaus wächst, auf die Seite gedrängt und erscheint bald nur als ein Anhängsel des wachsenden Stammes. Der zweite Polyp bildet sich aus einer Erweiterung eines Ernährungskanals, in die gewöhnlich noch zwei benachbarte Kanäle münden, auf der dem ersten Polypen, oder eigentlich nur oraler Hälfte desselben, entgegengesetzten Seite. Auf ähnlicher Weise entstehen weitere Polypen. Der Stamm und auch die Zweige der Gorgonidenkolonie also stellen je die aborale Hälfte der Axialpolypen dar. In den Zweigen, wie bei *Muricea* in welcher die acht Stammkanäle gleichmässig um die Skeletachse angeordnet sind, ist der Bautypus der Polypen selbst sehr gut beibehalten.

Obgleich v. Koch nun sich damit die Gorgonacea von der *Rhizoxenia* ausgegangen zu sein dachte, ergibt sich doch aus seinen Schilderungen dass die Gorgonidenkolonie gerade einen Bautypus der *Telesto* besitzt, und auch dass es nicht *Rhizoxenia*, sondern *Telesto* ist, welche als die Ahnenform angenommen werden darf.

In derselben Abhandlung äusserte v. Koch auch ausführlicherweise seine Ansicht über die Ableitung der Pseudaxonia, welche er vorher (**3**) in Kürze ankündigte. Er schloss sich nämlich Kölliker (**3**), Klunzinger (**1**) und Hickson (**1**) gänzlich an. Er sagt darüber Seite 7 folgendes:

"In derselben Richtung schreitet dann die Ausbildung der Gestalt weiter fort, begleitet von einer Regularisierung der Polypenhöhlungen und ihrer sie verbindenden Gefässe, deren Veränderungen in der Lage der Skelettheile zur Seite gehen, und es entstehen Buschformen, die sich denen der echten Gorgonien nähern. Von solchen sind anzuführen *Siphonogorgia* und Verwandte. Wird durch weitere Vermehrung oder durch Verschmelzung der Skelettheile die Colonie immer mehr geeignet, sich selber zu tragen, so werden die Aeste schlanker und ihre Verzweigung reicher und die Gefässe werden immer regelmässiger in ihrem Verlaufe, so dass sie zuletzt einen regelmässigen Zylinder

(Kreis in Querschnitt) bilden, welcher den Axentheil von der Peripherie trennt. Ersterer behält dann bloss die Function des Tragens, letzterer dient als Schutz für die Polypen und ihre Verbindungskanäle. Eine Anschauung von dieser allmählichen Umwandlung geben am besten die in Figur 19–21 dargestellten Querschnitte von *Siphonogorgia*, *Corallium* (Zweigspitze, weiter unten ähnlich wie bei folgender Gattung), *Mopsea* (Hornglied). Von anderen dieser Reihe angehörenden Formen sind noch zu erwähnen *Briareum*, *Semperina*, *Sclerogorgia*, *Melithaea* etc.''

Diese Ansicht v. Koch's über die Struktur der Kolonie der Scleraxonia und über die Stellung derselben in den Alcyonacea ist in der folgenden Synopsis der Familien, welche er (**7**) 1890 in seinen vorläufigen Mitteilungen über die Alcyonaceen des Golfes von Neapel gab, bestimmt ausgesprochen:

I. Polypen miteinander durch basale Stolonen oder Stolonenplatten verbunden. Die Länge der vollständig ausgebildeten Polypen einer Colonie nahezu gleich.
Fam. *Cornularidae.*

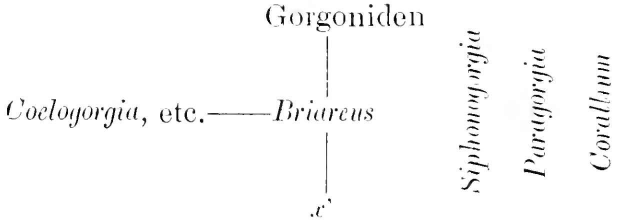
II. Polypen mit einander durch verästelte Röhren verbunden, die in verschiedener Höhe über der Basis einer Kolonie verlaufen und deren Wände zu einer gemeinsamen Masse verschmolzen sind. Die Länge der vollständig ausgebildeten Polypen kann sehr ungleich sein und ist dann von deren relativem Alter abhängig.

1. Spicula von einander getrennt. Fam. *Alcyonidae.*
2. Spicula entweder durch Hornsubstanz oder durch krystallinische Kalkausscheidung zu zusammenhängenden Skeletten vereinigt.
Fam. *Scleraxonidae.*

v. Koch meinte nämlich dass die Pseudaxonia den Alcyoniden ähnlich gebaut seien, indem die Polypen, wenn vollständig gewachsen, Längendifferenz zeigen und also in verschiedenen Ordnungen stehen.

Etwas früher als die Veröffentlichungen der letzteren zwei Arbeiten v. Koch's, hat Hickson (**1**) 1883 mit besonderer Berücksichtigung auf die Schlundrinne, Siphonoglyph, einen Versuch gemacht, die Alcyonarien systematisch zu klassifizieren. Was nun die Stammesgeschichte der Gorgoniden anbelangt, so stand er auch Kölliker (**3**) und Klunzinger (**1**) nahe. Er nahm die *Siphonogorgia* als die gemeinsame Ahnenform von *Paragorgia* und *Corallium* an. Von einer hypothetischen *Alcyonium*-ähnlichen

Ahnenform (x') wollte er *Briareus* ableiten, von welchem er wieder *Siphonogorgia*, *Coelogorgia* etc., und auch die übrigen Gorgoniden abgestammt dachte.



Studer (**2**) veröffentlichte 1887 seinen Versuch eines Systemes der Alcyonarien, welches auf das umfangreiche Material des Challenger basierte. Im demselben hielt er die Gorgoniden ebenso wie v. Koch für eine diphyletische Gruppe und teilte sie ein in zwei Sektionen, Scleraxonia und Holaxonia, welche resp. beinahe den Familien Pseudaxonia und Axifera v. Koch's entsprechen. Was die Ableitung dieser Gruppen anbelangt, so war er jedoch der Meinung, dieselben von den anderen Ahnenformen, als denjenigen in der Auffassung v. Koch's, abzuleiten

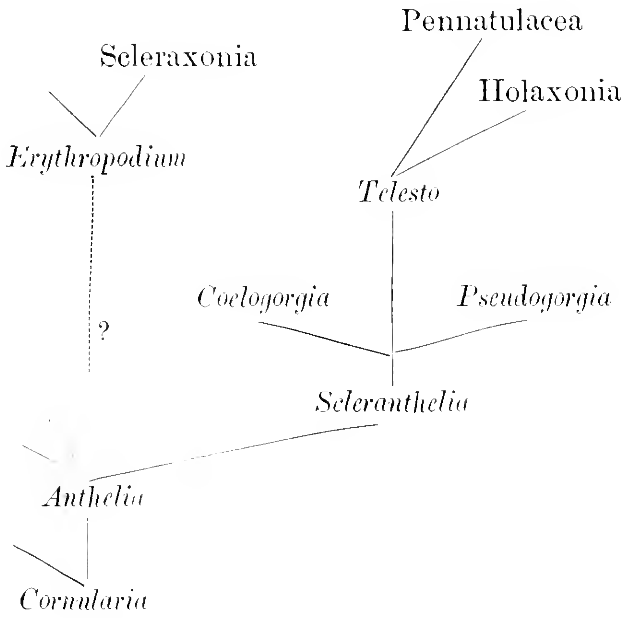
Als den Bautypus der Holaxonia stellt sich Studer eine *Telesto*-Kolonie vor, deren Stamm und Zweige je einen verlängerten Axialpolypen darstellen und zahlreiche Seitenpolypen mit kurzen Magenhöhlen tragen. Die Gorgonienkolonie, meint er, lasse sich von der *Telesto*-Kolonie leicht ableiten, wenn man bei der letzteren die zentrale Höhlung der Axialpolypen von unten her von einer zur Skeletachse sich differenzierenden Mesodermwucherung, welche sich am besten mit der Kolumella der Madreporarier vergleichen lässt und natürlich das Entoderm der Axialpolypen—Achsenepithel—vor sich herschiebt, ausgefüllt denkt. Die Radialfächer der Verdauungshöhle der Axialpolypen könnten dabei direkt zu in Achtzahl auftretenden Stammkanälen umwandeln.

Diese Auffassung, dass die Stämme und Zweige je die Axialpolypen darstellen, stimmt gewissermassen mit den Schilderungen v. Koch's (**5**, **6**) überein. Der Unterschied zwischen den Ansichten beider Autoren liegt nur darin, dass die Axialpolypen nach Studer meist nicht mehr vollständig geformte, sondern reduzierte, rein vegetative Individuen sind, während dieselben nach v. Koch sich den gewöhnlichen Polypen vergleichen lassen.

Betreffs der Herkunft der Skleraxonier äusserte Studer die folgende Idee:

"Eine solche Anordung ist aber nur von Vortheil unter günstigen Nahrungsverhältnissen, unter denen nicht nur den Randpolypen, sondern auch den im Centrum der Colonie befindlichen gleichmässig die Beute zugeführt wird, oder wo die Colonie mannigfach gestaltete Körper überzieht, welche bewirken, dass die Einzelthiere in verschiedene Lage zu einander kommen, und verschiedene Wasserschichten beherrschen. Immer wird dieses abhängig sein von dem Vorkommen der Fremdkörper, welche als Unterlage dienen. Der Vortheil der Vertheilung der Einzelthiere wird jedoch bei höheren Formen in anderer Weise erreicht. Die Colonie, statt Fremdkörper zu überziehen, erhebt sich von einer Basis, welche sich überrindend an fremde Körper anheftet, frei in die Höhe in Form eines Blattes, dessen eine Fläche die Polypen einnehmen, während die andere der Basalseite der Rasenkolonie entspricht. Aus statischen Gründen bleibt aber die Colonie nicht flächenhaft, sondern rollt sich röhrenförmig zusammen, so dass die polypentragende Seite nach aussen kommt, die frühere Basis die Innenwand der Röhre darstellt. Zugleich gruppiren sich im Coenenchym besonders differenzirte Spikula dicht an einander, um eine aus Spicula gebildete stützende Axe darzustellen. Diese Verhältnisse zeigen noch niedere Briareiden, so *Solenocaulon*, bei höheren Typen ist diese Axe mehr entwickelt, rückt ins Innere der Colonie und bildet einen cylindrischen Stab, der rings von polypentragendem Coenenchym umgeben ist. In dieser Weise können wir uns die Ableitung der Scleraxonia, deren höchste Form *Corallium* darstellt, entwickelt denken."

Kükenthal (**1**,**2**) schloss sich über die Ableitung sowohl der Gorgonacea als auch der Scleraxonia beinahe gänzlich der Ansicht Studer's an. Die Gattungen *Telesto* und *Erythropodium* nahm er resp. als die Ahnenformen der Gorgonacea und Scleraxonia an. Diese Auffassung ist in dem folgenden Schema, welches er Seite 99 gab, leicht zu ersehen:



Wenn er Seite 52 bemerkt, dass *Alcyonium* (*Erythropodium*) *contortum*, welches einen durch die Kutikula gefütterten basalen Hohlraum zeigt, die Zwischenform zwischen den Alcyonaceen und den Gorgonaceen bildet, bezog sich dies wahrscheinlich auf die Scleraxonia und nicht auf die Axifera hin, da er (**3**) später eine ähnliche Umbildung bei *Solenocaulon stechei* berichtete, von der er glaubte, dass sie für die *Solenocaulon*-Hypothese eine neue Stütze liefere.

Im Gegensatz zu den übrigen neueren Forschern betrachtete Hickson (**3**) 1906 die Gorgoniden, welche nach ihm sich von den Alcyonacea nur durch die von den Polypenhöhlen nicht durchzogene Skeletachse unterscheiden, als eine monophyletische Gruppe. Er fasste also die Pseudaxonia und die Gorgonacea als Unterordnungen in der Ordnung Gorgonacea zusammen. Die Ansicht Hickson's über die Abstammung dieser beiden Gruppen ist in den Sätzen, welche ich folgends wörtlich anführe, wohl ersichtlich:

"It has been suggested that as the Axifera represent a line of descent distinct from that of the Pseudaxonia they should be placed in a separate order. Apart from the character of the axis, however, the two suborders show so many affinities in their general anatomy that it is better to regard the two lines of descent as united within the Gorgonacean limit. It is very improbable that the two groups sprung independently from a stoloniferous ancestor."

Wie schon angedeutet, scheinen die neueren Forscher mit alleiniger Ausnahme von Hickson alle darin übereinzustimmen, die Gorgoniden als diphyletisch zu betrachten. Während diese Trennung wohl ausser Zweifel gesetzt zu sein scheint, bleibt jedoch die Frage, ob bei den beiden Gruppen die Axialpolypen vorkommen oder nicht, ganz unentschieden. Uebrigens ist die morphologische Bedeutung der Skeletachse beider Gruppen von den verschiedenen Forschern verschieden beantwortet, so dass ihre Ableitung auch verschiedenartig versucht worden ist.

In dem folgenden also möchte ich nunmehr über die morphologische Bedeutung der Kolonie und über die Stammesgeschichte der Gorgoniden, besonders von dem Standpunkte meiner Auffassung aus, diskutieren.

II. Gorgonacea.

Wie im vorigen Kapitel angeführt, ist die morphologische Bedeutung der Gorgonidenkolonie sowie die Abstammung der Gorgonacea von den verschiedenen Forschern abweichend aufgefasst worden.

Kölliker (**3**) und Hickson (**1**), welche beide die Gorgoniden als einheitlich betrachteten, meinten dass die Gorgonacea, durch Zwischenformen wie *Siphonogorgia* oder *Briareum*, von den Alcyoniden abzuleiten seien. Diese Auffassung beruht jedoch auf die Voraussetzung dass alle unter den Gorgoniden zusammengefassten Formen phyletisch einheitlich seien. v. Koch (**2**, **3**, **5**, **6**) jedoch stellte fest, dass die echten Gorgoniden einen anderen Entwicklungszweig als die Skleraxonier darstellen; er glaubte dass dieselben von der *Rhizoxenia* ausgegangen seien. **Studer** (**2**), der die Gorgoniden auch als diphyletisch betrachtete, war der Ansicht, dass dieselben, ganz wie es sich aus den Schilderungen v. **Koch**'s (**6**) ergibt, von den Telestiden abgeleitet werden müssen. Während man Grund hat, die Auffassung der ersteren zwei Forscher als veraltete anzunehmen, scheint doch die Idee, dass die Gorgonacea aus den Telestiden ausgegangen seien, jetzt allgemein zu herrschen. Der Grund, weshalb diese so allgemeine Annerkennung fand, liegt wahrscheinlich darin, dass v. **Koch** und **Studer**, obgleich sie die Skeletachse morphologisch ganz verschieden andeuteten, doch gleich übereinstimmend die Existenz der Axialpolypen behaupteten. Diese hier in Bezug genommene Idee scheint mir jedoch, wie ich im folgenden zeigen möchte, nicht ganz statthaft zu sein.

Beim Studium der Stammesgeschichte der Gorgonacea nun ist es dringend wichtig die folgenden zwei Punkte voraus festzustellen: 1) Die morphologische Bedeutung der Skeletachse; und 2) die Art und Weise, wie die Polypen sich an der Kolonienbildung beteiligen, oder in welcher die Polypen und das Coenenchym im Zusammenhange stehen. In dem folgenden beziehe ich mich nun auf diese Fragen.

1. Morphologische Bedeutung der Skeletachse.

Lamarck (**1**), **Ehrenberg** (**1**), **Dana** (**1**,**2**) und **Milne-Edwards** (**1**) sahen die Skeletachse der Gorgoniden als ein epitheliales Sekret an. Diese Annahme war jedoch nicht auf wirkliche Beobachtung gestützt. **Kölliker** (**1**) konstatierte die Tatsache, dass die Teilnahme der Skleriten an der Ausbildung der Skeletachse, was schon bei *Corallium rubrum* von **Lacaze-Duthiers** (**1**) nachgewiesen worden war, auch bei denjenigen Formen der Gorgoniden, welche man jetzt in den Melitodiden und Suberogorgiiden zusammenfasst, der Fall ist. Da es ihm aber nicht gelungen war, bei den echten Gorgoniden ein Epithel zwischen der Skeletachse und Mesogloea nachzuweisen, sah er diese Skeletachse als ein mesogloeales Sekret an.

Als Stütze dieser Annahme führte KÖLLIKER die folgenden fünf Gründe an:

"1) Manche Axen dieser Abtheilung schliessen, wenn auch nur zufällig, im Innern vereinzelte Kalkkörper des Coenenchyms ein, was zu beweisen scheint, dass der Zusammenhang zwischen Coenenchym und Axe ein viel grösserer ist, als man bisher anzunehmen geneigt war.

"2) In der That habe ich auch nirgends als Begrenzung des Coenenchyms gegen die Axe eine Epithelschicht gefunden, wie sie doch dasein müsste, wenn die gang und gäbe Auffassung der Axen die richtige wäre.

"3) Scheinen die netzförmigen Verbindungen, die die Axen vieler Gorgonien eingehen (*Rhipidogorgia* etc.) zu beweisen, dass die Axen innere Productionen des Coenenchyms sind. Wenn nämlich Aeste verschmelzen, so verschmilzt erst das Coenenchym derselben und erst dann bildet sich eine Vereinigung der Axen auf Kosten des Coenenhyms, wie man am besten daraus sieht, dass diese Axentheile häufig viele Kalkkörper einschliessen.

"4) Der Bau der fraglichen Axen ist derart, dass sie viel mehr an Bindesubstanz als an Cuticularbildungen sich schliessen, und erinnere ich vor Allem 1) an die feinen Fasernetze im Centralstrange und dem Schwammgewebe der Rinde bei vielen Gattungen mit hornigen Axen und 2) an den Bau der Weichtheile der Pennatulidenaxen mit ihren feinen Fäserchen und sie durchsetzenden Radialfasern.

"5) Endlich erwähne ich noch eine Thatsache, die im Allgemeinen zeigt, dass auch Hornsubstanz für sich allein im Innern des Coenenchyms sich bilden kann. Bei *Alcyonium palmatum* fand ich in Einem Falle in den oberen Theilen des Stammes eine kurze Axe aus lamellöser Hornsubstanz, rings umgeben von der gewöhnlichen Bindesubstanz des Coenenchyms, eine Bildung, die sicher nicht auf eine Epithelialausscheidung zurückzuführen ist."

KÖLLIKER verglich somit die Skeletachse mit den Kalkkörpern. Darüber drückte er Seite 167 aus: "Zum Schlusse kann ich die Bemerkung nicht unterdrücken, dass die Bildung einer Gorgoniden- und Pennatulidenaxe, sofern sie aus homogener Substanz besteht, im Grossen das wiederholt, was ein spindelförmiger Kalkkörper im Kleinen zeigt."

Studer (**1**)[1] trat dann an die Seite von Kölliker. Nach ihm bildet sich die Skeletachse folgendermassen: Die Spicula dringen aus dem Coenenchym in die Tiefe, dienen als Centra für die Hornablagerung; sie werden aber dort später resorbirt und an ihre Stelle treten mit spongiöser Substanz ausgefüllte Lücken; sie bleiben nur in seltenen Fällen erhalten.

v. Koch (**2**, **3**) jedoch zeigte, dass diese Auffassung von Kölliker und Studer ein Irrtum ist. Er fand nämlich bei einigen Gorgonien das Achsenepithel um die Skeletachse, welches er (**5**, **6**) nachher embryologisch als vom Ektoderm der Fussscheibe des Primärpolypen herstammend feststellte.

Studer (**2**) aber mass diesem Befunde keinen Glauben bei. Obgleich er auch das Vorkommen eines Epithels um die Skeletachse bestätigte, nahm er dasselbe doch nicht als das Ektoderm an. Diese Auffassung Studer's wurde 1905 von Schneider (**1**) abermals durch wirkliche Beobachtungen zu stützen versucht. Wenn er jedoch sagt, dass das Achsenepithel die Zellauskleidung des axialen Hohlraumes sei, so ist ihm hierin keinen Glauben zu schenken.

Diese Frage nun glaube ich durch meine Untersuchungen über die Entwicklung von *Anthoplexaura dimorpha* beinahe entschieden zu haben.[2] Hier ist das Achsenepithel, ganz wie die Befunde v. Koch's, entschieden ein Derivat vom Ektoderm der Fussscheibe, mit welcher der junge Primärpolyp an dem Substratum anwächst. Da beim Wachsen des jungen Primärpolypen die Erweiterung der Fussscheibe an der Peripherie nicht gleichmässig stattfindet, so rückt die Stelle, wo das Achsenepithel und das Sekret desselben, die Skeletachse, sich befinden, nach einer Seite zu, was auch bei den v. Koch'schen Exemplaren als allgemein angegeben worden ist.

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[1] Diese Arbeit Studer's stand mir leider nicht zur Gebote, darum habe ich mich mit den Zitaten in den Abhandlungen von v. Koch (**6**), Studer (**2**) und Schneider (**1**) begnügen müssen.

[2] Kinoshita (**1**).

Das Achsenepithel ist von der Form eines blinden Sackes und setzt sich weder in das Entoderm der Solenia, welche sich in der Mesogloea um das Achsenepithel reichlich entwickeln, noch in dasjenige der Magenhöhle des Primärpolypen fort. Es ist also ganz unmöglich, dass dieses Achsenepithel entodermal ist, wie dies von Studer und Schneider behauptet wurde. Auch kann dasselbe bei den Zweigspitzen der erwachsenen Kolonien, falls das Achsenepithel dort nachweisbar ist, ebenso mit Sicherheit behauptet werden.

Das Achsenepithel scheidet die dünnen Hornlamellen wiederholt aus, welche nur in ihrem zentralen Abschnitt durch die gallertartige Substanz getrennt, doch durch ein diese durchziehendes Fasernetzwerk, verbunden sind. Eine gute Vorstellung von der Skeletachse gewinnt man, wenn man diese Hornlamellen mit Probiergläsern vergleicht, welche derart tief in einander gesteckt worden sind, dass an den Boden derselben enge Zwischenräume zurückbleiben. Aus dem Verhalten des Fasernetzwerks in der interlamellären Gallerte könnte man schliessen, dass die Hornlamellen zuerst dicht auf den vorhergehenden ausgeschieden, und erst nachher durch die Anschwellung der dazwischen vorhandenen Gallerte auseinander getrennt worden sind. Die Tatsache, dass die Skeletachse, soweit meine Erfahrung reicht, immer mit der Hornlamelle, aber nie mit der Gallerte endet, macht diese Vermutung wahrscheinlich.

Es ist nun beinahe nicht mehr zu bezweifeln, dass bei den gewöhnlichen Gorgoniden die Skeletachse, welche die lamellöse Struktur besitzt, das Sekret des Achsenepithels ist. Dieses letztere ist jedoch nicht immer gleich leicht nachweisbar, da dasselbe nicht selten Umbildung zu erleiden scheint.

v. Koch (**2**, **3**, **6**) beschreibt dass das Achsenepithel am Zweigende im allgemeinen aus den höheren Zellen besteht, die aber proximalwärts immer niedriger werden, um endlich ganz flach zu werden. Nach meinen Erfahrungen scheint das Achsenepithel auch in den unteren Abschnitten der Zweige sich ähnlich zu verhalten. Darin dass das derart membranartig gewordene Epithel noch die Sekretionsfähigkeit beibehält, darf einiger

Zweifel gesetzt werden. Dieser nimmt im Grade zu, wenn man hierbei das Verhalten der Skeletachse von *Keroeides*[1] in Betracht zieht. Diese Gattung, obgleich sie diagnostisch von den gewöhnlichen Gorgonaceen sehr weit abweicht, scheint doch eine allgemeine Tendenz zur Reduktion des Achsenepithels zu zeigen. Bei *Keroeides* verhält sich die Skeletachse folgendermassen:

Dieselbe besteht aus zwei Komponenten gänzlich differenten Ursprungs. Es sind nämlich der hornig lamellöse Zentralstrang und die sklerogorgische Rindenlage.

Der erstere, welchen schon HILES (**1**) 1899 gesehen, aber nicht näher studiert hat, zeigt deutlich die eigentümliche Struktur, welche bei den gewöhnlichen Gorgonaceen ganz allgemein zu sehen ist. Die Rindenlage, die den ersteren dicht und direkt umschliesst, ist von ganz typisch sklerogorgischer Struktur, sodass WRIGHT und STUDER diese Gattung in die Suberogorgiidae hineinstellte, da die Existenz des Zentralstranges ihnen unbekannt blieb. Sie besteht aus den spindelförmigen Skleriten und der dieselben verkittenden Hornsubstanz, welch letztere allmählich ohne Grenze in die Substanz der Mesogloea übergeht. Verfolgt man nun die Skeletachse nach der Zweigspitze hin, so sieht man sie die Scheidewand hindurchziehen, welche die Magenhöhlen der meist gegenüber stehenden Apikalpolypen von einander trennt, und gerade unterhalb der oberflächlichen Skleritenschicht des Zweigapex terminieren. Dieselbe besteht auf einige Länge nur aus dem Zentralstrange und ist, soweit es nackt bleibt, von dem fingerhutförmigen Achsenepithel bekleidet. Die spindelförmigen Skleriten, welche die Rindenlage aufbauen, sieht man schon in der Mesogloea der oben erwähnten Scheidewand, wohin das Achsenepithel noch reicht, sich ausbilden. Unten aber werden diese Skleriten um den Zentralstrang durch die Hornsubstanz gebunden, wobei die Zellen des Achsenepithels in die Mesogloea sich verlieren und wahrscheinlich schliesslich zugrunde gehen.

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[1] KINOSHITA (**2**).

Durch Betrachtung der erwähnten Verhältnisse der *Keroeides*-Skeletachse wird man gewahr von der Analogie welche zu bestehen scheint zwischen diesen und der Tatsache dass bei manchen Gorgoniden, in der Rindenlage der Skeletachse im unteren Abschnitte der Zweige, zahlreiche Rindenskleriten sich eingebettet zeigen, was wohl einer anderen Erklärung zu bedürfen scheint, als dass sie nur aus mechanischen Gründen in die Rindenlage hineingekommen sind.

Ein etwas differenter, doch ähnlicher Fall der Umbildung der Skeletachse wurde neuerdings von MÜLLER (**1**) bei *Corallium* berichtet. Diese Gattung ist nach ihm, wie schon v. KOCH (**3**) vermutete, eine echte Gorgonie mit einem vollkommenen Achsenepithel, welches die Kittsubstanz ausscheidet, während die Skleriten, welche die Skeletachse aufbauen, anfangs im Coenenchym gebildet werden und dann durch das Achsenepithel in den Abschnitt der Skeletachse hineinkommen.

2. *Morphologische Bedeutung der Polypen.*

KÖLLIKER (**1**) gab der Familie die Charakterisierung, dass die Polypen kurze Magenhöhlen besitzen, und er brachte in diese Familie die kriechenden Formen, *Sympodium* und *Erythropodium*, hinein. KÖLLIKER also scheint gemeint zu haben, dass die Polypen der Gorgonidenkolonie alle gleichwertig sind, und dass die Stämme und Zweige alleinig aus dem Coenenchym bestehen, ohne Beteiligung der Polypen. Diese Auffassung hat er jedoch später fallen lassen. Er nahm nämlich die *Siphonogorgia*, wegen der vier bleibenden Mesenterien in den unteren Abschnitten der Polypenhöhlen (Stammkanälen) als eine Zwischenform zwischen den Gorgoniden und den Alcyoniden an. Nach dieser Auffassung stellen die Stämme und Zweige deutlich nicht das eigentliche Coenenchym, sondern die Bündel verlängerter Polypen (Axialpolypen) dar.

v. KOCH (**5**, **6**) erlangte in seiner Untersuchung über die Entwicklung von *Gorgonia cavolini* unter anderm ein wichtiges Resultat, dass nämlich die wachsende Skeletachse in das

Coelenteron des Primärpolypen eindringt. Obgleich v. KOCH selbst die Gorgonien nicht von den Telestiden, sondern von der *Rhizoxenia* ableiten wollte, ergibt sich doch offenbar aus diesem Resultate, dass der Aufbau der Gorgonienkolonie, ganz wie STUDER behauptet, dem *Telesto*-Typus angehört.

Diese Idee hatte wahrscheinlich auf STUDER (**2**) Einfluss, wenn er, auf das Challenger-Material basierend, seine Hypothese vorschlug, dass die Gorgonien in ihrem Aufbau der Kolonie vom *Telesto*-Typus seien und demnach von der *Telesto* abzuleiten seien. Die Stämme und Zweige stellen nach ihm je die Axialpolypen dar. In normalen Fällen werden die acht Radialfächer der Magenhöhle der Axialpolypen direkt zu den acht Stammkanälen. Die Fälle, in welchen die letzteren weniger als acht zählen, hielt STUDER für Umbildungen. Obgleich v. KOCH sich darauf beschränkte, die Axialpolypen nur bei den jungen Kolonien zu beschreiben, versuchte STUDER dieselben der Zweigspitzen bei erwachsenen Kolonien zu schildern. Er sagt nämlich Seite 37:

"Fernere Analogieen mit den Pennatuliden zeigen sich darin, dass der als axialer Polyp aufgefasste Stamm selten an seinem Ende in einen Polypen mit Mund und Magenrohr ausläuft sondern ein rein vegetatives Individuum darstellt, das am Ende blind geschlossen ist, resp. immer auf dem Stadium eines Stolonen bleibt. Selten sind übrigens die axialen Polypen radiär, wie in den erwähnten Fällen, meist macht sich eine Tendenz zur bilateralen oder biradiären Symmetrie geltend. So können sich, wie bei *Dasygorgia*, die Längskanäle auf zwei reduciren, welche auf zwei Seiten der Axe verlaufen, oder es können, wie bei den meisten Gorgonelliden, zwei Hauptkanäle vorhanden sein, welche an zwei Seiten verlaufen, während zwischen diesen eine Anzahl kleinerer entwickelt sind. Mit diesem primär biradiären Bau des axialen Stammpolypen steht dann gewöhnlich auch ein nach demselben Princip angeordnetes System von Aesten und Zweigen im Zusammenhang."

Diese Annahme STUDER's, dass rein vegetative Axialpolypen an den Zweigenden auftreten, ist nichts als eine

Hypothese. Das ist auch klar zu schliessen aus dem Satze SCHNEIDER's (**1**), welcher folgendermassen lautet: "Dieser Befund stimmt in geradezu frappierender Weise mit der auf rein theoretischen Erwägungen beruhenden Darstellung der Achsenbildung STUDER'S überein, die er in seinem Versuch eines Systemes der Alcyonaria niedergelegt hat."

SCHNEIDER (**1**) beschrieb bei *Eunicella cavolini* einen am Stammapex vorhandenen axialen Hohlraum als einen Axialpolypen. Den Grund, weshalb er diesen Hohlraum als einen solchen ansieht, gab er aber niemals an. MENNEKING (**1**) beschrieb auch Zweige gewisser Primnoiden als umgewandelte Axialpolypen. Es ist jedoch auch nicht angegeben, warum er die Scheidewände der Stammkanäle als die Mesenterien der Axialpolypen, ansieht. Das Vorhandensein eines solcherweise reduzierten Polypen kann nur durch die Untersuchungen derselben im Anfange der Knospung, im Zusammenhang mit der Knospung von den Zweigen, bewiesen werden.

KÜKENTHAL (**1**, **2**) schloss sich STUDER auch darin an, dass er die Gorgonienkolonie als dem *Telesto*-Typus angehörend ansah.

Wie angeführt, stimmen die neueren Forscher alle merkwürdigerweise darin überein, dass sie in der Gorgonienkolonie die Existenz der Axialpolypen behaupten. Die Schilderung v. KOCH's, dass die wachsende Skeletachse in das Coelenteron des Primärpolypen eindringt, lag wahrscheinlich den Auffassungen der späteren Autoren zugrunde. Es könnte sein dass v. KOCH seine Schilderung auf direkte Beobachtungen basierte; gleichwohl scheint es unläugbar zu sein dass seine Angabe mit vielen anatomischen Verhältnissen leider kaum in Einklang steht. 1. Kommen wirklich Axialpolypen vor, welche nicht wie nach STUDER rein vegetative, aber wie nach v. KOCH normal gebaute sind, so ist kaum erklärbar, dass die Mesenterien der oberst gelegenen Polypen sich ganz wie bei den gewöhnlichen Polypen verhalten und niemals in die Scheidewände der Stammkanäle übergehen.

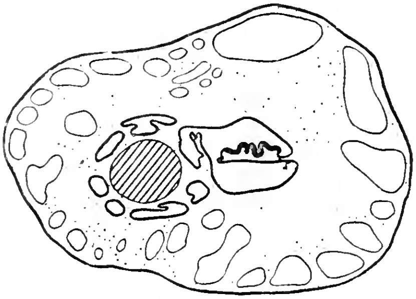

Abbildung 1.

Primnoa pacifica KINOSHITA.

Querschnitt eines Zweiges gerade oberhalb des obersten Polypen. Ektoderm und Entoderm mit dicker Linie, Lacunae der Skleriten mit dünnen Konturen gezeichnet; Mesogloea punktiert; Achsenskelet schraffiert. In der rechten Seite des Achsenskelettes ist eine weite Polypenhöhle mit einer frei hängenden Mesenterie zu sehen, welch erstere in eins der acht Hauptkanäle sich fortsetzt. ×20.

2. Sind die Stammkanäle in der Tat direkte Fortsetzungen der Radialfächer von den Magenhöhlen der Polypen, so sollen einige Mesenterien ebenfalls in den Stammkanälen, wenn auch in zufälliger Weise, gefunden werden, falls natürlich die lezteren in weniger Anzahl als acht vorkommen. Das ist jedoch nicht der Fall, soweit berichtet ist oder meine eignen Erfahrungen hinreichen. 3. Dass bei *Primnoa pacifica* die mehr apikalen Abschnitte der Zweige als bei dem obersten Polypen auch acht Stammkanäle zeigen (Abbildung 1), darf nur entweder durch die Annahme STUDER's dass die Axialpolypen rein vegetative Individuen darstellen, oder durch eine andere Annahme dass der achtstrahlige Bau die Eigenschaft der Zweige selbst ist, aber nicht durch die Annahme v. KOCH's, aufgeklärt werden. 4. Der Einwand, welchen VERSLUYS (**1**) 1907 gegen die Hypothese STUDER's anführte, ist auch durch die v. KOCH'sche Annahme nicht leichter zu beseitigen, als durch diejenige von STUDER. Der hier in Betracht genommene Einwand lautet nämlich folgendermassen: ''Auch stehen bei den Telestidae die Magenhöhlen der Seitenpolypen immer nur mittels Solenia in Verbindung mit der Magenhöhle der Mutterpolypen, aus denen sie sich entwickelt haben. Bei den Gorgoniden dagegen können die Magenhöhlen der Polypen unmittelbar übergehen in die geräumigen Rindenkanäle, welche nach STUDER den Magenhöhlen der Mutterpolypen der Telestidae entsprechen. Diese deutet aber darauf hin, dass die Rindenkanäle der Gorgoniden selbst Solenia sind.''

Während die Annahme v. KOCH's, ungeachtet dessen dass sie auf die direkte Beobachtung basiert sein dürfte, doch kaum hinreicht, die angegebenen anatomischen Verhältnisse zu erklären, giebt das Resultat meiner Untersuchung über die Entwicklung von *Anthoplexaura dimorpha*, wie es mir scheint, genügend klare Hinweisung zur Beseitigung der angeführten Einwände.

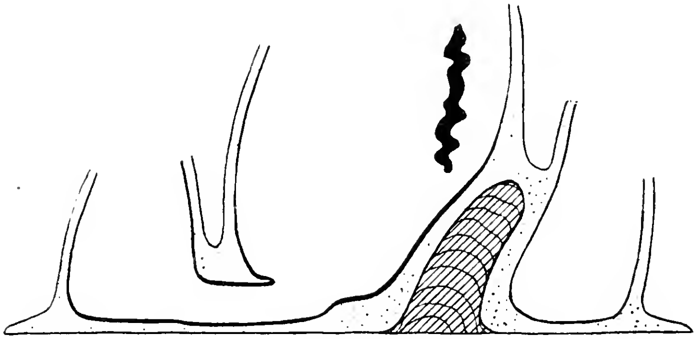

Abbildung 2.
Anthoplexaura dimorpha Kükenthal.
Rekonstruierte Abbildung von einer Schnittserie einer jungen Kolonie. Ein Primärpolyp mit zwei auf Stolonen gebildeten Sekundärpolypen; die distale Hälfte der Polypen nicht gezeichnet; Achsenskelet schraffiert. ×30.

Die Skeletachse, welche, wie auch bei der v. Koch'schen Untersuchung, in der Basis des Primärpolypen exzentrisch liegt, ragt nicht ins Coelenteron desselben hinein, sondern bleibt immer unterhalb der Fussscheibe, indem dabei ihre Umgebung mehr vaskulär wird, je mehr sie in die Höhe wächst. Die Spitze derselben also bleibt immer ausserhalb der Polypenhöhle und richtet sich schief dazu (Abbildung 2). Obgleich das obige Verhältnis bei meiner Untersuchung nur durch ein einziges Exemplar dargestellt worden war, liegt doch kein Grund vor, dieses Verhältnis als anormales anzusehen, denn es fehlte nicht an Fällen der Skeletachse, welche, wenn auch in jügeren Ausbildungsgraden, in Zustimmung mit jener Beobachtung standen.

Durch die Annahme, dass die Skeletachse immer ausserhalb des Primärpolypen bleibt indem die Stämme und Zweige besonders ausgebildetes Coenenchym darstellen, dürfen die bisher angeführten Einwände gar leicht entfernt werden. Die Tatsache, dass die Hauptkanäle in Zweigen an der Zahl nach den Spezies bestimmt sind, möchte ich vor allem auf die Eigenschaft der

Zweige zurückführen. Dahin weist die Tatsache, dass bei *Primnoa pacifica* in den mehr apikalen Abschnitten der Zweige als bei dem obersten Polypen auch acht Kanäle zu finden sind.

Schlussbemerkung zu den Gorgonacea.

In den vorgehenden Paragraphen habe ich dargetan, erstens dass die Skeletachse der Gorgonien nicht, wie Kölliker (**1**) und Studer (**1**, **2**) es behaupten, im Innern des Coenenchyms entsteht, sondern wie v. Koch (**2**, **3**, **6**) angibt, ein Ausscheidungsprodukt des Achsenepithels ist; und zweitens, dass die Polypen sämmtlich gleichwertig sind, und unter sich nicht Differenz in Länge oder in Ordnung zeigen, sodass die Stämme und Zweige, wie v. Koch (**6**) und Studer (**2**) es schilderten, durch die Umbildung der Axialpolypen gebildet worden sind. Diese zwei Resultate künden offenbar dass der Aufbau der Gorgonienkolonie nicht, weder wie Studer (**2**) und Kükenthal (**1**, **2**) meinen noch wie es aus den Schilderungen v. Koch's (**6**) hervorgeht, vom *Telesto*-Typus ist, und also auch dass man die Gattung *Telesto* nicht als die Ahnenform betrachten kann, aus welcher die Gorgonien entsprungen sind.

Sieht man nun in der Gorgonienkolonie von der Skeletachse ab, welche das Sekret des Ektoderms ist und also zur Organisation des Tierkörpers von unwesentlicher Bedeutung ist, so darf man die Gorgonienkolonie direkt mit den auf dem Boden flach kriechenden Kolonien vergleichen. Wenn man jedoch noch einsieht dass die Rinde der niederen Gorgonien meist ein einfaches Kanalsystem besitzt, so wird man sich gerechtfertigt finden, die Gorgonien, wie v. Koch dieselben von *Rhizoxenia* abzuleiten versuchte, von den Stolonifera hergestammt zu denken.

III. Scleraxonia.

Wie in den vorigen Kapiteln angeführt, ist die Gruppe der echten Gorgoniden von v. Koch (**3**, **6**) unwiderlegbar nachgewiesen als einem phyletisch besonderen Stamm der

Entwicklung angehörend, als die Gruppe der Scleraxonia oder Pseudaxonia. STUDER (**2**) stimmt auch darin mit v. KOCH überein, dass er die Gorgoniden als diphyletischen Ursprungs ansieht.

Ueber die Herkunft der Gruppe der Scleraxonia scheint nun KÖLLIKER (**1**, **2**) der Meinung gewesen zu sein, dass die Paragorgiaceae mit den Sympodiidae, welche er auf den Gattungen *Sympodium* und *Erythropodium* errichtete, in direkter Verwandtschaftsbeziehung ständen, da er diese beiden Gruppen in eine Unterfamilie, Briareaceae, zusammenstellte. In einer späteren Abhandlung aber äusserte er seine neue Ansicht über die Ableitung der Scleraxonia. Er hielt nämlich die *Siphonogorgia* für die Zwischenform zwischen den Alcyoniden und den Paragorgiaceae, was sich auf die Gründe stützt, dass die *Siphonogorgia* im äusseren Habitus den Gorgoniden sehr stark ähnelt, und dass die Mesenterien bei dieser Gattung in den Stammkanälen, welche die proximalen Abschnitte der Polypenhöhlen darstellen, bis zu vier reduziert sind, während sie bei den Alcyoniden in Achtzahl erhalten bleiben.

Diese Ansicht aber bedarf noch vielfacher Beweisführungen, da zwischen der *Siphonogorgia* und den Briareiden eine zu weite Lücke vorhanden ist, während darin, dass die *Siphonogorgia* sich aus den Nephthyiden entwickelt haben, kein Zweifel mehr zu setzen ist.

STUDER (**2**) machte 1887 einen Versuch, die Scleraxonia von einer kriechenden Ahnenform wie *Sympodium* und *Erythropodium* durch die Erhebung des Coenenchymrandes und durch die Einrollung und Solidifizierung der erhobenen Abschnitte abzuleiten. Diese Ansicht, welcher KÜKENTHAL (**1**, **2**) sich anschloss, ist von derjenigen von KÖLLIKER (**3**) gründlich verschieden. Wenn man nämlich bei den kriechenden Stammformen wie *Sympodium* oder *Erythropodium*, von welchen die Skleraxonier allerdings direkt oder indirekt hergestammt sind, die Hauptachse des Coenenchyms in vertikaler Richtung auf dem horizontal ausgebreiteten Coenenchym annimmt, so stimmt diese Hauptachse, nach der Auffassung KÖLLIKER's, mit der

Stammachse überein, während sie nach dem Studer'schen Bauplan mit der letzteren senkrecht zusammenstösst.

Die Hypothese von Studer basiert sich nur auf die Tatsache, dass die Gattung *Solenocaulon* neben den kompakten, auch noch rinnen- sowie röhrenförmige Zweige aufweist. Obgleich Kükenthal (**2**, **3**) von seiten des *Erythropodium* zu dieser Hypothese eine weitere Stütze liefert, doch ist sie nicht endgültig bewiesen, sodass die folgenden Einwände dadurch noch kaum überwindbar erscheinen.

Hickson (**2**) gibt nämlich an, dass es sich bei den rinnen- oder röhrenförmigen Zweigen der Gattung *Solenocaulon* um eine pathologische Umformung handele, welche durch parasitische Krebstiere von der Gattung *Alpheus* verursacht würde, und auch dass solche Formen kaum als die Grundform der höheren Skleraxonier angenommen werden können.

Die Frage, ob diese Umformung der Zweige eine eigentümliche Charakteristik von *Solenocaulon* oder eine pathologische Erscheinung ist, kann nur durch entweder eine genauere anatomische oder eine experimentale Untersuchung auf lebenden Exemplaren entschieden werden. Wenn man jedoch das folgende Verhältnis in Betracht zieht, so wird man nicht im geringsten zögern, diese Umformung mit Hickson auf eine pathologische Erscheinung zurückzuführen, welche für die Kolonienbildung von keiner Bedeutung wäre.

Die Zweigneubildung in *Solenocaulon*, wenn diese Form wirklich nach dem Studer'schen Bauplan aufgebaut ist, kann nur an den Zweigspitzen oder an den Rändern der flachen rinnenförmigen Zweige stattfinden, da nach ihm das Wachstum der Zweige die Ausdehnung des Coenenchyms an den Randsäumen bedeuten und diese letzteren bei *Solenocaulon* nur an den gegebenen Stellen anzutreffen sind. Die Aeste von *Solenocaulon tortosum* und *cervicorne*, wie sie von Janower (**1**, Pl. VII., Fig. 1, Pl. VIII., Fig. 4, 5) dargestellt wurden, scheinen dieses Verhältnis wahrscheinlich zu machen. Aber in den Abbildungen von den *Solenocaulon*-Arten, welche in den Schriften von Germanos (**1**), und besonders von Nutting (**1**, Pl. I., Fig. 1) gegeben sind, findet man Aeste, welche zweifellos durch Knospung gebildet worden zu sein scheinen. Da man denn unter Knospung allgemein die Verdickung eines Coenenchymabschnittes in der senkrechten Richtung zur Oberfläche versteht, so ist zwischen den durch die marginale Extension des Coenenchyms gebildeten und den durch Knospung entstandenen Zweigen ein gründlicher Unterschied zu erwarten. Es ist nun kaum denkbar, dass in einer selben Kolonie nach zwei solcherweise gründlich verschiedenen Bauplänen gebildete Stämme und Zweige vorkommen. Aus diesem Widerspruche schliesst man wohl mit Recht, dass die Kolonienbildung bei *Solenocaulon* nur durch die Verdickung des Coenenchyms in der Richtung der Hauptachse vor sich geht, und dass die gegebenen Umformungen der Zweige ganz auf eine pathologische Erscheinung zurückführbar sind.

Was nun die Resultate meiner Untersuchung anbelangt, so scheinen die Skleraxonier, wie schon angegeben, durch die Verdickung des Coenenchyms in ihrer Hauptachse von einer kriechenden Stammform wie *Erythropodium* ableitbar zu sein, was ganz anders zutrifft als die Hypothese von STUDER, aber mit derjenigen von KÖLLIKER sehr viel Uebereinstimmung zeigt. Meine Befunde, dass bei den Gattungen *Briareum* und *Paragorgia* die Terminalpolypen an ihrer Basis je zu einem Längskanal führen, welcher durch den Zentralstrang der Skeletachse hindurch bis zum Ausgangspunkt der betreffenden Zweige reicht, scheinen uns gewiss zu der Auffassung zu führen, dass die Stämme und Zweige dieser Formen, ähnlich wie bei der Gattung *Siphonogorgia*, je eine Syndete[1] darstellen. Die Lücke zwischen der Gattung *Siphonogorgia* und diesen Formen, ist jedoch immer noch zu weit, um die erstere als eine Ahnenform der letzteren anzunehmen. Es wird nun noch beim jetztigem Stande der Kenntnis gerechtfertigt sein, die Skleraxonier aus den *Erythropodium*-ähnlichen niederen Alcyonaceen, parallel mit den höheren Formen der letzteren, abgestammt zu denken.

In dem folgenden gebe ich nun die Beschreibung derjenigen

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[1] Siehe BOURNE (**1**).

anatomischen Verhältnisse einiger Skleraxonier, welche hauptsächlich den theoretischen Betrachtungen über ihre Stellung im Systeme wichtig zu sein scheinen.

Briareidae.

Diese Familie umfasst die niedersten Formen der Scleraxonier, bei denen die Differenzierung der Rinden- und Achsenteile in einem noch sehr primitiven Zustande verharrt. Die Mitglieder dieser Familie werden darnach in zwei Unterfamilien eingeteilt, ob der Achsenabschnitt von Solenia durchzogen ist (Briareinae), oder derselben entbehrt (Spongioderminae).

Von dieser Familie habe ich nur zwei Gattungen *Briareum* und *Paragorgia*, welche beide der Unterfamilie Briareinae angehören, untersucht. Leider habe ich jedoch keine Formen aus der Unterfamilie Spongioderminae untersuchen können.

Briareum BLAINVILLE.[1]

Der Typus dieser Gattung ist *Gorgonia briareus* ELLIS & SOLANDER. STUDER (**2**) gab 1887 dieser Gattung eine erneuerte Charakterisierung, welche folgendermassen lautet:

"Bei *Briareum* endlich, das unregelmässig lappige, aufrechte Colonie bildet, ist die von Kanälen durchzogene Axe wenig begrenzt, die regelrecht am Stamme verteilten Polypen sind ohne Kelche und ganz in das Coenenchyma zurückziehbar."

Wie ein Vergleich mit dem Originale von BLAINVILLE (**1**) zeigt, deckt diese Diagnose nicht den Typus von ELLIS und SOLANDER. Es ist auch nicht sicher ob *Briareum briareum* eine von den Solenia durchzogene Skeletachse besitzt, was im Sinne von STUDER als die Haupteigentümlichkeit der Gattung *Briareum* gilt. Daneben scheint die Differenzierung der Skeletachse bei *B. briareum*, *B. suberosum* und *B. fielei*, von welchen die letztere bis jetzt die einzige genau beschriebene Art ist, weiter gerückt zu sein, als STUDER in seiner Diagnose angab.

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[1] *Briareum* BLAINVILLE, 1834; DANA, 1846; MILNE-EDWARDS, 1865; *Briarea* DUCHASSAING et MICHELOTTI, 1860; *Briareum* KÖLLIKER, 1866; STUDER, 1887; WRIGHT & STUDER, 1889.

Wenn man diese Tatsachen in Betracht zieht, dürfte man wohl sagen, dass diese Diagnose alleinig auf *B. asbestinum* (Pallas) basiert ist.

Von dieser Gattung nun steht mir ein Exemplar, welches aus den Bahamas stammt und den Namen *Briareum asbestinum* trägt, zur Verfügung. Die Richtigkeit der Bestimmung dieses Exemplares ist mir nicht positiv sicher, da die Beschreibungen der Autoren alle dazu kaum hinreichend sind. Es liegt jedoch kein genügender Grund vor, jene Bestimmung zu verwerfen.

Abbildung 3.
Briareum asbestium (Pallas).
Aeusserer Habitus. Nat. Gr.

Briareum asbestinum (Pallas).

Das vorliegende Exemplar weist zwei verschieden grosse Stämme auf, welche von einer gemeinsamen Basalausbreitung emporsteigen. Sie sind einfach, fingerförmig, im Querschnitte gerundet, zeigen jedoch einige leichte Anschwellungen, von welchen die eine, die im Drittel vom Apex beim grösseren Stamme auftritt, offenbar als ein hervortretender Ast anzusehen ist.

Die monomorphischen Polypen sind auf die ganze Oberfläche der Kolonie uniform dicht verteilt. Ihr vorstülpbarer Abschnitt entbehrt durchaus der Skleritenbewehrung, und im zurückgezogenen Zustande werden da auf der glatten Coenenchymoberfläche kleine gerundete oder längsspaltförmige Oeffnungen gelassen, weil eben da die Kelche gar nicht oder ganz rudimentär entwickelt sind.

Die Magenhöhlen sind, von dem Niveau der Rindenoberfläche gemessen, 3 Mm. tief, und sind etwas schräg nach unten gerichtet. Sie enden nicht am Boden blind abgerundet, sondern führen je zu einem schmalen Kanal, welcher, bald sich verschmälernd, gerade hinunter läuft und sich in das Netzwerk der Solenia verschwindet. Dieses Verhalten ist bei dem am Stammapex befindlichen Polypen viel stärker betont. Die Magenhöhlen bei diesen Polypen sind nämlich viel tiefer als bei den Lateralpolypen und gehen in den Kanalabschnitt, der den Stamm hinunter durchläuft, ganz allmälich über (Abbildung 4).

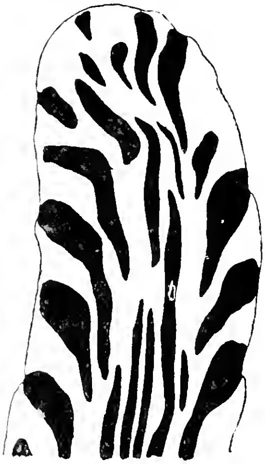

Abbildung 4.
Briarem asbestinum (Pallas). Medianer Längsschnitt des Apex des kleineren Stammes. Polypenhöhlen und Längs-Kanäle schwarz gemalt. ×5.

Der Stamm oder das Coenenchym, welcher durch seinen plumpen Bau ausgezeichnet ist, weist in sich zwei Abschnitte, den Rinden- und den Achsenabschnitt, auf, welche beide auch wieder in zwei Schichten zerfallen (Abbildung 5). Es sind nämlich:

Coenenchym
- Rindenabschnitt
  - Aeussere Rinde
  - Tiefere Rinde
- Achsenabschnitt
  - Rindenlage
  - Zentralstrang.

Die Differenzierung in diese vier Abschnitte bleibt aber in einem sehr primitiven Zustande. Die Grenzen dieser Schichten sind nämlich nicht ganz deutlich und die Skleriten stimmen, zwar nicht in der Farbe und Grösse, doch in der Form und Skulptur beinahe überein.

Aeussere Rindenschicht.—Diese die ganze Kolonie ununterbrochen überziehende Schicht beträgt durchschnittlich 0.5 Mm. in der Dicke und ist von einem Netzwerke feiner Solenia durchzogen. Die Skleriten, welche diese Schicht aufbauen, sind

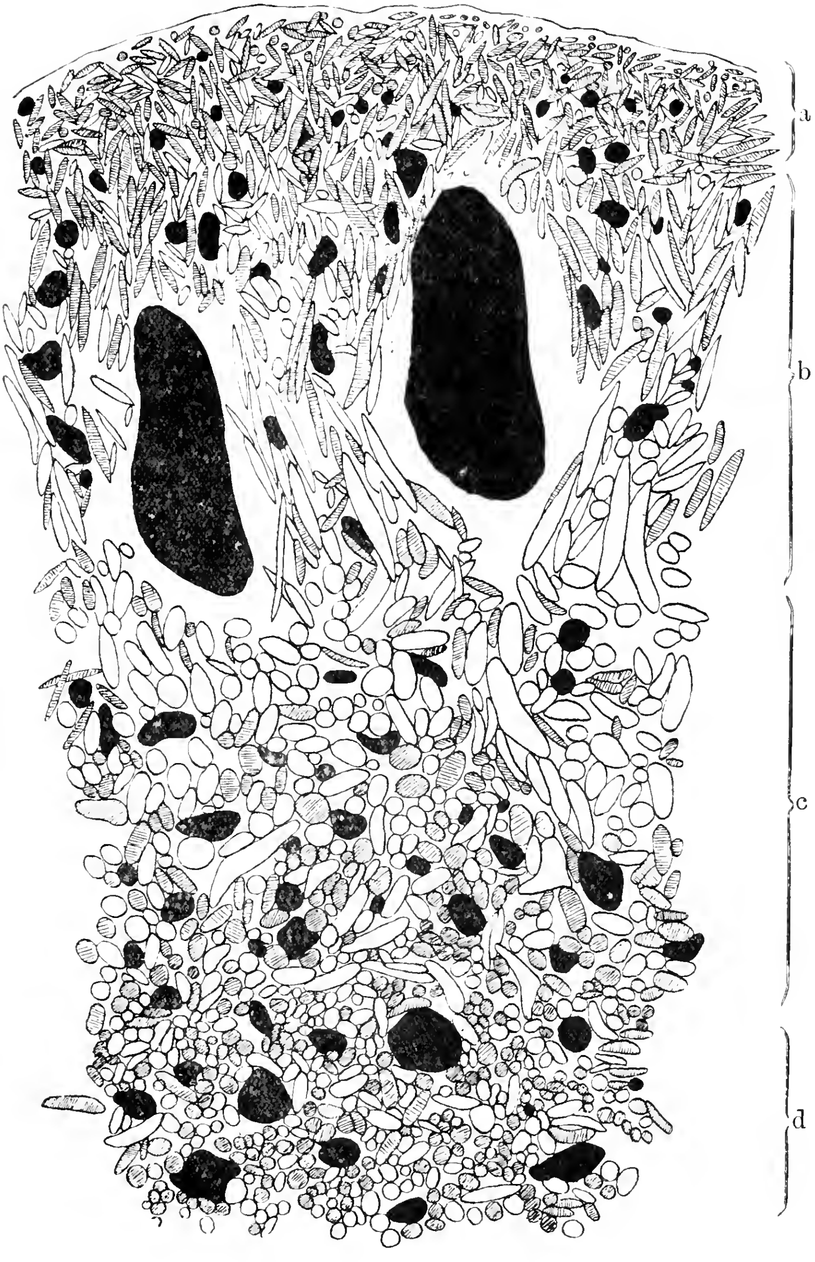

Abbildung 5. *Briareum asbestinum* (Pallas).
Querschnitt des Stammes. Polypenhöhlen, Längskanäle und Solenia schwarz gemalt; gefärbte Skleriten schraffiert; a äussere, b tiefere Rindenschicht, c Rindenlage der Achse, d Zentralstrang der Achse. × 20.

klein und in der Mehrheit tief purpurn gefärbt. Sie sind parallel der Rindenoberfläche, sonst unregelmässig gelagert. Ihre Grösse nimmt in der Regel je nach der Tiefe zu.

Tiefere Rindenschicht.—Diese Schicht ist dick und durch dünne sowie mittelweite Solenia durchzogen. Die Polypenhöhlen erreichen beinahe die innere Grenze der Schicht. Die Skleriten sind gross und meist farblos, selten leicht purpur. Sie sind den Wandungen der Polypenhöhlen parallel, also in der Mehrheit senkrecht zur Stammachse gelagert. In diesem Falle auch nimmt ihre Grösse durchschnittlich von aussen nach innen zu.

Die beiden Rindenschichten jedoch sind am Apex des Stammes wenig differenziert, und die dort tief gelagerten Skleriten sind auch tief purpurn gefärbt.

Rindenlage der Achse.—Dieser Abschnitt der Achse ist von den grossen Skleriten, welche in harten Längsbündeln gelagert sind, aufgebaut. Er enthält nicht das Netzwerk der Solenia, sondern eine Anzahl einfach längs verlaufender Längskanäle, welche distalwärts in die tiefere Rindenschicht hineintreten.

Zentralstrang der Achse.—Das Zentrum der Achse ist durchaus von Skleriten anderer Art besetzt. Wie in der Rindenlage greifen dieselben aneinander und so bilden die harten Längsbündel, aber zeichnen sie sich dadurch aus, dass sie viel kleiner und in der Mehrheit tief purpurn gefärbt sind. Die Längskanäle, welche auch diesen Abschnitt durchlaufen, besitzen meist weiteren Kaliber wie diejenigen der Rinde. Verfolgt man nun diesen Abschnitt nach den Apex, so findet man, dass er dort zur Rindenschicht übergeht, indem die Skleritenbündel loser werden. Dass die Längskanäle je zu einer Polypenhöhle sich fortsetzen, habe ich schon angegeben.

Paragorgia MILNE-EDWARDS.

Von dieser Gattung stehen mir einige Exemplare zur Verfügung, welche aus der Sagami-Bai stammen, und in drei oder vier Arten oder Varietäten teilbar zu sein scheinen. Von diesen Formen scheint die eine zu *Paragorgia arborea* (L.), die zweite zu *Paragorgia nodosa* Koren & Danielssen einbezogen werden zu dürfen, während die anderen neu zu sein scheinen. Die eine von diesen möchte ich hier provisorisch *P. granulosa*, die andere *P. tenuis* nennen.

Ueber die Struktur der Kolonie bemerke ich folgendes.

Siphonozooiden.—Studer **(2)** bemerkt in seiner Diagnose der Gattung, dass "neben den Polypen bei *Paragorgia nodosa* auch noch Siphonozooiden ohne Tentakel vorkommen." Es könnte dieser Satz zur Annahme misleiten, dass *Paragorgia arborea* (L), die Typenart der Gattung und die einzige von ihm anerkannte Art neben *P. nodosa*, der Siphonozooiden entbehrt. Dieses Misverständnis beruht wahrscheinlich darauf dass die letzteren bei *P. arborea* nicht über die Rindenoberfläche hervorragen. Das weist deutlich die Abbildung (Pl. IX., fig. 5) eines Schnittes von *P. arborea* auf, welche Koren und Danielssen **(1)** zum Vergleich mit ihrer Art gaben. Dasselbe ist auch der Fall bei meinen Exemplaren, *P.* affinis *arborea* (Abbildung 6) und *P. tenuis*. Also die Tatsache dass die Polypen bei allen Arten dieser Gattung, soweit bekannt, dimorphisch sind, scheint nicht mehr zu bezweifeln.

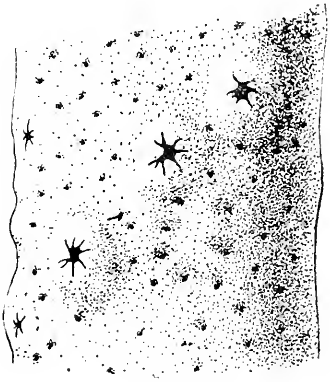

Abbildung 6.
Paragorgia aff. *arborea* (L).
Vordere Ansicht eines Zweigabschnittes mit fünf Autozooiden und zahlreichen Siphonozooiden. × 6.

Autozooiden.—Milne-Edwards **(1)** schon bemerkte dass die Polypen bei *Paragorgia* Magenhöhlen besitzen, welche kurz und blind terminieren. Dies bezieht sich jedoch nur auf die Seitenpolypen. Die Polypen, welche sich auf den Zweigspitzen finden und Köpfe bilden, führen, wie wir es bei *Briareum asbestinum* gesehen haben, direkt je in die Längskanäle welche durch den Zentralstrang bis zur Ausgangsstelle der betreffenden

Zweige hinunterlaufen (Abbildung 7). Hierbei auch bleiben die Mesenterien kurz und gehen nicht in die Kanalabschnitte ein.

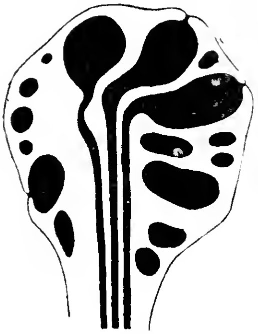

Abbildung 7.
Paragorgia tenuis, n. sp.
Medianer Längsschnitt eines Zweigapex. × 5.

Das Coenenchym ist auch hier wie in *Briareum asbestinum* in vier Schichten differenziert, was aber in viel deutlicher Weise vor sich geht (Abbilduug 8).

Aeussere Rindenschicht.—Diese, die ganze Kolonie, sogar die Polypenkelche, überziehende äussere Schicht ist kaum 0.15 Mm. dick. Sie entbehrt in sich gänzlich der Solenia. Diese, welche von geringerem Kaliber sind und im ganzen der Länge nach verlaufen, bilden ein einfaches Netzwerk und trennen die in Rede stehende Schicht von der tieferen Rindenschicht ab. Die Skleriten, welche dieser Schicht eigentümlich sind, sind kleine Achter[1] von roter oder gelbroter Farbe.

Tiefere Rindenschicht.— Diese Schicht weicht in der Struktur und Spikulation von der letzteren bedeutend ab. In ihr ist die proximale Hälfte der Polypenhöhlen aufgenommen. Darum hängt die Ausbildung der Schicht sehr viel von der Verteilung der Polypen ab. Sie ist nämlich in der Proximität der Polypen, also an der Vorderseite der Kolonie und an den Zweigspitzen, sehr dick–bis 2 Mm.–entwickelt, während sie sich in den polypenlosen Stellen sehr wenig ausbildet, sodass oft die Solenia gerade unterhalb der äusseren Rindenschicht beinahe den Achsenabschnitt zu berühren scheinen. Von den vorliegenden Exemplaren ist bei *P. granulosa* diese Rindenschicht sehr gering entwickelt, infolge dessen die Polypen hoch konisch

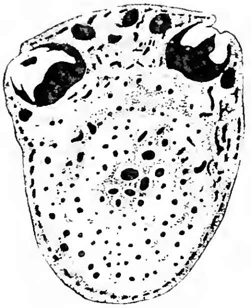

Abbildung 8.
Paragorgia aff. *arborea* (L.).
Querschnitt eines Zweiges. Zwei Autozooiden und fünf Siphonozooiden gerade getroffen; Polypenhöhlen, Längskanäle und Solenia schwarzangegeben; Areae, wo die gefärbten Skleriten sich befinden, punktiert. × 6.

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[1] Kölliker (1), Seite 122.

hervorragen, während dieselben bei den andern Exemplaren meist niedrig bis beinahe flach bleiben.

Diese Rindenschicht ist von den weiten, Netzwerk bildenden Solenia durchzogen. Die Skleriten lassen sich in zwei Typen unterscheiden: 1) Diejenigen Skleriten, welche von den der äusseren Rindenschicht eigentümlichen Achtern durch Weiterentwicklung der Achsensprossen abzuleiten sind. Obgleich sie sehr oft beträchtlich verlängert sein können, sind sie doch an ihren medialen sechs Warzen, welche am Scheitel pilzhutförmig ausgebreitet sind, erkennbar. 2) Diejenigen Skleriten, welche typisch spindelförmig, mit zerstreuten Stacheln besetzt und an den beiden Enden zugespitzt sind. Oft jedoch zeigen die Stacheln eine Andeutung von mehr oder weniger regelmässigen Gürteln. Was die Färbung dieser Skleriten betrifft, so sind sie farblos oder schwach rötlich.

Von diesen beiden Arten der Skleriten ist nur die erste als die eigentlichen Rindenskleriten anzusehen. Die zweite betrachte ich als die eigentlich der Rindenlage des Achsenabschnitts angehörige, da jene Lage für die grössten Teile durch die Skleriten dieses Typus gebildet ist.

Rindenlage des Achsenabschnittes.—Diese Schicht stellt wie bei *Briareum asbestinum* den eigentlichen Achsenabschnitt dar. Sie besteht aus den in festen Längsbündeln gelagerten Skleriten, welche in der grossen Mehrheit farblos, sonst sehr schwach rötlich gefärbt sind, und denjenigen des zweiten Typus in der tieferen Rindenschicht ganz gleichen. Neben diesen Skleriten kommen auch diejenigen Skleriten, welche ich ebenda als die der tieferen Rindenschicht eingentümlichen angegeben habe, vereinzelt oder meist in konzentrischen unregelmässigen Gruppen vor (Abbildung 8). Diese Skleriten sind mit Recht als solche anzunehmen, welche sich an der Peripherie dieses Abschnittes zufällig hinzugefügt haben. Diese Eindringung geht bei *P. granulosa* auch noch rege vor sich, sodass die Achter, welche der äusseren Rinde angehören, auch manchmal in diesem Abschnitte angetroffen werden. Das Verhältnis, dass die äussere Rinde bei dieser Art wegen der schwachen Ausbildung der tieferen Rindenschicht beinahe die Achsen berührt, wird diese Tatsache leicht verständlich machen.

Dieser Achsenabschnitt ist von den mittelweiten Längskanälen, welche vereinzelt oder meist in mehreren konzentrischen Reihen sich anordnen, durchzogen.

Zentralstrang.—Der Zentralstrang zieht sich inmitten des Achsenabschnittes der Stämme und Zweige hindurch. Es ist jedoch an der Basis jedes Zweiges von dem Zentralstrang des Stammes oder des Zweiges höherer Ordnung durch die Rindenlage getrennt, wie es durch die Wandung der Axialpolypen bei *Telesto*-Kolonie mit Axialhöhlen geschieht, da bei der Zweigbildung nicht die Gabelung wie bei den Melitodiden, sondern allein Knospung stattfindet.

Der Zentralstrang weist eine ganz gleiche Struktur wie die Rindenlage auf. Der Unterschied liegt nur darin, dass die Skleriten Rindenskleriten sind, und dass die Längskanäle, welche einen weiteren Kaliber besitzen, dichter gedrängt vorkommen. In jeder Schnittfläche quer durch die Zweige ist der Zentralstrang an den gewöhnlich als "Hauptkanäle" bezeichneten Längskanälen und der roten Area, welche sich von der Umgebung deutlich unterscheiden lässt, zu erkennen (Abbildung 8). An dem Zweigapex, wo eine Anzahl Polypen den Kopf bilden, geht der Zentralstrang ganz vollkommen zur Rindenschicht über. Die Rindenlage oder der eigentliche Achsenabschnitt kommt erst unterhalb des Kopfes in der Form einer Röhre zum Vorschein.

Bemerkungen über die Gattungen Briareum und Paragorgia.

Wie es in den vorhergegangenen Beschreibungen ersichtlich sein dürfte, stimmen *Briareum* und *Paragorgia* im wesentlichen Aufbau der Kolonie mit einander ganz überein, sodass es keinem Zweifel unterliegt, dass diese beiden Gattungen in einer sehr innigen Verwandtschaftsbeziehung stehen.

Die Kolonien dieser Gattungen zeigen nun unter anderm zwei Verhältnisse, welche besonders beachtenswert sind. Nämlich, erstens dass im Zentrum der Skeletachse ein Zentralstrang, welcher aus den Rindenskleriten besteht und am Zweigapex in die Rinde übergeht, vorhanden ist (Abbildungen 5 und 8), und zweitens dass die Terminalpolypen an ihrer Basis je zu einem den Zentralstrang durchlaufenden Kanal, der bisher nur als "Hauptkanal" bezeichnet worden war, führen (Abbildungen 4 und 7).

In den Kolonien beider Gattungen darf die Rindenlage der Skeletachse als der eigentliche Achsenabschnitt angesehen werden, da der Zentralstrang seiner Struktur nach der Rinde zuzurechnen ist. Die Form der Skeletachse bei diesem Typus ist dann ein Hohlzylinder.

In der *Solenocaulon*-Hypothese von STUDER ist jedoch die Skeletachse der höheren Skleraxonier nur als "ein zylindrischer Stab" vorgestellt, welcher im Zentrum der Zweige liegt. Dies trifft aber derselben beim *Briareum-Paragorgia*-Typus durchaus nicht zu. Da jedoch dieselbe in der STUDER'schen Hypothese als eine solche gedacht ist, welche sich einst im Stadium von *Solenocaulon* an der Innenseite der rinnen- oder röhrenförmigen Zweige in derselben Form wie die Zweige selbst ausgebildet haben sollte, so dürfte man auch wohl annehmen, dass der als zylindrisch angesehene Stab in Wirklichkeit ein Hohlzylinder ist. Dann scheint der *Briareum-Paragorgia*-Typus dieser Hypothese nicht zu widersprechen. Wenn man jedoch die Längskanäle im Innern des Zentralstranges in Betracht zieht, welche je zu einem Terminalpolypen führen, wird man kaum den Zentralstrang mit der Rinde der Innenseite der hohlen Zweige bei *Solenocaulon* homologisieren können. Diese Kanäle, nämlich, möchte ich doch nicht einfach als die Solenia, sondern als einen Abschnitt der Polypenhöhlen ansehen, obgleich sie niemals Mesenterien enthalten. Der Grund liegt darin, dass bei *Paragorgia* diejenigen Lateralpolypen, welche noch nicht in die Länge gewachsen sind, keine mit ihnen zusammenhängende Kanalverlängerung aufweisen, und dass bei *Briareum asbestinum* anderseits, welches phyletisch in einem jüngeren Stadium als *Paragorgia* zu stehen scheint, die Lateralpolypen auch basalwärts verlängert sein können, eine starke Stütze zu liefern.

Wie schon angedeutet ist es kaum denkbar dass in einer und derselben Kolonie die Stämme und Zweige nach zwei verschiedenen Bautypen aufgebaut sind. Aus diesem Grunde können wir den Modus der Kolonienbildung im allgemeinen durch das Verhältnis, in welchem die Zweige sich bilden, klar stellen. Die Zweigbildung geht, wie schon angegeben, durch Knospung vor sich. Bei der Knospung hebt sich eine Gruppe der Lateralpolypen, deren kurze Magenhöhlen proximal abgerundet enden, und bildet den Kopf, indem unterhalb desselben ein Stiel allmählich zutage tritt. Beim Erheben bleibt das proximale End jeder Polypenhöhle in der Form eines Kanales zurück, da die Zone des Längenwachstums nicht unterhalb der Polypenbasis, sondern etwas oberhalb derselben liegt. Darauf im Stiele und zwar um das Bündel dieser Kanäle wird die eigentliche Skeletachse in der Form eines Hohlzylinders von unten her gebildet. Bei einer jungen, kaum 1 Cm. hohen Kolonie (Abbildung, 9), welche wahrscheinlich *Paragorgia nodosa* angehört, konnte ich auch konstatieren, dass die Terminalpolypen sich gleich wie bei den Zweigen erwachsener Kolonien verhalten.

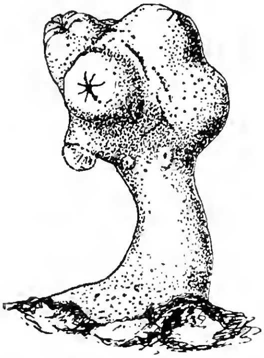

Abbildung 9.
Paragorgia aff. *nodosa* Kor. & Dan.
Aeusserer Habitus einer jungen Kolonie. × 6.

Melitodidae.

Die Melitodidenfamilie umfasst deutlich ausgezeichnete Formen, deren Stamm und Aeste die Skeletachse aufweisen, welche aus den durch Verschmelzung besonderer Spikula entstandenen harten, und den die Nodien bildenden weichen Gliedern besteht. Die Mitglieder dieser Familie stimmen in wesentlichen Eigenschaften mit einander überein. Nur *Parisis* weicht nicht unerheblich von den übrigen ab, indem bei ihr der Zentralstrang beinahe reduziert ist und die Verzweigung, im Gegensatz zu den übrigen Gattungen, nur in den harten Gliedern stattfindet.

Die Anatomie der Melitodiden war schon vor längerer Zeit ziemlich klar gestellt worden. KÖLLIKER (**1**) 1866 wies nämlich nach, dass die harten Achsenglieder bei *Mopsea* und *Melithaea* aus verschmolzener Skleriten bestehen, und dass ein Zentralstrang, welcher aus den Coenenchymskleriten vergleichbaren Skleriten besteht, sich durch die Skeletachse ganz hindurch zieht. Auf diese neuen Befunde basierend, stellte sich KÖLLIKER gegen die Hypothese von MILNE-EDWARDS vor, dass die Skeletachse der Gorgoniden ein ektodermales Ausscheidungsprodukt sei, und hob besonders hervor, dass dieselbe im Coenenchym entsteht. Er hat aber die Frage nicht verfolgt, wie diese kompliziert gebaute Skeletachse im Coenenchym entsteht, oder was der Zentralstrang morphologisch bedeutet.

Von dieser Familie habe ich nun die Gattungen *Mopsella*, *Melitodes*, *Acabaria* und *Parisis* untersuchen können. Zuerst gebe ich die Resultate der Untersuchung an *Melitodes*, *Mopsella* und *Acabaria*, und zuletzt dieselben an *Parisis* an.

Verzweigung.—Bei den Gattungen *Melitodes*, *Mopsella* und *Acabaria* werden die Zweige gewöhnlich durch typische Spitzendichotomie gebildet. Die Zweigbildung durch Knospung findet aber nur ausnahmsweise statt.

An den Apikalabschnitten der Zweige stehen die Polypen in zwei gegenseitigen Streifen, und zwar bei den typischen Fällen gewöhnlich beinahe in Paaren. In der Regel stehen die Paaren von kleineren und grösseren Polypen in Abwechselung, und das oberste Paar ist immer von den völlig erwachsenen, grossen, sogar oft in der Grösse die allen übrigen weit übertreffenden Polypen gebildet. Durch die angedeutete Verteilung der jungen Polypen kann man schliessen dass das Längenwachstum der Rinde nicht am Scheitel, sondern in einer Zone unterhalb der Apikalpolypen stattfindet, indem neue Polypen in den erweiterten Zwischenräumen zwischen den schon vorhandenen Polypen ausknospen. Bei den Formen mit gedrängt stehenden Polypen, z. B. bei *Melitodes flabellifera*, ist diese regelmässige Abwechselung mehr oder minder undeutlich. Dennoch lässt es sich immer einblicken dass auch hier dasselbe Verhältnis in gewissem Masse Geltung hat.

Der Apex der Zweige ragt gewöhnlich ein wenig über die Apikalpolypen– bei *Acabaria* sp. (Abbildung 10), die in der Nachbarschaft der Biologischen Station zu Misaki ziemlich allgemein vorkommt, oft bis 1 Mm.– hervor. Der Apex weist in der Mitte der Spitze eine kleine, mehr oder minder seichte, kraterförmige Vertiefung auf, welche uns an einen zurückgezogenen Polypen erinnert. Beim Verzweigen gabelt sich der Zweig an der Spitze in zwei. Die zwei obersten Polypen schreiten je an die äussere Seite der neu gebildeten Zweige über, und darnach wird, an der Innenseite gerade ihnen gegenüber, je ein neuer Polyp gebildet, welcher bald aufwächst und den an der Aussenseite gelegenen alten Polypen gleich kommt. Diese zwei neuen Polypenpaare an den Zweigspitzen behalten ihre endständige Stellung bei, während alle nachträglich sich bildenden Polypen unter ihnen auftreten.

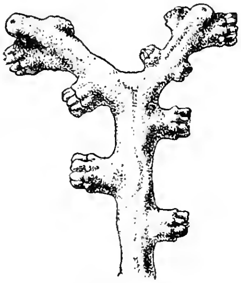
Abbildung 10.
Acabaria sp.
Neu gegabelter Zweig.
×5.

Zentralstrang.—Wie es in den Abbildungen von Kölliker (**1**) und Kükenthal (**4**) deutlich angegeben ist, ist der Zentralstrang bei den Gattungen *Melitodes*, *Mopsella* und *Acabaria* immer sehr gut ausgebildet. Er läuft die ganze Länge der Stämme und Zweige ununterbrochen mit gleicher Dicke durch.

Die Skleriten, welche diesen Zentralstrang aufbauen, sind natürlich von denjenigen der Rindenlage verschieden. Bei *Melitodes* und *Acabaria* sind sie bedornte Spindeln, welche denen der Rinde ganz gleichen. Bei *Mopsella* jedoch werden auch Stachelkeulen, untermengt in den Spindeln, sehr häufig angetroffen (Abbildung 11). Wie man deutlich nach der Form schliessen kann, gehören diese Skleriten eigentlich zur Rindenschicht, wo sie einst an der Oberfläche derart angeordnet waren, dass die Stacheln sich nach aussen richteten und so der Rinde Schutz bieteten. Von da aus sollen sie zufällig in den Zentralstrang hineingekommen sein.

Der Zentralstrang nun ist in der Nähe der Zweigspitze ganz ähnlich gebaut wie die Rinde. Die Rinde an der Zweigspitze ist von einem Netzwerke dünner Solenia durchzogen und weist meist kleine, nicht ganz ausgebildete, aber dicht gedrängt auftretende junge Skleriten auf. Im obersten Abschnitte lässt sich der Zentralstrang kaum von diesem Rindengewebe unterscheiden, aber nach abwärts fangen die Skleriten allmählich an, durch kalkige Ablagerung fest an einander verkittet zu werden, indem die Solenia degenerieren und sich schliesslich spurlos verschwinden.

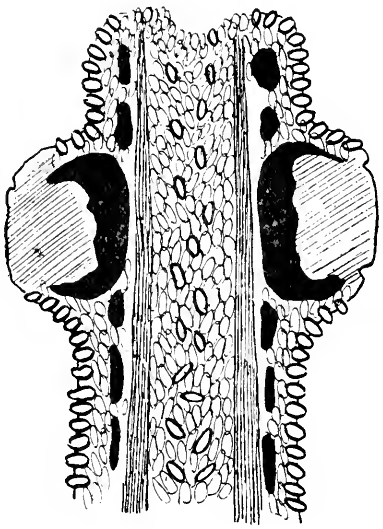

Abbildung 11.
Schematischer Längsschnitt eines Zweigapex von einer *Mopsella*-Kolonie. Polypenhöhlen und Solenia schwarz; oberflächliche Rindenskleriten mit dicken Konturen, tiefere Rindenskleriten mit dünnen Konturen gezeichnet; Rindenlage der Achse längs schraffiert.

Diese Verkittung findet in den weichen Gliedern, wie schon Kölliker bemerkt, nicht statt.

Die harten Achsenglieder werden gerade unterhalb der Rinde der Zweigspitze durch Ansätze neuer Skleriten, und zwar von Anfang an in der Form einer Röhre, gebildet. Die Röhrenform kommt daraus zustande dass die Rinde, welche jene Achsenglieder von aussen umgibt, an die Zweigspitze in die letzteren als den Zentralstrang hinein dringt.

Von der Gattung *Parisis* habe ich *Parisis fruticosa* und *Parisis* affinis *minor* untersuchen können. Diese Formen weichen in mancher Hinsicht von den übrigen Mitgliedern der Familie ab. Es liegt jedoch kein positiver Beweis vor, diese Gattung als solche zu betrachten, welche von den letzteren phyletisch sehr fern steht.

Der Zentralabschnitt der harten Achsenglieder von *Parisis* besteht aus dornigen Skleriten, welche von denjenigen der Umgebung in der Form unterscheidbar sind. Ich habe jedoch nicht genau ermitteln können, welche Form dieselben besitzen, da sie wie die letzteren ganz durchsichtig sind. In den meisten angefertigten Schliffen habe ich gefunden, dass zwischen den

Skleriten zahlreiche kleine Luft enthaltende Lücken existieren. Der Zentralstrang, wenn man auch hier diese Bezeichnung brauchen darf, scheint in den weichen Gliedern unterbrochen zu sein, denn das Zentrum derselben ist auch durch die den weichen Gliedern eigentümlichen Skleriten besetzt, welche so dicht vorkommen dass der Abschnitt sich von der Umgebung sehr leicht unterscheiden lässt.

Bemerkung über die Melitodidae.

In einem vorhergehenden Kapitel, in welchem ich über die Gattungen *Briareum* und *Paragorgia* Bemerkungen gegeben habe, habe ich folgende drei Verhältnisse als Einwände gegen STUDER'-sche Hypothese hervorgehoben: 1) dass die Skeletachse im Zentrum den aus Rindenskleriten bestehenden Zentralstrang aufweist; 2) dass die sogenannten Hauptkanäle in diesem Zentralstrange nicht als Solenia, sondern als Verlängerungen der Polypenhöhlen anzusehen sind; 3) dass die Neubildung der Zweige bei *Paragorgia* (wohl auch bei *Solenocaulon*) alleinig durch Knospung unterhalb der Zweigspitze stattfindet. Von diesen drei Verhältnissen wurden die zwei letzteren als besonders unüberwindbare Einwände gegen STUDER'sche Hypothese angegeben. Bei den Melitodiden jedoch zeigen sich dieselben etwas anders, da der Zentralstrang nämlich gänzlich der Hauptkanäle entbehrt, und die Zweigbildung gewöhnlich (mit einer Ausnahme von *Parisis*) durch Spitzen gabelung, nur ausnahmsweise durch Knospung, vor sich geht.

Dass bei der Zweigbildung Spitzengabelung vorherrscht, scheint für die *Solenocaulon*-Hypothese eine gewisse Stütze zu liefern, da nach dieser Hypothese die Randsäume des eigentlichen flachen Coenenchyms nur an der Zweigspitze ausgestellt sind, und das Wachstum des Coenenchyms nur an den Randsäumen stattfinden sollte. Jedoch falls die Zweige, wenn auch ausnahmsweise, unterhalb der Zweigspitze durch Knospung gebildet werden, so kann man diese Zweige, bezw. die Kolonie, auch als solche annehmen, welche durch Verdickung des Coenenchyms in der Richtung der Hauptachse ausgebildet sind.

Die durch Knospung gebildeten Zweige wurden manchmal bei verschiedenen *Melitodes*- und *Mopsella*-Arten angetroffen. Sie sind alle dünn und kurz, aber tragen Polypen in gewöhnlicher Weise. Dass diese Zweige durch Knospung gebildet worden sind, ist daran deutlich zu erkennen dass der Zentralstrang der harten Achsenglieder gerade hinweggeht und von demselben des Zweiges durch eine dicke Rindenlage getrennt sind (Abbildung 12). Solche Zweige weisen in ihrem Basalabschnitte eine Menge in den Achsenskleriten untermengt auftretender Skleriten auf, welche bald in die Mittellinie der Achsen dicht ansammeln, um endlich einen typischen Zentralstrang zu bilden. An der Spitze des Zweiges ist auch sogar die Apikalvertiefung zu finden. Also ist der Apikalabschnitt der Zweige ganz normal gebaut.

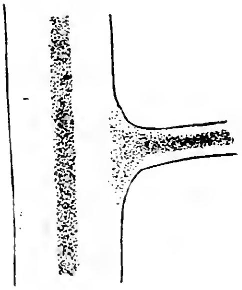

Abbildung 12.
Melitodes sp.
Hartes Achsenglied mit einem sekundären Zweig. Zentralstrang punktiert.

Aus dieser Tatsache ist zu ersehen dass der Zentralstrang bei den Melitodiden nicht mit der Rinde, welche nach der *Solenocaulon*-Hypothese die Innenwand der rinnen- oder röhrenförmigen Zweige bilden soll, sondern mit dem Zentralstrange des *Briareum*-*Paragorgia*-Typus zu vergleichen ist; denn dieser Zentralstrang ist auch in normaler Weise in den Skeletachsen derjenigen Zweige entwickelt, welche nicht durch Spitzengabelung, sondern durch Knospung gebildet worden sind.

Die Tatsache, dass die Hauptkanäle im Zentralstrang, welche als proximale Verlängerungen der Magenhöhlen der Terminalpolypen anzusehen sind, bei den Melitodiden nicht erhalten bleiben, scheint allerdings nicht völlig mit dieser Homologisierung zu stimmen. Aber wenn man in Betracht zieht, dass die Terminalpolypen etwas seitwärts von der Zweigspitze gerückt sind, und wenn man weiter annimmt, dass bei diesen Terminalpolypen die Kanalabschnitte sich infolge der Ortveränderung reduziert haben, aber der Zentralstrang zurückgeblieben ist, so kann man wohl vermuten dass die Melitodiden demselben Typus wie *Briareum* und *Paragorgia* angehören. Jedenfalls ist es nicht vernünftig, den Bautypus der Melitodidenkolonie durch die *Solenocaulon*-Hypothese zu erklären, solange diese als gar statthaft nicht gestützt wird.

Suberogorgiidae.

Von dieser Familie sind drei Gattungen, *Suberogorgia*, *Keroeides* und *Dendrogorgia*, bekannt.

Wie ich (**2**) schon dargetan habe, ist die Gattung *Keroeides* keine Skleraxonie, sondern eine aberrante Gorgonie, bei welcher nur der Zentralstrang der Skeletachse von einem denselben an der Spitze fingerhutförmig bekleidenden Achsenepithel ausgeschieden wird, aber die Rindenlage derselben von mesogloealen Skleriten und Hornsubstanz aufgebaut wird.

In demselben Jahre, aber etwas früher als ich die obige Ansicht veröffentlichte, gab Simpson (**1**) die Beschreibung seiner neuen Gattung *Dendrogorgia*, welche er, wegen der sklerogorgischen Struktur der Skeletachse, auf eine früher als *Juncella capensis* bezeichnete Spezies errichtete. Ueber den Zentralstrang der Skeletachse von dieser Form nun machte Simpson keine Bemerkung. Aber soweit man nach den von ihm gegebenen Abbildungen schliessen kann, scheint die Skeletachse einen deutlichen Zentralstrang zu besitzen. Es ist jedoch nicht sicher, ob der Zentralstrang bei seinem Exemplare demselben Typus wie bei *Keroeides* oder bei den Melitodiden und *Suberogorgia* angehört.

Suberogorgia

Der Typus dieser Gattung ist *Pterogorgia suberosa*. Kölliker (**1**) wies nach, dass die Skeletachse dieser Art eine sklerogorgische Struktur zeigt, und demnach errichtete er auf diese Form eine neue Gattung *Sclerogorgia* die in seiner Klassifikation eine besondere Unterfamilie bildete. Dieser Gattungsname soll aber mit dem älteren Namen *Suberogorgia* von Gray ersetzt werden.

Von dieser Gattung nun habe ich zwei Arten, *Suberogorgia köllikeri* und *Suberogorgia* affinis *appressa* untersuchen können.

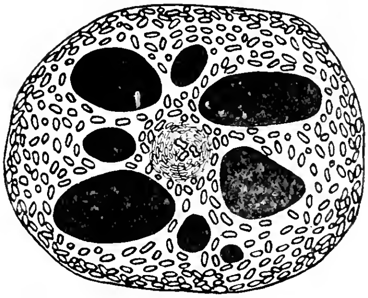

Abbildung 13.
Suberogorgia aff. *appressa* Nutt.
Querschnitt eines Zweiges. Polypenhöhlen und Stammkanäle schwarz; Rindenskleriten mit dicken Konturen, Achsenskleriten mit dünnen Konturen gezeichnet. ×20.

Die Skeletachse bei diesen Formen besteht aus glatten Spindeln, welche dicht mit einander verschmelzen, sodass meistens ihre originale Form verloren geht. Sie zeigen in Querschnitten der Achse deutliche konzentrische Anordnung. Kölliker (**1**) schilderte schon das Vorkommen der Rindenskleriten in der Skeletachse. Darüber sagt er: "Auch die Axe der *Sclerogorgia* enthält wie die der Melithaeaceen vereinzelt oder in kleinen Nestern warzige Kalkkörper von der Form, Grösse und Farbe derer des Coenenchyms." Bei meinen Exemplaren habe ich auch in der Mitte der Skeletachse beinahe unfehlbar eine geringe Anzahl von Rindenskleriten finden können (Abbildung 13). Diese Skleritenreihe möchte ich mit dem sehr wohl entwickelten Zentralstrang der Melitodiden und auch der *Briareum* und *Paragorgia* vergleichen, denn diese Skleriten sind es, welche auch von der Spitze in die Skeletachse hineingelangt sind.

Bei den vorliegenden zwei Formen dieser Gattung scheint die Verzweigung nur durch Knospung vor sich zu gehen.

Wenn man die oben erwähnten Verhältnisse in Betracht zieht, so wird man finden dass diese Gattung auch demselben Typus wie die Melitodiden, sowie auch wie die Gattungen *Briareum* und *Paragorgia* angehört.

Schlussbemerkung zu den Scleraxonia.

In den vorhergehenden Kapiteln habe ich geschildert, dass die untersuchten Skleraxonier sich in drei Typen zerfallen, welche resp. von *Briareum*, *Melitodes* und *Suberogorgia* repräsentiert werden, und welche phyletisch in einer direkten Verwandtschaft mit einander stehen würden. Den *Briareum-Paragorgia*-Typus, welcher den anderen Typen zugrunde liegt, möchte ich, wie schon angeführt, nicht durch die *Solenocaulon*-Hypothese von STUDER, sondern durch die Verdickung des Coenenchyms in der Richtung der Hauptachse erklären. Diese Auffassung scheint mir beinahe unwiderlegbar zu sein, da die Verhältnisse, welche die Stämme und Zweige bei diesen beiden Gattungen zeigen, nur erst dadurch erklärt werden können.

Von den Eigentümlichkeiten, wodurch sich der *Briareum-Paragorgia*-Typus auszeichnet, gilt die Existenz der sogenannten "Hauptkanäle" im Innern des Zentralstranges als die wichtigste für Erwägung der systematischen Stellung der Gattungen *Briareum* und *Paragorgia*, oder vielmehr der ganzen Skleraxonier. Dass es sich dabei nicht um Solenia handelt, habe ich schon erwähnt. Wenn man nun die Hauptkanäle als proximale Abschnitte der Terminalpolypen betrachtet, so muss man die Stämme und Zweige natürlich als die Bündel der Axialpolypen ansehen. Diese Eigenschaft der Axialpolypen, d. h. dass dieselben Syndete[1] bilden, bildet eine Eigentümlichkeit der Ordnung Alcyonacea. Da die Scleraxonia nach den bisherigen Auffassungen[2] als solche, bei denen alle Polypen, wie bei den Gorgonacea, kurze Magenhöhlen besitzen, charakterisiert worden sind, so sollen die beiden Briareidengattungen theoretisch aus der Ordnung Scleraxonia entnommen und in die Ordnung Alcyonacea gebracht werden. Aber in der letzteren Ordnung sind keine Formen bekannt, bei welchen die Anthostele[3] gänzlich der Mesenterien entbehren. Weiter es existiert zwischen dem *Briareum-Paragorgia*-Typus und der *Siphonogorgia*, welch letztere KÖLLIKER (**3**) wegen der nur in Vierzahl bleibenden Mesenterien in den "Stammkanälen" als eine Zwischenform zwischen den Alcyoniden und den Paragorgiaceae annahm, noch eine zu weite Lücke, um die beiden Briareiden in die direkte Nähe von *Siphonogorgia* zu bringen.

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[1] Siehe Bourne (**1**).

[2] v. KOCH (**7**) schildert deutlich die Differenz der Polypen in der Länge, also in der Ordnung der Polypen bei Skleraxoniern. Es ist jedoch nicht klar genug, auf welche Tatsachen sich diese Auffassung stützt. Siehe Seite 9.

[3] Siehe BOURNE (**1**).

Schliesslich ist noch eine Möglichkeit nicht ausgeschlossen, dass dieselben durch einen mit der Entwicklungsbahn der höheren Alcyonacea parallel gehenden Weg aus den *Erythropodium*-ähnlichen, niederen Alcyoniden abstammten, da *Briareum asbestinum* und wahrscheinlich auch noch viele andere niederen Skleraxonier, in den Beschaffenheiten der Skleriten sowie im Modus der Polypenverteilung, mehr den niederen als den höheren Alcyoniden verwandt sind.

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Published Mar. 31st, 1913.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY,
TOKYO, JAPAN.

VOL. XXXII., ART. 11.

Ueber die charakteristische Mannigfaltigkeit der partiellen Differentialgleichungen erster Ordnung.

Von

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Die vorliegende Arbeit ist eigentlich als eine Fortsetzung meiner Arbeit[*] in den "Mathematischen Annalen," Bd. 57, anzusehen. Es wird jetzt durch die Variationsmethode die charakteristische Mannigfaltigkeit eines Systems partieller Differentialgleichungen erster Ordnung mit einer einzigen abhängigen Variabeln hergeleitet.

I.

Es sei

$$\begin{array}{c} F_1(z, x_1, \cdots, x_n, p_1, \cdots, p_n)=0 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ F_m(z, x_1, \cdots, x_n, p_1, \cdots, p_n)=0 \end{array} \qquad (1)$$

das vorgelegte System partieller Differentialgleichungen erster Ordnung, wobei z die zu bestimmende Funktion von $x_1, \cdots, x_n$ und p_i ihre Ableitung $\frac{\partial z}{\partial x_i}$ bezeichnet. Man kann offenbar festsetzen, dass die Determinante $\frac{\partial(F_1, \cdots, F_m)}{\partial(p_1, \cdots, p_m)}$ nicht identisch verschwindet, denn mindestens eine Determinante von der Form $\frac{\partial(F_1 \cdots, F_m)}{\partial(p_\alpha \cdots p_\mu)}$ nicht identisch verschwindet, sobald die Gleichungen

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[*] „Anwendungen der Variationsrechnung auf partielle Differentialgleichungen mit zwei unabhängigen Variabeln."

von (1) von einander verschieden sind: wir nehmen sogar an $\frac{\partial(F_1,\cdots F_m)}{\partial(p_1,\cdots p_m)}\neq 0$

Das System (1) definirt eine Schar von ∞^{2n-m+1} Flächenelemente $(z, x_1, \cdots, x_n, p_1, \cdots, p_n)$ im $n+1$ dimensionalen Raume. Wir mögen nun den eindimensionalen Elementverein aus dieser Schar finden, nämlich das Funktionensystem $z, x_1, \cdots, x_n, p_1, \cdots, p_n$ einer einzigen Variabeln t, welches die Beziehung

$$z'-\sum_{i=1}^{n} p_i\, x_i'=0 \tag{2}$$

befriedigt. z', x_i' stehen für die Ableitungen von z, x_i nach t.

Zu diesem Zwecke bilden wir das Integral

$$\int_{t_0}^{t_1}[\lambda\,(z'-\sum_{i=1}^{n} p_i\, x_i')+\sum_{k=1}^{m}\mu_k\, F_k]\, dt,$$

wobei λ und $\mu_1, \cdots, \mu_m$ beliebige Funktionen von t, und t_0, t_1 gewisse bestimmte Werte von t bezeichnen.

Dieses Integral verschwindet offenbar, wofern die Gleichungen (1) und (2) erfüllt sind. Daraus folgt unmittelbar die Gleichung

$$\delta\int_{t_0}^{t_1}[\lambda\,(z'-\sum_{i=1}^{n} p_i\, x_i')+\sum_{k=1}^{m}\mu_k\, F_k]\, dt=0,$$

sobald die Variationen den Bedingungen

$$\delta z'-\sum_{i=1}^{n}\delta(p_i\, x_i')=0,$$
$$\delta F_k=0 \qquad (k=1, 2.\cdots m)$$

genügen.

Diese Gleichung und die Bedingungsgleichungen können wir folgendermassen umschreiben:

$$\begin{aligned}&[\lambda\delta z]_{t_0}^{t_1}-\sum_{i=1}^{n}[\lambda p_i\,\delta x_i]_{t_0}^{t_1}+\int_{t_0}^{t_1}\left[\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial z}-\lambda'\right]\delta z\, dt\\&+\sum_{i=1}^{n}\int_{t_0}^{t_1}\left[\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_i}+(\lambda p_i)'\right]\delta x_i\, dt+\sum_{i=1}^{n}\int_{t_0}^{t_1}\left[\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial p_i}-\lambda x_i'\right]\delta p_i\, dt=0\end{aligned} \tag{3}$$

$$\left.\begin{aligned}&\delta z'-\sum_{i=1}^{n}(p_i\,\delta x_i'+x_i'\,\delta p_i)=0\\&\frac{\partial F_k}{\partial z}\,\delta z+\sum_{i=1}^{n}\frac{\partial F_k}{\partial x_i}\,\delta x_i+\sum_{i=1}^{n}\frac{\partial F_k}{\partial p_i}\,\delta p_i=0 \quad (k=1, 2, \cdots m)\end{aligned}\right\} \tag{4}$$

Man erhält ein Funktionensystem z, x, p, welche die Gleichung (3) befriedigt, wenn man z, x, p so bestimmen kann, dass jedes Glied der Gleichung (3) identisch verschwindet.*

Wir unterscheiden nun zwei Fälle, $m<n$ und $m=n$.

Der Fall $m<n$. Könnte man nun jeden Ausdruck unter dem Integralzeichen aus dem letzten Glied von (3) verschwinden lassen, dann müssen die Grössen z, x, p die folgenden $n-m$ Gleichungen befriedigen:

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \frac{\partial F_1}{\partial p_2} & \frac{\partial F_2}{\partial p_2} & \cdots & \frac{\partial F_m}{\partial p_2} & x_2' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ \frac{\partial F_1}{\partial p_i} & \frac{\partial F_2}{\partial p_i} & \cdots & \frac{\partial F_m}{\partial p_i} & x_i' \end{vmatrix} = 0 \qquad (i=m+1, \cdots n) \tag{5}$$

Wir setzen also diese $n-m$ Gleichungen (5) fest als die Bedingungsgleichungen für die Grössen z, x, p. Dann sind nur m Gleichungen aus den folgenden n Gleichungen

$$\sum_{k=1}^{m} \mu_k \frac{\partial F_k}{\partial p_i} - \lambda x_i' = 0 \qquad (i=1, 2, \cdots n)$$

wesentlich.

Wir betrachten also die $n+1$ Gleichungen

$$\begin{aligned} &\sum_{k=1}^{m} \mu_k \frac{\partial F_k}{\partial z} - \lambda' = 0, \\ &\sum_{k=1}^{m} \mu_k \frac{\partial F_k}{\partial p_i} - \lambda x_i' = 0 \qquad (i=1, 2, \cdots n) \end{aligned} \tag{6}$$

als die Bestimmungsgleichungen von $m+1$ Grössen λ, $\mu_1, \cdots, \mu_m$.

Nach den Beziehungen (5) sind die $m+1$ Ausdrücke

$$x_1' \delta p_1 + \cdots + x_n' \delta p_n, \qquad \frac{\partial F_k}{\partial p_1} \delta p_1 + \cdots + \frac{\partial F_k}{\partial p_n} \delta p_n \qquad (k=1, 2, \cdots m)$$

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* Da (4) eine Differentialgleichung enthält, kann man nicht ohne weiteres, wie im gewöhnlichen Variationsprobleme, das Verschwinden jedes Gliedes von (3) schliessen.

in den Bedingungen (4) nicht von einander linear unabhängig, und daher folgt die Gleichung:

$$\begin{vmatrix} \delta z' - \sum\limits_{i=1}^{n} p_i \, \delta x_i' & x_1' & x_2' & \cdots & x_m' \\ \frac{\partial F_1}{\partial z} \delta z + \sum\limits_{i=1}^{n} \frac{\partial F_1}{\partial x_i} \delta x_i & \frac{\partial F_1}{\partial p_1} & \frac{\partial F_1}{\partial p_2} & \cdots & \frac{\partial F_1}{\partial p_m} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_m}{\partial z} \delta z + \sum\limits_{i=1}^{n} \frac{\partial F_m}{\partial x_i} \delta x_i & \frac{\partial F_m}{\partial p_1} & \frac{\partial F_m}{\partial p_2} & \cdots & \frac{\partial F_m}{\partial p_m} \end{vmatrix} = 0 \qquad (7)$$

Denkt man sich die Variationen $\delta x_1, \cdots, \delta x_n$ gegeben, dann ist (7) die Bestimmungsgleichung von δz, welche die Form der linearen Differentialgleichung

$$\delta z' + X \delta z + X_1 = 0$$

besitzt. Wie man leicht sieht, ist λ gleich $e^{\int X dt}$, und daher kann die Integrationskonstante von δz nicht immer so gewählt werden, dass $[\lambda \delta z]_{t_0}^{t_1}$ gleich Null wird.

Wir nehmen also an, dass $\delta x_1, \cdots, \delta x_n$ an einem Endpunkte t_0 verschwinden. Man kann offenbar die Integrationskonstante von δz so bestimmen, dass $\lambda \delta z$ am Punkte t_0 verschwindet. Am anderen Endpunkte t_1 nehmen wir an: eins aus $\delta x_1, \cdots, \delta x_n$, etwa δx_j, wird immer so eingerichtet, dass der Wert $[\delta z - p_j \, \delta x_j]_{t_1}$ gleich Null wird, während alle anderen an diesem Punkte verschwinden. Dann verschwinden die von Integralzeichen freien Glieder von (3). Diese Annahme für δx_j ist immer möglich, sobald p_j am Punkte t_1 nicht verschwindet, und da der Parameterwert t_1 beliebig gewählt werden kann, ist diese Annahme immer möglich, wenn p_j nicht identisch Null ist. Die Schwierigkeit tritt also nur dann ein, wenn alle p identisch Null sind. Im letzten Falle wird z, wegen der Beziehung (2), gleich konstant. Diesen Fall schliessen wir aus.

Die Gleichung (3) nimmt nun die Form an:

$$\sum_{i=1}^{n} \int_{t_0}^{t_1} \left[\sum_{k=1}^{m} \mu_k \frac{\partial F_k}{\partial x_i} + (\lambda p_i)' \right] \delta x_i \, dt = 0.$$

Alle Variationen δx_i, ausser δx_j, verschwinden an den Punkten t_0 und t_1, sonst willkürlich; die Variation δx_j verschwindet am Punkte t_0, aber nicht am Punkte t_1. Wenn man alle δx_i, ausser δx_j, identisch gleich Null denkt, dann erhält man

$$\int_{t_0}^{t_1}\left[\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_j}+(\lambda p_j)'\right]\delta x_j\,dt=0.$$

Obgleich δx_j am Punkte t_1 einen von Null verschiedenen Wert annimmt, doch kann man aus der letzten Gleichung, in ähnlicher Weise wie bei der Herleitung der Eulerschen Gleichung in der Variationsrechnung, schliessen

$$\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_j}+(\lambda p_j)'=0.$$

Das Verschwinden von den anderen Integranden $\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_i}+(\lambda p_i)'$ kann gewöhnlicherweise bewiesen werden. Wir haben nämlich

$$\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_i}+(\lambda p_j)'=0 \qquad (i=1,2,\cdots n)$$

welche sich durch die Gleichung

$$\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial z}-\lambda'=0$$

in die folgenden

$$\sum_{k=1}^{m}\mu_k\left(\frac{\partial F_k}{\partial x_i}\right)+\lambda p_i'=0 \qquad (i=1,2,\cdots n)$$

umschreiben lassen. Das Symbol $\left(\frac{\partial F_k}{\partial x_i}\right)$ steht für den Ausdruck $\frac{\partial F_k}{\partial x_i}+p_i\frac{\partial F_k}{\partial z}$.

Setzt man die durch (6) bestimmten Werte von $\lambda, \mu_1, \cdots, \mu_m$ in die letzten Gleichungen ein, so erhalten wir n Gleichungen, welche mit (5) zusammen $2n-m$ Bedingungen für die Funktionensystem $z, x_1, \cdots, x_n, p_1, \cdots, p_n$ bilden.

Dieselben Bedingungen erhalten wir offenbar von den Gleichungen

$$\left.\begin{aligned}&\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial p_i}-\lambda x_i'=0\\&\sum_{k=1}^{m}\mu_k\frac{\partial F_k}{\partial x_i}+\lambda p_i'=0\end{aligned}\right\}\qquad(i=1,2,\cdots n)$$

durch Elimination von $\lambda, \mu_1, \cdots, \mu_m$. Wir haben nämlich

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ \frac{\partial F_1}{\partial p_i} & \frac{\partial F_2}{\partial p_i} & \cdots & \frac{\partial F_m}{\partial p_i} & x_i' \end{vmatrix} = 0 \qquad (i = m+1, \cdots n)^*$$

$$(8)$$

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ \left(\frac{\partial F_1}{\partial x_i}\right) & \left(\frac{\partial F_2}{\partial x_i}\right) & \cdots & \left(\frac{\partial F_m}{\partial x_i}\right) & -p_i' \end{vmatrix} = 0 \qquad (i = 1, 2, \cdots n)$$

Die Gleichungen (8) sind hinreichend fürs Bestehen der Gleichung (3), wenn λ und μ geeignet bestimmt sind; die Gleichungen (1) und (2) folgen aber nicht notwendig daraus. Wir dürfen also zu den Gleichungen (9) noch die Gleichung

$$z' - \sum_{i=1}^{m} p_i x_i' = 0 \qquad (2)$$

oder was dasselbe heisst:

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ \sum_{i=1}^{n} p_i \frac{\partial F_1}{\partial p_i} & \sum_{i=1}^{n} p_i \frac{\partial F_2}{\partial p_i} & \cdots & \sum_{i=1}^{n} p_i \frac{\partial F_m}{\partial p_i} & -z' \end{vmatrix} = 0$$

hinzufügen.

Wir gehen nun über in den

Fall $m = n$. Das Gleichungensystem (4) besteht aus $n+1$ Gleichungen. Von den n letzten Bedingungen lassen sich die n Variationen $\delta p_1, \cdots, \delta p_n$ als lineare Funktionen von $\delta z, \delta x_1, \cdots, \delta x_n$

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* Die Gleichungen (5) selbst.

ausdrücken, da wir am Anfang die Determinante $\frac{\partial(F_1\cdots F_n)}{\partial(p_1\cdots p_n)}$ nicht gleich Null vorausgesetzt haben. Setzt man diese Ausdrücke in die erste ein, dann erhält man für δz eine lineare Differentialgleichung erster Ordnung wie früher. Man kann daher die von Integralzeichen freien Glieder von (3) als verschwunden annehmen.

Die Bestimmungsgleichungen von λ und μ lauten hier

$$\sum_{k=1}^{n} \mu_k \frac{\partial F_k}{\partial z} - \lambda' = 0$$

$$\sum_{k=1}^{n} \mu_k \frac{\partial F_k}{\partial p_i} - \lambda x_i' = 0 \qquad (i=1,2,\cdots n)$$

Wir brauchen keine Bedingungsgleichung wie (5).

Wegen der Willkür von $\delta x_1, \cdots, \delta x_n$ folgen die Gleichungen

$$\sum_{k=1}^{n} \mu_k \frac{\partial F_k}{\partial x_i} + (\lambda p_i)' = 0 \qquad (i=1,2,\cdots n)$$

Durch die Elimination von λ und μ ergiebt sich das Gleichungensystem

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_n}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_n} & \frac{\partial F_2}{\partial p_n} & \cdots & \frac{\partial F_n}{\partial p_n} & x_n' \\ \left(\frac{\partial F_1}{\partial x_i}\right) & \left(\frac{\partial F_2}{\partial x_i}\right) & \cdots & \left(\frac{\partial F_n}{\partial x_i}\right) & -p_i' \end{vmatrix} = 0 \quad (i=1,2,\cdots n) \quad (8')$$

In diesem Falle haben wir zu bemerken, dass das System (8′) die notwendige Folge von (1) und (2) ist, welches für $m<n$ nicht der Fall war.

II.

Bezeichnet man, wie gewöhnlich, den Ausdruck

$$\sum_{\nu=1}^{n} \left\{ \frac{\partial F_i}{\partial p_\nu} \left(\frac{\partial F_k}{\partial x_\nu}\right) - \left(\frac{\partial F_i}{\partial x_\nu}\right) \frac{\partial F_k}{\partial p_\nu} \right\}$$

mit dem Symbol $[F_i, F_k]$, dann folgt aus (2) und (8) die Beziehung

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ [F_1F_i] & [F_2F_i] & \cdots & [F_mF_i] & F_i' \end{vmatrix} = 0$$

Soll nun der Ausdruck F_i für die Lösungen des Systems der Gleichungen (2) und (8) einen konstanten Wert annehmen, so muss die folgende Beziehung identisch bestehen.

$$\begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \frac{\partial F_1}{\partial p_m} & \frac{\partial F_2}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} & x_m' \\ [F_1F_i] & [F_2F_i] & \cdots & [F_mF_i] & 0 \end{vmatrix} = 0$$

Nach den Gleichungen (8) sind x_{m+1}', $\cdots$, x_n', p_1', $\cdots$, p_n' lineare Funktionen von x_1', $\cdots$, x_m' und die letzteren Grössen sind von einander unabhängig, und daher können sie sich willkürlich verändern. Daher müssen die Koeffizienten von x_1', $\cdots$, x_m' in der letzten Determinante identisch verschwinden. Wir haben also m Gleichungen

$$\begin{gathered} \Delta_{11}[F_1F_i] + \Delta_{12}[F_2F_i] + \cdots + \Delta_{1m}[F_mF_i] = 0 \\ \Delta_{21}[F_1F_i] + \Delta_{22}[F_2F_i] + \cdots + \Delta_{2m}[F_mF_i] = 0 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ \Delta_{m1}[F_1F_i] + \Delta_{m2}[F_2F_i] + \cdots + \Delta_{mm}[F_mF_i] = 0, \end{gathered}$$

wobei Δ_{ik} das algebraische Komplement des Elementes $\frac{\partial F_k}{\partial p_i}$ in der Determinante

$$\Delta = \frac{\partial(F_1 \quad F_m)}{\partial(p_1 \cdots p_m)} = \begin{vmatrix} \frac{\partial F_1}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} \\ \dots\dots & \dots\dots & \dots\dots \\ \frac{\partial F_1}{\partial p_m} & \cdots & \frac{\partial F_m}{\partial p_m} \end{vmatrix}$$

bezeichnet.

Da nun die Determinante der Koeffizienten der letzteren Gleichungen gerade Δ^{n-1} gleich ist und daher nicht verschwindet, so folgt, dass jeder von den Klammerausdrücken $[F_1 F_i']$, $[F_2, F_i']$ $\ldots$, $[F_m, F_i']$ verschwindet.

Umgekehrt, wenn alle Klammerausdrücke $[F_i F_k]$ für ein Lösungssystem von (2) und (8) identisch verschwinden, so ist unmittelbar ersichtlich, dass alle F_i' identisch verschwinden müssen, d.h. dass dann $F_1, \cdots, F_m$ konstante Werte erhalten.

Dieser Fall tritt offenbar ein, wenn alle Ausdrücke $[F_i F_k]$ als Funktionen der Veränderlichen $x_1, \cdots, x_n, p_1, \cdots, p_n$ identisch verschwinden, d.h. wenn die vorgelegten Gleichungen (1) ein Involutionssystem bilden.

Im folgenden setzen wir also fest, dass das System (1) zuerst zu einem Involutionssystem gebracht worden ist.

Wählt man nun, bei der Integration vom System (2) (8), die Anfangswerte so, dass dafür alle Ausdrücke $F_1, \cdots, F_m$ gleich Null werden, dann befriedigen die Lösungen dieses Systems das vorgelegte Involutionssystem (1). Nennen wir ein solches Lösungssystem eine charakteristische Mannigfaltigkeit, so haben wir im Ganzen $2n-2m+1$ fach unendlichviele charakteristische Mannigfaltigkeiten.

Die gesammten ∞^{2n-m+1} Elemente, welche dem Involutionssystem (1) entsprechen, schliessen sich zu $\infty^{2n-2m+1}$ charakteristische Mannigfaltigkeiten zusammen.

Da wir die simultanen Gleichungen (2), (8) nach

$$x_{m+1}', \cdots, x_n', z', p_1', \cdots, p_n'$$

auflösen können, wobei die rechten Seiten eindeutig bestimmt werden, können wir folgendermassen schliessen:

Jede charakteristische Mannigfaltigkeit wird durch $2n-2m+1$ Anfangswerte von $x_{m+1}, \cdots, x_n, z, p_1, \cdots, p_n$ eindeutig bestimmt.

Wir möchten nun zeigen, dass die so definirte charakteristische Mannigfaltigkeit mit der gebräuchlichen übereinstimmt.

Bezeichnet man die $2n-2m+1$ von einander und von $F_1, \ldots, F_m$ verschiedenen Lösungen des Gleichungensystems

$$[F_1, \Phi]=0,\ [F_2, \Phi]=0,\ \cdots,\ [F_m, \Phi]=0 \tag{9}$$

durch $\Phi_1, \cdots, \Phi_{2n-2m+1}$, so ist die charakteristische Mannigfaltigkeit gewöhnlich durch die Gleichungen

$$F_1=0,\ \cdots,\ F_m=0,\ \Phi_1=c_1,\ \cdots,\ \Phi_{2n-2m+1}=c_{2n-2m+1}, \tag{10}$$

wobei $c_1, \cdots, c_{2n-2m+1}$ Konstanten bezeichnen, gegeben.*

Es sei $\Phi\ (z, x_1, \cdots, x_n, p_1, \cdots, p_n)$ irgend eine Lösung des Systems (9).

Wenn man irgend ein Lösungssystem z, x, p vom System (2) (8) in die Funktion Φ einsetzt, dann gilt identisch die Gleichung

$$\begin{vmatrix} \dfrac{\partial F_1}{\partial p_1} & \dfrac{\partial F_2}{\partial p_1} & \cdots & \dfrac{\partial F_m}{\partial p_1} & x_1' \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \dfrac{\partial F_1}{\partial p_m} & \dfrac{\partial F_2}{\partial p_m} & \cdots & \dfrac{\partial F_m}{\partial p_m} & x_m' \\ [F_1\Phi] & [F_2\Phi] & \cdots & [F_m\Phi] & \Phi' \end{vmatrix} = 0$$

Da aber alle Klammerausdrücke in der Determinante verschwinden, so folgt unmittelbar die Beziehung

$$\Phi=\text{Konst.}$$

Diese letzte Beziehung zeigt uns, dass jede Lösung Φ von (9) für jedes Lösungssystem z, x, p von (2) (8) konstant wird, d.h. $\Phi_i=c_i\ (i=1, 2, \cdots, 2n-2m+1)$ sind Lösungen vom System (2) (8), und daher bildet das System (10), welches im Ganzen $2n-m+1$

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* Goursat, Leçons sur l'intégration des équations aux dérivées partielles du premier ordre. §94.

Gleichungen mit $2n-2m+1$ Integrationskonstanten enthält, dieselbe charakteristischen Mannigfaltigkeiten, welche durch das System (2) (8) definirt sind.

Da die Gleichungen (8) nichts anders als die Gleichungen für Extremalen des Variationsproblems

$$\delta\int_{t_0}^{t_1}[\lambda(z'-\sum_{i=1}^{n}p_i\,x_i')+\sum_{k=1}^{m}\mu_k\,F_k]\,dt=0$$

sind, bekommen wir den folgenden Satz:

Die charakteristischen Mannigfaltigkeiten eines Involutionssystems der partiellen Differentialgleichungen erster Ordnung

$$F_1(z,\,x_1,\,\cdots,\,x_n,\,p_1,\,\cdots,\,p_n)=0$$

$$\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots$$

$$F_m(z,\,x_1,\,\cdots,\,x_n,\,p_1,\,\cdots,\,p_n)=0$$

sind die Extremalen des Variationsproblems, dass das Integral

$$\int_{t_0}^{t_1}\lambda(z'-\sum_{i=1}^{n}p_i\,x_i')\,dt$$

zu einem Extremum zu machen, dabei die zulässigen Funktionen den Nebenbedingungen

$$F_1=0,\ \cdots\ F_m=0$$

unterworfen sind, und λ eine geeignet zu bestimmende, nicht mitvarierende Funktion von t ist.*

III.

Von den charakteristischen Mannigfaltigkeiten kann man,

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* Von den Gleichungen (6) und $\Sigma\mu_k\left(\frac{\partial F_k}{\partial r_i}\right)+\lambda\,p_i'=0$ erhält man sofort:

$$\sum_{k=1}^{m}\mu_k\left\{F_k'-\frac{\partial F_k}{\partial z}\,(z'-\sum_{i=1}^{n}p_i\,x_i')\right\}=0$$

daher folgt, wegen der Nebenbedingungen, $z'-\sum_{i=1}^{m}p_i\,x_i'=0$.

nach Cauchy und Lie, die allgemeine Lösung des vorgelegten Involutionssystems ableiten.*

Wir nehmen nämlich an, dass ein Integralgebilde des vorgelegten Involutionssystems (1) für die Anfangswerte $x_1^\circ, \cdots, x_m^\circ$ von $x_1, \cdots, x_m$ sich auf das Gebilde

$$\overline{z} = \Phi(\overline{x}_{m+1}, \cdots \overline{x}_n)$$

reduzirt. Das genannte Integralgebilde ist dann umgekehrt durch das letzte Gebilde im Allgemeinen eindeutig bestimmt.**

Für dieses Wertsystem $x_1^\circ, \cdots, x_m^\circ$ erhalten wir

$$\overline{p}_{m+i} = \frac{\partial \Phi}{\partial \overline{x}_{m+i}} \qquad (i=1, \cdots, n-m);$$

die Werte $\overline{p}_1, \cdots, \overline{p}_m$ lassen sich durch die Beziehungen

$$F_1=0,\ F_2=0,\ \cdots,\ F_m=0$$

bestimmen.

Hierdurch sind längs des Gebildes $\overline{z} = \Phi$ alle diese Elemente

$$[x_1^\circ, \cdots, x_m^\circ, \overline{x}_{m+1}, \cdots, \overline{x}_n, \overline{z}, \overline{p}_1, \cdots, \overline{p}_n]$$

an einander gereiht und wir machen jetzt jedes einzelne Element zum Ausgangspunkt für die Konstruktion einer charakteristischen Mannigfaltigkeit.

Alle so konstruirten charakteristischen Mannigfaltigkeiten bilden zusammen wieder das ganannte Integralgebilde.

Wenn man die Funktion Φ als willkürlich betrachtet, so erhält man die allgemeine Lösung des vorgelegten Involutionssystems.

Wir haben nun zu verifizieren, ob die partiellen Ableitungen der eben gewonnenen Lösung wirklich mit p_i der charakteristischen Mannigfaltigkeiten übereinstimmen. Den Beweis dafür kann man ähnlicherweise wie in Goursat's ,,Leçons" §50 führen.

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* Goursat, Leçons. § 95.

** Goursat, Leçons. § 71.

Braucht man, nämlich, die dort benutzten Bezeichnungen, dann wird

$$\begin{aligned} U &= \delta z - p_1\,\delta x_1 - \cdots - p_n\,\delta x_n \\ dU &= d(\delta z) - p_{m+1}\,d(\delta x_{m+1}) - \cdots - p_n\,d(\delta x_n) \\ &\quad - dp_1\cdot\delta x_1 - \cdots - dp_n\cdot\delta x_n \\ &= \sum_{i=1}^{n}(\delta p_i\cdot dx_i - dp_i\cdot\delta x_i). \end{aligned}$$

Aus den Gleichungen (8) leitet man leicht die Beziehung ab:

$$\begin{vmatrix} \dfrac{\partial F_1}{\partial p_1} & \dfrac{\partial F_2}{\partial p_1} & \cdots & \dfrac{\partial F_m}{\partial p_1} & dx_1 \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \dfrac{\partial F_1}{\partial p_m} & \dfrac{\partial F_2}{\partial p_m} & \cdots & \dfrac{\partial F_m}{\partial p_m} & dx_m \\ U\dfrac{\partial F_1}{\partial z} & U\dfrac{\partial F_2}{\partial z} & \cdots & U\dfrac{\partial F_m}{\partial z} & -dU \end{vmatrix} = 0,$$

welche sich in der folgenden Form schreiben lässt:

$$\frac{dU}{U} = Z_1\,dx_1 + Z_2\cdot dx_2 + \cdots + Z_m\,dx_m.$$

Man erhält daher

$$U = U_0\,e^{\sum\limits_{i=1}^{m}\int_0^{x_i} Z_i\,dx_i}$$

Falls alle Z_i endlich bleiben, kann man, da U_0 für unsere Anfangswerte gleich Null sein muss, daraus schliessen

$$U = 0,$$

was zu beweisen war.

Sollte aber weiterhin durch Verschwinden von $\dfrac{\partial(F_1\cdots F_m)}{\partial(p_1\cdots p_m)}$ sich eine Schwierigkeit ergeben, so bemerke man, dass man bei Integration längs einer charakteristischen Mannigfaltigkeit statt $(x_1, \cdots, x_m)$ irgend m der Variabelen

$$z,\ x_1,\ \cdots,\ x_n,\ p_1,\ \cdots,\ p_n$$

gerade so gut als unabhängig ansehen kann. Eine Schwierigkeit kann also nur dann eintreten, wenn auf dem gerade betrachteten Gebilde eine Stelle erreicht wird, an welcher alle Determinanten m-ter Ordnung aus der Matrix

$$\left|\begin{array}{cccc} \frac{\partial F_1}{\partial p_1} & \frac{\partial F_2}{\partial p_1} & \cdots & \frac{\partial F_m}{\partial p_1} \\ \multicolumn{4}{c}{\dotfill} \\ \frac{\partial F_1}{\partial p_n} & \frac{\partial F_2}{\partial p_n} & \cdots & \frac{\partial F_m}{\partial p_n} \\ \left(\frac{\partial F_1}{\partial x_1}\right) & \left(\frac{\partial F_2}{\partial x_1}\right) & \cdots & \left(\frac{\partial F_m}{\partial x_1}\right) \\ \multicolumn{4}{c}{\dotfill} \\ \left(\frac{\partial F_1}{\partial x_n}\right) & \left(\frac{\partial F_2}{\partial x_n}\right) & \cdots & \left(\frac{\partial F_m}{\partial x_n}\right) \end{array}\right|$$

verschwinden.

Die bisherige Methode gibt also kein Integral, für welches alle diese Determinanten gleichzeitig verschwinden. Ein solches bezeichnet man als singuläre Lösung.

Wählt man jetzt für Φ eine bestimmte Funktionsform, so ergibt sich ein bestimmtes Integralgebilde. Eine Schar von ∞^{n-m} charakteristischen Mannigfaltigkeiten bildet ein Integralgebilde. Da es nun im Ganzen $\infty^{2n-2m+1}$ charakteristische Mannigfaltigkeiten gibt, so haben wir Scharen von ∞^{n-m+1} Integralgebilden, welche man die vollständige Lösung nennt.

Um also eine vollständige Lösung zu erhalten, wählen wir für Φ eine bestimmte Funktionsform mit $n-m+1$ wesentlichen Parametern. Die so gewonnene Lösung mit $n-m+1$ Parametern ist eine vollständige Lösung.

Wir wollen nun ein Beispiel geben, welches sich leicht durch diese Methode integrieren lässt.

Beispiel.[*] Es sei das System

$$p_1 p_4 - x_2 x_3 = 0$$
$$p_2 p_3 - x_1 x_4 = 0$$

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[*] Goursat, Leçons p. 156.

vorgelegt; wir bilden daraus das Involutionssystem

$$p_1 - \frac{x_2 x_3}{p_4} = 0,$$

$$p_2 - \frac{x_4 p_4}{x_2} = 0,$$

$$p_3 - \frac{x_1 x_2}{p_4} = 0.$$

Das Gleichungensystem (2) (8) besitzt, ausser dieser drei die drei folgenden Integrale:

$$z - 2x_4 p_4 = \alpha,$$

$$p_1 p_3 - x_2 x_4 = \beta,$$

$$p_2 p_4 - x_1 x_3 = \gamma,$$

mit den Integrationskonstanten α, β, γ.

Nehmen wir für die Anfangswerte die folgenden:

$$x_1^\circ = -1, \qquad x_2^\circ = 1, \qquad x_4^\circ = 0,$$

dann erhalten wir die Beziehungen zwischen den Konstanten

$$\alpha = \overline{z} - 2\overline{x}_4 \overline{p}_4,$$

$$\beta = -\overline{x}_4,$$

$$\gamma = \overline{x}_4 (\overline{p}_4)^2.$$

Die Gleichungen für charakteristische Mannigfaltigkeiten lassen sich in der folgenden Form schreiben:

$$x_4 = \frac{1}{(\overline{p}_4)^2} \; \frac{x_1 x_3 + \overline{x}_4 (\overline{p}_4)^2}{x_2}$$

$$z = \overline{z} + \frac{2x_1 x_3}{\overline{p}_4},$$

$$p_1 = \frac{x_3}{\overline{p}_4},$$

$$p_2 = \frac{x_1 x_3 + \overline{x}_4 (\overline{p}_4)^2}{\overline{p}_4 \cdot x_2},$$

$$p_3 = \frac{x_1}{\overline{p}_4},$$

$$p_4 = \overline{p}_4 x_2 .$$

Um die allgemeine Lösung zu erhalten haben wir nur zu setzen:

$$\overline{z} = \Phi(\overline{x_4}), \qquad \overline{p_4} = \Phi'(\overline{x_4}),$$

wo Φ eine willkürliche Funktion und Φ' ihre Ableitung nach $\overline{x_4}$ bezeichnet, und dann sind die zwei ersten Gleichungen aus dem letzten Systeme als die allgemeine Lösung zu betrachten, wenn man $\overline{x_4}$ als Parameter denkt.

Setzt man speziell

$$\overline{z} = a\,\overline{x_4} + b,$$

so erhält man gerade diejenige vollständige Lösung wie man im „Goursat's Leçons" p. 157 findet, welche lautet:

$$z = \frac{x_1 x_3}{a} + a\,x_2 x_4 + b.$$

IV.

Ein spezieller Fall ist die Integration eines Involutionssystems linearer partieller Differentialgleichungen erster Ordnung.*

Jede Gleichung ist von der Form

$$P_1 p_1 + P_2 p_2 + \cdots + P_n p_n = R,$$

worin $P_1, P_2, \cdots, P_n, R$ Funktionen von $z, x_1, \cdots, x_n$ sind.

Das Gleichungensystem von (2) und (8) sind offenbar Beziehungen zwischen $z, x_1, \cdots x_n$, und enthält kein p drin.

Schreibt man die Integrale dieses Systems in der Form

$$\overline{x}_{m+1} = \varphi_1(x_1, \cdots, x_n, z)$$
$$\cdots\cdots\cdots\cdots\cdots\cdots$$
$$\overline{x}_n = \varphi_{n-m}(x_1 \cdots, x_n, z)$$
$$\overline{z} = \varphi(x_1, \cdots, x_n, z),$$

und setzt man, wie früher,

$$\overline{z} = \Phi(\overline{x}_{m+1}, \cdots, \overline{x}_n),$$

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* Vgl. Goursat, Leçons. § 97. II.

dann erhält man die allgemeine Lösung des vorgelegten Systems in der Form

$$\varphi = \Phi(\varphi_1, \varphi_2, \cdots, \varphi_{n-m}).$$

Wenn man, im Allgemeinen, irgend welche $n-m+1$ von einander unabhängigen Lösungen

$$\psi_1(x_1, \cdots, x_n, z) = c_1,$$

$$\cdots\cdots\cdots\cdots\cdots\cdots$$

$$\psi_{n-m+1}(x_1, \cdots, x_n, z) = c_{n-m+1}$$

mit den Integrationskonstanten $c_1, \cdots, c_{n-m+1}$ findet, dann liefert, wie man leicht sieht, die Gleichung

$$\Phi(\psi_1, \cdots, \psi_{n-m+1}) = 0$$

die allgemeine Lösung, wobei Φ auch eine willkürliche Funktion bezeichnet.

Beispiel. 1. Das vorgelegte System sei

$$p_1 + p_2 = \frac{x_3 + x_4}{z},$$

$$p_3 + p_4 = \frac{x_1 + x_2}{z}.$$

Diese beiden Gleichungen bilden ein Involutionssystem. Da hier $\frac{\partial(F_1 F_2)}{\partial(p_1 p_2)}$ identisch verschwindet, nehmen wir $x_2, x_3,$ anstatt $x_1, x_2,$ für unabhängige Variabeln an.

Man findet leicht die folgenden drei Integrale vom System (2) und (8):

$$x_1 - x_2 = \text{Konst.}$$

$$x_3 - x_4 = \text{Konst.}$$

$$\frac{z^2}{2} - x_1 x_4 - x_2 x_3 = \text{Konst.}$$

Die allgemeine Lösung des vorgelegten Systems lautet also:

$$\frac{z^2}{2} - x_1 x_4 - x_2 x_3 = \Phi(x_1 - x_2, x_3 - x_4).$$

Beispiel 2. Das vorgelegte System sei

$$\begin{aligned} &p_1 + (x_2+x_4-3x_1)\,p_3 + (x_3+x_1\,x_2+x_1\,x_4)\,p_4=0, \\ &p_2 + (x_3\,x_4-x_2)\,p_3 + (x_1\,x_3\,x_4+x_2-x_1\,x_2)\,p_4=0. \end{aligned} \quad *$$

Durch Hinzufügung der Gleichung

$$p_3 + x_1\,p_4 = 0$$

erhalten wir ein vollständiges System. Löst man diese Gleichungen nach p_1, p_2, p_3 auf, dann bekommt man das Jacobische System:

$$\begin{aligned} &p_1 + (x_3+3x_1^2)\,p_4=0, \\ &p_2 + x_2\,p_4 = 0, \\ &p_3 + x_1\,p_4 = 0. \end{aligned}$$

Man findet leicht die zwei Integrale

$$z = \text{Konst.}$$

$$x_1^3 + \frac{x_2^2}{2} + x_1\,x_3 - x_4 = \text{Konst.}$$

Die allgemeine Lösung unseres Systems lautet daher:

$$z = \Phi\left(x_1^3 + \frac{x_2^2}{2} + x_1\,x_3 - x_4\right).$$

Ich fühle mich Herrn Geheimrat Hilbert in Göttingen für die wertvollsten Ratschläge zu grossem Danke verpflichtet.

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* Goursat, Leçons, p. 62.

Publ. Aug. 25th, 1913.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.

VOL. XXXII., ARTICLE 12

On *Cyathocormus mirabilis* nov. gen., nov. sp., the Type of a New Family of Compound Ascidians from Japan.

By

Dr. Asajiro Oka.

With 3 Plates and 6 Text-figures.

Although the Ascidiae Salpaeformes or Luciae have all along been regarded as a subdivision of the Order Ascidiacea, the difference between the free swimming *Pyrosoma* and an ordinary fixed compound ascidian is certainly very striking. No form has as yet been made known which might be considered intermediate between these two groups. Even the curious unattached colony, *Coelocormus huxleyi*, which was believed by Prof. HERDMAN to be a transition form between them, has in reality nothing in common with *Pyrosoma* beyond the tubular shape of the colony. On the other hand, there are some recent investigators who regard *Pyrosoma* as more closely related to *Salpa* and *Doliolum* than to the ascidians. NEUMANN ('09), for instance, in BRONN's Klassen und Ordnungen des Tierreichs, has transferred the family Pyrosomidae to the Thaliacea in which it constitutes the group Synthaliacea ; and PARKER and HASWELL ('97 & '10), in their excellent text-book, have also adopted a similar view.

The new genus of compound ascidians described in the present paper is quite unique in combining the characters of the compound ascidians and the Ascidiae Salpaeformes. In shape and general appearance of the colony it very much resembles the latter, while it agrees with some of the former in the possession of a peduncle by which it is attached to some foreign body. The colony proper or head, which alone is composed of zooids, has the form of a short hollow cylinder, about as long as it is wide and closed at one end where it joins the stalk. Unlike *Pyrosoma* there is no diaphragm at the open end, so that the terminal aperture is of the same width as the central cavity. The peduncle is short, columnar, and dilated at the lower extremity to form a base of attachment. The entire animal, in consequence, is so perfectly cup-like in appearance that I could think of no better generic name than the one given in the title of this paper.

The zooids forming the wall of the hollow cylinder are arranged in vertical lines which run distinctly in pairs. Looked at from inside each double row of zooids with their common investing mass is found to form a cushion-like longitudinal ridge projecting into the central cavity and separated from its neighbours on both sides by narrow deep furrows. The zooids are imbedded in the common test in such a manner that the branchial apertures all open on the outer surface of the colony, and the atrial cavities all communicate directly with the longitudinal furrows just mentioned, which, of course, are nothing but the peripheral portions of the central cavity. There are no definite atrial apertures present, since the wall of the peribranchial cavity is wanting in the greater part of the thoracic region and the stigmata of the branchial sac as well as the anal and genital apertures open immediately into the adjacent longitudinal furrow. Thus the central cavity serves, as in the case of *Pyrosoma*, as the common cloaca of the whole colony which may be regarded as consisting of a single system of zooids, but this system is, in the present case, divided into groups of zooids whose atrial cavities are partly fused together to form a large continuous peribranchial space.

It is perfectly obvious that a compound ascidian with such characters as those mentioned above can not be included in any of the recognized families, and I consider myself fully justified in forming a new family for its reception. Since, however, only one genus of this family is at present known, I believe it would be of no use to consider the diagnostic characters of the family and the genus separately. They are naturally the same and may be summed up as follows:

Cyathocormus nov. gen.

Colony fixed, stalked; the head having the form of a short hollow cylinder closed at one end and open at the other.

Systems—only one present, the terminal aperture being the common cloacal opening, and the central cavity the common cloaca.

Zooids placed in a single layer with their anterior ends external and their posterior ends internal. Body divided into two regions, thorax and abdomen, the latter provided with a long vascular appendage. Branchial apertures opening on the outer surface of the colony, not lobed. Peribranchial wall imperfectly developed, stigmata of the branchial sac as well as the anal and genital apertures opening directly into the centrally placed common cloaca.

Test soft, gelatinous, and transparent; no calcareous spicules, bladder cells very numerous.

Branchial sac large and well developed, with four rows of stigmata; no internal longitudinal vessels present. Stigmata very long and narrow.

Tentacles simple.

Dorsal lamina represented by a series of languets.

Alimentary canal forming a simple loop placed posteriorly to the branchial sac. Stomach ellipsoidal and smooth walled, no cœcum. Duodenal portion of intestine distinctly bounded, fine tubular intestinal gland well developed.

Reproductive organs not conspicuous. Incubatory pouch present. Larva tailed.

It will be seen at once from the above diagnosis that the present genus exhibits in certain essential points a close relationship to the Pyrosomidae, while in other characters no less important it markedly approaches the Distomidae (Polycitoridae) among the compound ascidians. It agrees with *Pyrosoma*, on the one hand, not only in the form and general appearance of the colony already referred to, but also in the structure of the alimentary canal, which is practically the same in both forms. On the other hand, the presence of numerous bladder cells in the test naturally reminds of the condition found in the genera *Colella* (=*Sycozoa*) and *Distaplia* (=*Holozoa*) among the Distomidae (Polycitoridae), in some members of which these cells form by far the greater part of the investing mass. The stalk, too, much resembles that of some species of the genus *Colella*, e.g. *C. quoyi*; but this is unimportant, as similarly stalked forms are also met with in some other families.

One of the most notable points about this form is without doubt the partial fusion of the peribranchial cavities in a number of zooids. So far as I am aware, there is but one member of the Ascidiae compositae in which all the zooids exhibit a similar structure. According to Lahille ('90), the zooids of *Diplosomoides lacazei* (=*Polysyncraton l.*) have their peribranchial walls very imperfectly developed so that the greater part of the branchial sac is uncovered. Since other species of the genus do not present the same condition, this character ought to be looked upon as simply specific. In the present family, however, of which no other genera or species are known yet, it must be left doubtful whether this peculiarity should be regarded as a family character or as of only generic or even specific importance.

This genus contains the single species *C. mirabilis*.

Cyathocormus mirabilis nov. sp.

The colony is cup-shaped and is attached by the base of a short peduncle. The head has the form of a short hollow cylinder nearly as long as it is wide. The outer surface shows a number of very shallow longitudinal depressions separating as many slightly elevated longitudinal zones upon which double rows of very short branchial siphons are placed. The inner surface has a number of deep longitudinal furrows corresponding to the shallow depressions on the outer surface. In the ridges separated by them the dark coloured contents of the intestines look conspicuously through the test and body wall. The stalk is shorter than the head, columnar in shape, and is dilated at the lower end to form the base of attachment.

Size—head 18—22 mm. in length and 15—21 mm. in width; the stalk about 12 mm. in length and 4—5 mm. in diameter.

The test is soft, gelatinous, and perfectly transparent in the head, and considerably harder and more or less opaque in the peduncle.

The zooids are of moderate size and are entirely imbedded in the common test. They are 3—4 mm. in length and about 1½ mm. in greatest breadth. The body is divided, though not very distinctly, into thorax and abdomen, the latter provided with a long vascular appendage.

The mantle is very thin, muscle fibres being found only in the anterior region where they form a sort of sphincter around the branchial aperture.

The branchial sac is well developed but delicate. The transverse vessels are narrow and are all of the same size. The stigmata are very long and narrow with rounded ends.

The endostyle is conspicuous. It is plicated dorso-ventrally through the greater part of its length.

The dorsal lamina is represented by three short pointed languets projecting from the dorsal parts of the transverse vessels.

The tentacles are usually sixteen in number. Four are long and meet in the centre of the branchial aperture when laid flat; four others alternating with these are somewhat shorter, while the remaining eight are only half as long as the former.

The dorsal tubercle is very prominent, being unusually large in proportion to the size of the branchial sac. The aperture is a simple oval slit placed transversely on the anterior wall of the tubercle.

The alimentary canal forms a simple loop lying almost entirely behind the branchial sac. The stomach is only moderately large and is rather thick walled. The duodenal portion of intestine is somewhat pyramidal in shape with the base next the stomach, its wall is very thin. Anal aperture without lobes.

The reproductive organs are mostly atrophied in fully grown individuals. A large oval incubatory pouch containing a single larva is seen alongside the branchial region.

There are at present only two examples of this species known to me, both attached to a colony of a white coral. According to the statement of the collector, K. Aoki, they were obtained in the deeper parts of the Sagami Sea together with *Euplectella*, *Metacrinus*, etc., but the label having been lost, the exact date and locality of their capture can not be ascertained. A brief account of these colonies with remarks upon the systematic position of the species was given by me at the meeting of the Tokyo Zoological Society in January of the year 1907. The type specimens, partly injured by dissection, are deposited in the zoological collections of the College of Science, Imperial University, Tokyo. They are preserved in a mixture of alcohol, glycerin, and water, and seem not to have lost much of the original transparency.

Description of the Colony.

General appearance. The colony has exactly the shape of a drinking cup (Pl. I., fig. 1.) and may, for convenience of description, be divided into the stalk and the head. The stalk is attached by its lower extremity to some foreign body, and bears the head on its upper end. It is short and rather thick. It is of equal width throughout from the point of junction with the head to within a short distance of the lower end, where it expands to form a base of attachment. The diameter of the base measures 8—12 mm., that is, nearly as much as the length of the stalk and more than twice its diameter in the upper part. Its surface is quite smooth, showing neither longitudinal striae nor transverse wrinkles. It is almost transparent except the axial portion which is more or less opaque and whitish with a tinge of pale yellow, especially near the lower end. The stalk is made up entirely of the test substance, and no zooids, whether adult or in developmental stages, are found imbedded in its tissue.

The head has the form of a hollow cylinder open at one end and closed at the other. Viewed from the side, the lateral walls of the cylinder are nearly straight. At the open end the wall terminates quite abruptly, there being no thinning out of the investing mass to form a particular marginal zone (text-fig. 1). The bottom of the cylinder is somewhat lens-shaped, convex on both outer and inner surfaces. It is at the centre of its outer or lower surface that the peduncle joins the head. Like the stalk this part is entirely composed of the common test and contains no zooids. Near the periphery of the basal surface, however, a number of very small zooids, apparently in early stages of development, are to be seen. The side wall of the cylinder shows on its external surface a number (12 and 16 in the two colonies examined) of very shallow longitudinal depressions separating as many slightly elevated longitudinal zones. Under a low power of microscope these zones are found each to be composed of a double row of hexagonal areas representing the

Text-fig. 1.

Diagram showing the longitudlinal section of a colong.

Text-fig. 2.

Diagram showing the cross section of a colong.

anterior ends of zooids with a short branchial siphon at the centre. Looked at from inside, each double row of zooids forms a cushion-like ridge projecting into the central cavity and separated from its neighbours by narrow deep furrows. These furrows correspond in position to the shallow longitudinal depressions on the outer surface of the colony. A cross section through the middle of the head has therefore the shape represented in text-fig. 2. It consists of thick and thin portions placed alternately in a circle, the former being each a mass of the investing substance containing two rows of zooids, while the latter are nothing but a thin layer of the common test forming the bottom of the deep longitudinal furrows just referred to. As the test and body-wall are transparent the intestines with their dark coloured contents stand out very conspicuously on the inner surface as dark brownish loops (see Pl. I., fig. 1). Under a lens the stomach is also very clearly visible.

Arrangement of zooids. As stated before, the zooids are arranged in longitudinal rows which run distinctly in pairs. In one of the two colonies examined by me there are sixteen of such double rows present, while the other one, which is somewhat smaller, though not much shorter, has only twelve. Each row begins at the very margin of the lateral wall of the head and ends on the basal surface at some distance from the top of the peduncle. The number of zooids which form a longitudinal row is generally twelve or thirteen, not counting a few small buds situated on the basal surface of the head. The zooids in a pair of lines are placed alternately, and as the amount of the test substance intervening between them is proportionally very small, the anterior ends of the zooids are visible externally as hexagonal areas with the branchial siphon projecting from the centre. The whole external surface of the head therefore looks like a pavement composed of equal sized polygons (Pl. I., fig. 2) in which, however, the longitudinal rows are grouped in pairs separated from one another by narrow zones free of zooids.

The thoracic regions of the zooids are as a rule placed nearly at right angles to the outer surface of the colony. At the boundary between the thorax and abdomen the body is generally bent downwards, i.e., towards the closed end of the cylinder, in consequence of which the individuals overlap, so that the abdomen of one zooid covers the thorax of its neighbour below on the inner surface (Pl. I., fig. 4). For the same reason a cross section passing through the branchial sac of one individual cuts also the alimentary canal of one or even two individuals lying above it (Pl. I., fig. 3). Moreover, the median plane of each zooid does not lie parallel to the main axis of the colony, but, as shown in Pl. I., fig. 2, the zooids in a pair of rows have their endostyles turned toward one another, while their dorsal edges are next the space between that row and the adjacent one. In this respect the arrangement of zooids in the present form exactly agrees with that found in some species of *Colella* (=*Sycozoa*, Less), e.g. *C. pulchra* ('86, Herdman, Challenger Reports, Part 2, Pl. XV., fig. 6) and *C. tenuicaulis* ('99, Herdman, Australian Museum Catalogue, Pl. Dist. I., fig. 3). As will be described further on, the course of the intestinal loop is not the same in all the individuals, but is different according to the position of the zooid in a double row. Those of the left side have their intestines opening into the longitudinal furrow lying on the left side, while those belonging to the right hand row have their anal apertures looking to right, although in both cases the intestine is bent invariably to the left side of the stomach (see Pl., I. fig. 3).

Test. The test is only weakly developed in the side walls of the head. Here the bodies of the zooids themselves form by far the greater part of the mass, while the test exists only in the form of thin covering round each zooid. In some places it forms an exceedingly thin partition between the zooids, so that the latter seem to be separated only by a delicate membrane. Along the median line of the longitudinal ridges formed by double rows of zooids, however, the test substance is found to take the shape of more or less thickened masses. On the outer surface of the head the test forms a thin layer of nearly uniform thickness (0,035-0.045 mm.) covering the anterior ends of the zooids.

The extent and relative amount of the investing mass in the wall of the head may be most clearly understood by examining the transverse and longitudinal sections of this region. In Pl. I., fig. 3, representing a part of cross section of the head, the test is found to comprise the following parts: 1) a superficial layer covering the outer surface of the head, 2) thin partitions separating the thoracic regions of various zooids, and 3) more or less thickened masses in which their abdominal regions are imbedded. The superficial layer, which is nearly of the same thickness throughout, not only covers the external surface of the anterior ends of the zooids, but is turned inwards at the branchial aperture and reaches the bases of the tentacles so as to form an internal lining of the branchial siphon. The walls of test substance forming partitions between the thoracic regions of the zooids are in some places much thicker than the superficial layer, but in other places they are exceedingly thin. Their thickness depends on the configuration of the zooids the interstices between which they fill up, but on the whole the test is not particularly well developed in these parts. It is in the inner half of the longitudinal ridges that the common test attains its highest development. Here it is found to form masses of more or less considerable thickness in which the abdominal parts of the zooids are completely imbedded. The masses also contain blood vessels to be described further on. The extent of the common investing mass in the longitudinal ridges is perhaps better shown in Pl. I., fig. 4, which represents a part of longitudinal section through the side wall of the head. From this figure it will be seen that the posteror halves of the abdomens are imbedded in a continuous mass of test substance running longitudinally, while the anterior halves containing the oesophagus and stomach are covered separately by a thin layer of test. Where the peribranchial wall is wanting, as shown in the figure, the branchial sacs as well as the anterior portions of abdomens are separated from one another simply by the common peribranchial space (*prb.*) directly continuous with the adjacent longitudinal furrow. The transverse walls of test intervening between the anterior regions of the branchial sacs are as a rule of the same thickness as the superficial layer, and terminate quite abruptly at the level where the first row of stigmata begins to appear. As already metioned, the basal part of the head as well as the whole peduncle is entirely composed of test substance which is somewhat firmer and a little more opaque than that of the side walls of the head.

The test consists of a hyaline homogeneous matrix in which two kinds of cells are imbedded, the bladder cells and the test cells. The former are very large, oval, spherical, ellipsoidal, or polygonal in shape, and have only a thin layer of protoplasm lining the inner wall, against which the nucleus lies (Pl. I., fig. 5, *b.c.*). The nuclei are very distinct, oval or fusiform in shape, and are always situated close to the inner wall of the cell. There is often a little mass of protoplasm at the point where the nucleus lies. The bladder cells are exceedingly numerous throughout, forming by far the greater part of the test tissue. In some places they are so numerous that the matrix exists only in the form of delicate membranes surrounding the large vesicles which have become polygonal by mutual pressure. The test cells are found wherever a small patch of matrix can be seen (Pl. I., fig. 5, *t.c.*). They are small (0.005—0.006 mm. in diameter), oval or ellipsoidal in shape, and consist of a large nucleus surrounded by a small quantity of protoplasm.

In the superficial layer of test forming the external covering of the head the tissue consists mainly of bladder cells generally arranged in a single layer with only a little mass of matrix about them (Pl. I., figs. 7, 9, 10, 11). This layer, therefore, is throughout its whole extent only just as thick as the greater diameter of the bladder cells. The walls of test substance intervening between the branchial regions of the zooids are in some places much thicker than the surface layer and may contain a large number of bladder cells grouped irregularly, but in other places they are extremely thin and are entirely composed of matrix, being in fact too thin to contain a bladder cell. In the thickened masses of common test enclosing the abdominal regions of the zooids the bladder cells are also abundant, but small patches of matrix are found here and there, and in such places the test cells are very clearly visible (Pl. I., fig. 5).

Discription of the Zooid.

Form. As the zooids are attached to the common test rather firmly at the branchial aperture and at certain regions of the thorax, it is almost impossible to dissect out a zooid uninjured from the investing mass. It invariably breaks in the middle of the branchial region where it is weakest, since the body wall is here very imperfectly developed and the delicate longitudinal vessels of the branchial sac lie exposed on the outer surface. At other places, however, the body wall seems to be only loosely attached to the common test, since in sections of preserved specimens empty spaces are commonly found surrounding the zooids, apparently in consequence of contraction of the latter.

The body of the zooid may be divided into two regions, the thorax and the abdomen. They are about of the same size, and the boundary between them is not very distinct. The thorax comprises chiefly the branchial sac and its accessory organs, while the abdomen is composed of the remaining parts of the alimentary canal together with the heart and the reproductive organs. A vascular appendage springing from the posterior end of abdomen traverses the common test towards the base of the colony. The zooids, without the appendage, are 3—4 mm. in length and nearly half so much in breadth; when fresh and fully expanded they measured, of course, somewhat more.

The thorax is roughly cylindrical in shape. The anterior end is only slightly convex and hexagonal in outline, with the branchial siphon placed at the centre. The side walls of the thorax are very incomplete, as the external wall of the peribranchial space is developed only on the ventral side. Dorsally as well as laterally there is no body wall, and consequently the branchial sac is quite exposed on these sides (Pl. I., fig. 3). This condition may perhaps be considered as the result of the atrial aperture having become disproportionally widened so as to occupy the greater part of the surface of the thoracic region. As mentioned before, there is only one species of compound ascidians in which a similar condition is met with. LAHILLE, in his "Recherches sur les Tuniciers" ('30) describes the thoracic region of the zooids of *Diplosomoides lacazei* Giard in following words: "La paroi péribranchiale, fort réduite, laisse la branchie presque entièrement à découvert", and this is exactly what takes place in our species, though very probably we have here a case of convergence rather than that of a direct phylogenetical affinity. The posterior limit of the thorax is marked for the most part by the bottom of the branchial sac, at one point of which the funnel-shaped oesophagus commences. The terminal portion of intestine lying just beneath the branchial sac is also comprised in the thorax (Pl. II., fig. 8).

The abdomen is irregularly ellipsoidal and somewhat flattened from side to side. Its shape is determined principally by that of the intestinal loop, since the heart and other organs contained in the abdomen are all placed between the stomach and ascending part of the intestine. As the investing mass as well as the thin body-wall is perfectly transparent and colourless, the external form of the abdomen is hardly recognizable to the naked eye, while the intestine itself is rendered very conspicuous by its dark coloured contents. The vascular appendage, whose lumen is continuous with the blood spaces of the zooid, starts from the posterior end of the abdomen and runs, as will be more minutely described hereafter, inwards and downwards through the common investing mass to the base of the colony.

Body wall. The body wall or mantle forms the outer covering of zooids and lies immediately under the test, with which, however, it is in the greater part of its extent not closely connected. In preserved specimens a cavity in which the zooid lies is distinctly visible (Pl. I., fig. 3; Pl. II., figs. 7, 8; Pl. III., fig. 20, *sp.*). In the living animal, however, when the contractile tissues were relaxed and the viscera were filled with water, the body wall was doubtless in contact with the test throughout, and there was therefore no cavity around the zooid. In those places where the test ends with a free margin, the body wall is more firmly attached to the test and remains closely connected with it even when preserved. Such places are found at the base of the branchial siphon and along the border of the body wall in the thoracic region.

The body wall is composed mainly of three elements—the ectodermal epithelium, the connective tissue, and the muscular fibres. The ectodermal epithelium is present throughout the whole extent of the mantle and is in direct contact with the test. The cells of this layer are generally flattened (Pl. II., fig. 7, *ect.*), especially so in the walls of abdomen where they form a thin pavement epithelium, but at the margin of the branchial siphon they are considerably thicker and almost cubical in shape (Pl. II., fig. 9, *ect.*). The connective tissue is present in the form of a hyaline homogeneous mass containing scattered cells and perforated by blood spaces. The cells are fusiform or stellate in form and have distinct nuclei. The stellate cells are found generally in such places where the layer of connective tissue is rather thick, and are then scattered equally all over. Where the connective tissue forms a thin layer more fusiform cells are met with, sometimes with their longer axes perpendicular to the plane of the adjacent ectodermal epithelium.

The musculature is on the whole very feebly developed. Over the abdomen not a fibre is visible, and on the thorax the body wall has only a few scattered fibres here and there except on the anterior surface where they are more numerous. In the wall of the branchial siphon the fibres are placed transversely, forming a sort of sphincter round the external opening. Longitudinal fibres are also present, but are much less numerous. Compact bands of muscle fibres, such as are frequently met with in other genera, do not occur in any part of the body wall.

Branchial sac. This organ occupies the greater part of the thorax, and is only partly covered by the body wall. When fully expanded it is somewhat barrel-shaped and extends from the anterior wall to the basal part of the thorax (Pl. I., fig. 3, *br. s.*) In most zooids examined by me the branchial sac was strongly contracted, and it was with great difficulty that the exact form and structure of the organ could be made out. In a few exceptional cases, however, it could be satifactorily observed under a dissecting microscope.

The endostyle runs along the ventral, and the row of languets along the dorsal edge of the branchial sac, while the circlet of tentacles, the dorsal tubercle, and the peripharygeal band are situated at its anterior extremity (Pl. II., fig. 8). All these organs will be described further on. Very often one or two small copepod crustaceans were found living in the branchial cavity as commensals.

The stigmata occur over the whole extent of the sac, from the peripharyngeal band anteriorly to the base where the oesophagus opens posteriorly, with the exception of a narrow band along the dorsal and ventral edges, where the median dorsal vessel and endostyle are placed. They are arranged in horizontal (transverse to the antero-posterior axis) rows, and are separated by transverse and longitudinal vessels (Pl. II., fig. 12). There are four such rows and more than twelve stigmata in a row on each side. In shape they are elongated slits with parallel sides and rounded ends. The width of the stigmata is about equal to that of the fine longitudinal vessels separating them.

Examined under a moderate power of microscope, each longitudinal vessel is found to have the form of a rectangular pillar, the sides of which are made of two kinds of cells. On the sides facing the branchial and atrial spaces the wall is very thin and is composed of flattened polygonal cells. On the sides surrounding the stigmata, on the contrary, the cells are of considerable height. Seen from the interior or exterior of the branchial sac each of the stigmata appears to be surrounded by a single row of ciliated cells (Pl. II., fig. 12). A transverse section of the longitudinal vessels, however, shows most clearly that what looked like a single cell is in reality a group of very narrow cells placed side by side (Pl. II. fig. 13), and consequently what appeared as a single row of cells is in reality a longitudinal band of ciliated epithelium extending down the side of the vessel. The ciliated cells vary somewhat in shape, being taller and more columnar at the ends of the stigmata. The most common form is nearly semicirculer, the flat face being next the vessel and the curved one next the stigma. As they are grouped regularly in transverse rows they look somewhat like a pile of coins cut in halves. The nuclei are distinct and placed rather below the middle of the cells. The cilia are long and delicate. They are from five to ten on each cell, attached to the more or less convex outer edge, and when fully extended they are more than twice the height of the cells.

The transverse vessels are three in number and are all of the same size. They are about twice as wide as the fine longitudinal vessels and contain delicate muscle fibres (Pl. II., fig. 12, *tr. v.*). When contracted the branchial sac is always strongly constricted along these vessels. The zone devoid of stigmata along the dorsal edge of the branchial sac is very narrow, so that the rows of stigmata of one side appear to pass over to the opposite side without much interruption. The median dorsal vessel also contains muscle fibres in its walls and is found strongly contracted in most zooids.

Endostyle. The endostyle runs along the ventral edge of the branchial sac (Pl. II., fig. 8). It begins anteriorly at the base of the branchial siphon immediately behind the peripharygeal band and runs backwards to the base of the sac, ending at a short distance from the oesophageal aperture. The ends are bluntly conical, otherwise it is of the same width throughout. In the greater part of its course it forms a series of minute dorso-ventral undulations. Whether or not this is a result of contraction of the branchial sac I am not able to say. At any rate, in all the zooids examined by me the endostyle invariably showed this character. The anterior end of the endostyle is turned inwards forming a sort of blind sac at the point of bending (Pl. II., fig. 7, *end.*), so that in certain sections passing through this region the endostyle appears as a canal.

The endostyle is a groove with greatly thickened sides formed of columnar epithelium, while the base is covered with somewhat shorter cells (Pl. II., fig. 14). The summits of the edges are continued up as lip-like folds. A tract along each side and the base are richly ciliated. As shown in the figure several kinds of cells can be distinguished in the wall of the endostyle. Those forming the base stain deeply with haemalaun and are provided with very long cilia, reaching, if not exceeding, the free edge of the lateral lips. On each side of the base there is a zone of large columnar cells without cilia which stain only faintly and seem to be glandular in nature. Beyond this glandular zone the cells are again ciliated, but the cilia are very short, and the cells bearing them become successively shorter as they are traced away from the base. On the inner surface of the lips there is again a zone of ciliated epithelium composed of cubical cells. The cilia are very short. On tracing these zones anteriorly they are found to be continuous with the band of ciliated epithelium covering the peripharyngeal ridge to be described below. Seen from the dorsal or ventral aspect, the endostyle shows a pair of thick semi-opaque bands separated by a more translucent area (Pl. I., fig. 6, *end.*). The opaque bands are caused by the thickened sides, separated by the less massive floor of the groove. The narrow dark lines seen along both sides of the endostyle are the zones of ciliated epithelium on the lateral lips of that organ.

Dorsal lamina. The dorsal lamina is represented by a series of three short triangular languets springing from the dorsal edge of the branchial sac. Each languet is placed at the intersection with a transverse vessel and is ciliated at the sides. They seem to arise directly from the inner wall of the vessel, there being no ridge or membrane present to unite their bases.

Tentacles. The tentacles are placed in a circle round the base of the branchial siphon just at the entrance of the branchial sac. The branchial siphon is a short funnel with the rim turned outwards, and when wide open its diameter is about double its height. Its inner surface is lined by an invagination of the superficial layer of test, which is nearly of the same thickness as that layer and extends as far down as the tentacular circlet.

The tentacles are simple and rather stout. When directed upwards they project beyond the external opening of the branchial siphon (Pl. II., fig. 8, 10). They are generally sixteen in number and are of three different sizes. Four are long and meet in the centre of the branchial aperture even when the latter is wide open. Four others alternating with these are somewhat shorter, while the remaining eight are only half as long as the longest ones. Two of the longest tentacles are placed in the median plane of the zooid, the other two making right angles with them. At the level of their attachment a sphincter composed of loose circular muscle fibres encircles the base of the branchial siphon (Pl. II., figs. 9 & 10).

Each tentacle is attached separately and has a round tapering and generally curved stem and a rather blunt apex. The wall of tentacle is formed externally by an epithelium of flattened or cubical cells and is nowhere ciliated. The interior of the tentacle is filled with the homogeneous matrix of connective tissue with some scattered cells. A few delicate longitudinal muscle fibres are sometimes distinguishable under the epithelial layer. Whether the blood spaces are continued into the interior of the tentacles, though very probable, could not be ascertained.

Peripharyngeal band. In the present species the peripharyngeal band is remarkably well developed, resembling in many respects that of simple ascidians. It consists of two parts, a thin membrane and a ciliated ridge (Pl. II., fig. 9, *prph. m.*, *prph. r.*) For the greater part of their course they run close to and parallel with each other, forming between themselves a narrow groove, the "gouttière péricoronale" of French authors. They encircle the top of the branchial sac at a short distance from the bases of tentacles. The peripharyngeal membrane, called the "Ringfalte" by German writers, is a thin membrane of nearly equal breadth throughout, and is composed of flattened cells without cilia. At the ventral median line the membranes of both sides meet each other at the pointed anterior extremity of the endostyle. Dorsally the membrane reaches the dorsal tubercle where it is continued for some distance along the lateral region of that organ (Pl. II., fig. 11, *prph. m.*). Throughout its whole extent the breadth of the peripharyngeal membrane is about equal to the height of the ciliated ridge forming the other lip of the groove.

The peripharyngeal ridge is composed of a band of ciliated epithelium running parallel with the peripharyngeal membrane on its posterior side. It is connected at its ventral and dorsal ends with the anterior extremity of the endostyle and the dorsal tubercle respectively. By tracing the ridge ventrally it is found to be directly continuous with the ciliated band on the inner surface of the lip of endostyle. Near the dorsal end the ridge forms the greater part of the side wall of the dorsal tubercle and gradually disappears towards its free extremity. The cells composing the ridge are high and columnar, and the cilia are very short throughout.

Dorsal tubercle. This organ is placed at the anterior end of the dorsal edge of the branchial sac, and is very conspicuous on account of its unusually large size. As shown in Pl. II., figs. 8 and 10, it projects into the branchial cavity just below the base of the branchial siphon on the dorsal side and is clearly visible from outside when the branchial orifice is moderately open. It is conical in shape, with blunt apex, and attached obliquely to the anterior wall of the thorax in such a manner that the apex is directed towards the axis of the body. The aperture of the neural gland is situated on its anterior surface about half way between the apex and the base of the organ where it joins the base of the median dorsal tentacle (Pl. II., fig. 10). The aperture is simple, oval in outline, and is placed transversely in reference to the axis of the organ. As the peripharyngeal ridge is continuous with the ciliated patch covering the apex of the dorsal tubercle, and the peripharyngeal membrane almost reaches the anterior surface of the organ before it is lost to sight, these two components of the peripharyngeal band well deserve the names of "anterior and posterior lips", as they are sometimes called in simple ascidians. At the apex and on both sides the wall of the organ is made up of cubical or columnar cells. In the immediate neighbourhood of the aperture the cells are rather high and ciliated. In other places the tubercle is covered with an epithelium of flattened cells.

Nerve ganglion. The nerve ganglion is in its usual position on the dorsal side of the branchial sac immediately beneath the ectodermal epithelium of the body wall. It is oval or elliptical in outline and sends out nerve trunks both anteriorly and posteriorly.

The nuclei of the cells are found mostly in the peripheral parts, the centre being mainly composed of fibrous substance (Pl. II., fig. 10). The longer diameter, which is placed antero-posteriorly, measures almost 0,1 mm.

Neural gland. The neural gland lies immediately beneath the nerve ganglion and is nearly of the same size as that organ. It is bladder-like in structure with uniformly thick wall and a large cavity in the interior. The wall is composed throughout of a single layer of cells, the cytoplasm of which, however, seems not to be clearly bounded, forming rather a sort of syncytium. The dorsal portion of the wall is in close contact with the nerve ganglion, but the boundary between them is everywhere quite distinct, and there is no area in which the tissues of the two organs gradually pass over to each other[1] (Pl. II., fig. 10).

The central cavity of the neural gland communicates with the exterior by means of a short duct which opens on the anterior surface of the dorsal tubercle. This duct is of the same width throughout except the terminal portion which is somewhat widened so as to form a sort of funnel. At the very margin of the opening, however, the duct is again a little constricted (Pl. II., fig. 10). The wall of the duct is made up of cubical cells all over. In the terminal portion of the duct, where it is widened, the cells are provided with long vibratile cilia.

A cross section though the middle part of the dorsal tubercle is shown in Pl. II., fig. 11. At the centre of the figure the ciliated terminal portion of the duct of the neural gland is seen cut across. On both sides the wall of the dorsal tubercle is formed for the greater part by an epithelium of ciliated columnar cells, which is the direct continuation of the epithelial layer of the peripharyngeal ridge mentioned above. The peripharyngeal membrane is also seen immediately on the dorsal side of this epithelium. The posterior wall of the dorsal tubercle is formed of a thin epithelium

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[1] According to M. M. Metcalf ('00), who made a special study of the intersiphonal organs of various groups of Tunicata, there is in all the compound ascidians a region where the cells of the ganglion and the neural gland merge into one another and are indistinguishable.

of simple flat cells. The undulations of this epithelium shown in the figure are, I believe, due to contraction incident to preservation.

Alimentary canal. The alimentary canal is contained partly in the thorax and partly in the abdomen. Excluding the branchial sac, which is the foremost portion of the canal, it may be divided into three parts, the oesophagus, the stomach, and the intestine (Pl. III., fig. 15).

The oesophageal opening is placed at the posterior end of the branchial sac, nearer the dorsal than the ventral edge (Pl. II., fig. 8, *oe.*). It is separated from the hind end of the endostyle by a narrow space where the bottom of the branchial sac is lined with thin epithelium. As shown in the figure, the terminal portion of intestine lies immdiately beneath this part in close contact with the oesophagus. The oesophagus is rather short and funnel-shaped, with the wall thrown into irregular longitudinal folds (Pl. III., fig. 15). Generally the course of the oesophagus is a little curved. The anterior margin of its wall is somewhat raised and forms a distinct ridge or lip (Pl. III., fig. 18). Posteriorly the oesophagus projects into the cavity of the stomach considerably and seems to perform the function of a valve (Pl. III., fig. 16). The wall of the oesophagus is lined with columnar epithelium and is finely ciliated all over. In sections stained with haemalaun the zone formed by inner halves of these cells is coloured dark blue and stands out very conspicuously. In the part projecting into the interior of the stomach the cells do not show any such differentiation.

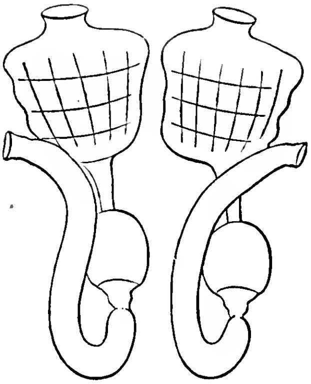
The stomach is oval-shaped with smooth and uniformly thick wall. The anterior end of the organ is rounded with an invagination at the centre, forming a sheath for the oesophagus which proceeds a short distance into the interior (Pl. III., fig. 16). The posterior end, on the contrary, terminates quite abruptly and without any constriction. The stomach, therefore, is comparable in form with an egg from which the posterior third (next the pointed end) has been cut away. The wall is of considerable thickness being lined with an epithelium of tall columnar cells.

It is perfectly smooth both externally and internally, and no folds or thickenings, such as are frequently met with in other compound ascidians, are to be seen. The stomach is nowhere ciliated.

The intestine begins at the posterior end of the stomach, runs backwards for a short distance, then turns to left and runs forwards till it reaches the bottom of the branchial sac; here it is curved either to right or to left and opens into the longitudinal furrow separating the double rows of zooids. A short tract of the intestine lying immediately behind the stomach and clearly bounded by a costriction posteriorly differs from the rest of the canal in many respects, and may, for the sake of convenience, be distinguished as "duodenum." It corresponds exactly to the "post-estomac" of some French authors and the "Mitteldarm" of German writers. The remaining portion of the canal exhibits nearly the same character throughout, though it may conveniently be divided into three regions in referrence to the area occupied by the intestinal gland.

The duodenal part of intestine has the shape of a truncated cone attached by the broad base to the posterior end of the stomach. The wall, which is generally a little wrinkled, is lined with a layer of cubical cells without cilia and stains very deeply with haemalaun. The alimentary canal has thinnest wall in this part, and, as the stomach lying immediately in front of it is the thickest walled part of the canal, the contrast in thickness of the walls is very striking.

The intestine, exclusive of the duodenum, may be divided into three regions of nearly equal length. The first third lying next the duodenum occupies the hindmost region of the abdomen and is bent somewhat in the form of the letter U. Next comes the middle third which is distinguished by the presence of the fine tubular intestinal gland covering the outer surface of the wall. The last third, which may be called the rectum, is simply tubular in form and opens by the anal aperture into the common peribranchial space. In microscopical structure of the wall, however, there is no noticeable difference between these parts. The course of the rectum is a little different according to the position of the zooid in the colony. In those zooids situated on the left side in a pair of rows the rectum turns to left and terminates in the anus without crossing the oesophagus. In those belonging to the right half of a pair of rows, on the other hand, the rectum turns to right and crossing the oesophagus on its dorsal and right side, opens into the longitudinal furrow lying next it on that side (see textfig 3). That the intestine lies mainly on the left side of the stomach in either case is clearly seen in a cross section through the lateral wall of the colony (Pl. I., fig. 3).


Text-fig. 3.
Two zooids placed side by side to show the difference in the course of intestine.

The intestine, with the exception of the duodenum, is nearly of the same width through its entire length. Its diameter is a little less than that of the stomach, but is greater than that of the posterior end of the duodenum. The relative sizes of these parts are shown in Pl. III., figs. 15 and 16 (*st.*, *d.*, *int.*) For the greater part of its length the intestine is smooth walled, exhibiting only slight wrinkles at the place of bending and in the terminal region just in front of the anus. The wall of the intestine is lined with low columnar cells with the nuclei situated near the base, and is, in comparison with that of the stomach, considerably thinner. A glance at Pl. III., fig. 20, representing a cross section of the abdomen, will suffice to make clear the difference in the thickness of walls of these organs. On the lips of the anus, however, the cells are taller. At the anal opening the wall of the rectum is turned outwards so as to form a sort of lip (Pl. III., fig. 17). Just in front of the anus the rectum is surrounded by a set of ring muscle fibres which no doubt perform the function of a sphincter.

In the middle third of its course the intestine is embraced externally by a system of fine branching tubules, corresponding to the digestive gland found in many simple ascidians. The duct from this system runs across from the intestine and opens into the stomach (Pl. III., fig. 19). The tubules are round or oval in cross section and measure 0,02–0,025 mm. in diameter. They are placed on the outside of the intestinal epithelium and are generally in close contact with it (Pl. III., fig. 21). The course of these tubules is wavy throughout. For the greater part they run parallel with the axis of the intestine. In the part lying nearest to the stomach, however, they are found to form two or three rings encircling the intestine. The duct is lined with cubical cells (Pl. III., fig. 19), but the tubules themselves are composed of much flatter cells.

Blood vascular system. The heart lies in the loop formed by the alimentary canal between the stomach and the ascending portion of the intestine. It is a fusiform tube with undulating walls, and is enclosed in an outer delicate membranous sac, the pericardium, which fills the greater part of the space between the stomach and the intestine (Pl. III., fig. 20). The heart is attached to the pericardium along a line on that side which lies next the intestine. The wall of the heart is not of the same thickness throughout, but is thinnest along the line where it joins the pericardium and becomes gradually thicker as it is traced to the other side, where it is sometimes as thick as the wall of the intestine. (Pl. III., fig. 25). A number of muscle fibres are clearly discernible in its tissue. In some sections it can be distinctly made out that the walls of the heart and pericardium are directly continuous with each other, and that the heart is simply an invagination of the pericardium.

The heart is open at both ends. The blood flowing out of the heart passes into definite canals channeled out in the connective tissue filling the space between the body wall and the internal organs (Pl. II., fig. 14; Pl. III., figs. 18 and 25, *bl. sp.*). The blood corpuscles are round or oval cells with distinct nuclei (Pl. III., fig. 23). They are gathered in some of the blood spaces while they are wholly absent in others.

As stated before, each zooid sends out from the posterior end of abdomen an ectodermal appendage. This is a thin walled tube of varying width divided longitudinally into two cavities by a delicate septum, so that in reality it is formed of two vessels running side by side (Pl. III., fig. 24). It passes through the test substance of the longitudinal ridge downwards towards the base of the colony. The lumen of these tubes is continuous with the blood spaces of the zooid to which they belong. Their number increases as they are traced downwards. They run mostly parallel with one another and, so far as I could ascertain, there is no anastomosing among them. In sections the vascular appendages are found to be surrounded by a space separating them from the test substance, but this is no doubt the result of contraction of the neighbouring tissues.

Reproductive Organs. Unfortunately in all the zooids examined by me the reproductive organs were not in full development. Neither the testes nor the ovaries could be made out with certainty. The genital duct, however, was tolerably large and very clearly visible. This fact, I believe, renders it very probable that the zooids examined by me had already passed through the period of sexual maturity rather than that they were still on the way of development. The duct runs along the rectum for some distance and opens quite near the anus, somewhat covered over by the expanded margin of that aperture. Its wall is lined with cubical cells (Pl. III., fig. 22).

Incubatory Pouch. In one of the colonies examined by me nearly all of the zooids situated near the free margin of the head are provided with an incubatory pouch. It is an appendage to the mantle, being merely an enormous diverticulum of the peribranchial or atrial cavity. It is oblong in shape, nearly twice as long as it is wide, and contains only a single embryo in the middle where it is widest. The tadpole-like larva has three large adhesive papillae and a long tail, and looks very much like that of *Diplosoma*. Since the other colony, though somewhat larger, shows no individual provided with a pouch, it is highly probable that the species is dioeceous.

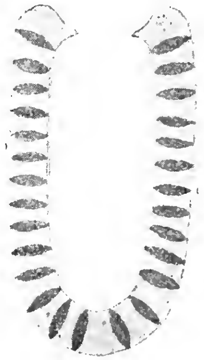
Systematic Position.

The external form of colony is, generally speaking, not a character of much importance in determining the systematic position of a compound ascidian, but it should certainly be taken into consideration when it is so highly specialised as in the present species. It is in fact one of the chief diagnostic characters by which the family Cyathocormidae differs from all the other recognized families of the Ascidiae compositae.

The hollow cylindrical form of the colony of *Cyathocormus* is so utterly different from that of other compound ascidians that it seems at first sight almost impossible to reduce it to one of the typical forms of colony prevalent among these animals. On the contrary, its extraordinary shape recalls the arrangement seen in *Pyrosoma*, where the zooids and their investing mass form the walls of a hollow cylinder closed at one end. As shown in the accompanying woodcuts (text-figs. 4, 5, and 6) the mode of arrangement of the zooids is practically the same in *Cyathocormus* (text-fig. 5) and *Pyrosoma* (text-fig. 6), whereas in *Coelocormus* (text-fig. 4), which was considered by Prof. Herdman to be the most *Pyrosoma*-like compound ascidian, the arrangement is quite different. Here the whole surface, both the outside of the colony and also the lining of the axial cavity, is morphologically the outer surface, and the branchial apertures of the zooids are found distributed all over it. It is therefore evident that although the form of the colony in *Coelocormus huxleyi* somewhat resembles that of *Pyrosoma*, still the inner surface lining the central cavity is homologous with part of the outer surface of an ordinary compound


Text-fig. 4.
Coelocormus


Text-fig. 5.
Cyathocormus


Text-fig. 6.
Pyrosoma

ascidian and not with the inner surface lining the central cavity of *Pyrosoma*. In *Cyathocormus* the case is wholly different. The central cavity of *Cyathocormus*-colony exactly corresponds with that of *Pyrosoma* both morphologically and functionally, the cavity in question representing in both cases the common cloaca of the whole colony. That a diaphragm is present in one form and lacking in the other is not of much importance, since the mode of life is entirely different in these animals, and the diaphragm, though highly useful in making the jet of water more powerful in a swimming animal, would be of no use in a sedentary colony.

So far as I can judge, the form of colony of *Cyathocormus* might most naturally be deduced from that of *Diplosoma*, such as is figured in BRONN's Klassen und Ordnungen des Tierreichs, III. Suppl. p. 184, or in LAHILLE's work ('90) p. 112. If we imagine the base of attachment of such a colony to become smaller and the common cloacal opening larger, until the shape of the colony has become cylindrical, we would have practically the same form of colony as it really occurs in *Cyathocormus*. In all probability, the thoracic region, lying nearest the superficial layer of test, would have kept its position perpendicular to the walls of the cylindrical head, while the abdomen, being connected with the base of the colony by means of the vascular appendage projecting from its posterior end, would be bent downwards and cover the thorax of the zooid lying next below on the inner side. In like manner, the test substance enveloping the vascular appendages of various zooids now arranged in longitudinal rows would fuse together to form compact masses. In short, the colony would be converted to one exactly similar to that of *Cyathocormus*.

It is, however, equally possible that the colony of *Cyathocormus* has been produced in the following way. Suppose a club-shaped colony of compound ascidian, such as *Colella murrayi* or *C. quoyi*, for example, has lost a part of the test substance at the top as well as in the interior of the head. The colony would in this case also become cup-shaped and would very much resemble a *Cyathocormus* colony. Moreover, the mode of formation of the colony might, in all probability, be much the same. In *Cyathocormus*, as in the genus *Colella*, the buds seem to be produced near the base of the colony and gradually pushed to the outer surface of the head. Here, probably, they soon reach maturity, the female individuals producing also a tailed larva from an egg fertilized by the spermatozoa of the older zooids. They are then constantly pushed upwards, and finally, having lived through the entire length of the head, they reach the free margin as old zooids, die and drop off. This is, I believe, the reason why we do not find young buds or functionally active reproductive organs in the zooids situated in the distal part of the head.

The similarity in the arrangement of zooids within the colony in *Cyathocormus* and in some members of the genus *Colella* (=*Sycozoa*), such as *C. pulchra*, *C. tenuicaulis*, etc. is also very striking. The zooids form, in both cases, longitudinal rows grouped in pairs, in which they are placed alternately in such a manner that the endostyles are turned towards one another. Moreover, in the last species the head is sometimes truncated at the top and much resembles that of *Cyathocormus*, so that if the head became hollow inside the colony would have exactly the same form as that of our species.

Turning now to the anatomy of the individual zooids we again find that the present genus is closely related to *Colella* among the Distomidae and to *Diplosoma*. In all these forms the body is divided into thorax and abdomen, to which a vascular appendage is attached. The branchial sac has four rows of stigmata. The intestine forms a simple loop lying posteriorly to the branchial sac. The stomach is smooth walled. In the possession of a large incubatory pouch, however, *Cyathocormus* agrees with *Colella* and differs from *Diplosoma*. If, in addition, the colonies of *Cyathocormus* should turn out to be really dioeceous, which is very probable, the relationship between the two genera would become decidedly closer.[1] In the unlobed condition of the branchial aperture, on the other hand, *Cyathocormus* differs

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[1] According to the researches of Caullery ('95) members of the genus *Colella* (=*Sycozoa*), with the single exception of *C. thompsoni*, are all dioeceous.

[2] *Astrallium spongiforme* Giard ('72) has unlobed branchial aperture.

from both *Colella* and *Diplosoma*,[2] but agrees with *Pyrosoma*. As stated before, the only other compound ascidian in which the peribranchial wall is so imperfectly developed as to expose the greater part of the branchial sac, is found among the family Diplosomidae.

In short, it seems highly probable that the new family is more closely allied to some members (genus *Colella*) of the Distomidae than to any other group of the Ascidae compositae. Though it is sufficiently characterised by the hollow cylindrical form of the colony with a large centrally placed common cloaca, this form might be regarded as a modification of the colony form actually met with in certain genera. If, in future, transition forms should happen to be discovered, it might of course become necessary to unite the Cyathocormidae with one of the closely related families. At present, however, it seems best to consider our form as the type of a distinct family and place it, in a phylogenetic classification of the Tunicata, somewhere in the neighbourhood of the Distomidae, representing a special branch leading in the direction of the Pyrosomidae. By the intervention of the present family the Ascidiae Salpaeformes would be much more closely connected with the rest of the Ascidiacea than was hitherto the case, rendering it doubtful whether we are justified in separating *Pyrosoma* from other compound ascidians and placing it along with *Salpa* and *Doliolum* in a different order, the Thaliacea.

Publ. Mar. 30th, 1913.

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List of the Abbreviations used in the Plases.

a.	Anus.	*b. c.*	Bladder cells.
bl. c.	Blood corpuscles.	*bl. sp.*	Blood spaces.
bl. v.	Blood vessel.	*bl. ap.*	Branchial aperture.
br. s.	Branchial sac.	*d. n. gl.*	Duct of neural gland.
d. int. gl.	Duct of intestinal gland.	*du.*	Duodenal portion of intestine.
d. t.	Dorsal tubercle.	*end.*	Endostyle.
ect.	Ectoderm of body wall.	*h.*	Heart.
g. d.	Genital duct.	*int. gl.*	Intestinal gland.
int.	Intestine.	*n. gl*	Neural gland.
n. g.	Nerve Ganglion.	*prb.*	Peribranchial cavity.
œ.	Oesophagus.	*prph. m.*	Peripharyngeal membrane.
prc.	Pericardial cavity.	*rct.*	Rectum.
prph. r.	Peripharyngeal ridge.	*sp.*	Space between test and body wall produced by shrinking.
sg.	Stigmata.		
st.	Stomach.	*t.*	Test.
t. c.	Test cells.	*tn.*	Tentacles.
tr. v.	Transverse vessel of branchial sac.		

Plate I.

PLATE I.

Fig. 1. Two colonies attached to a coral. Nat. size.
Fig. 2. External surface of colony. 8/1.
Fig. 3. Part of cross-section of colony. 15/1.
Fig. 4. Part of longitudinal section of colony. 15/1.
Fig. 5. Section of test. 400/1.
Fig. 6. Branchial aperture, seen from inside. 80/1.

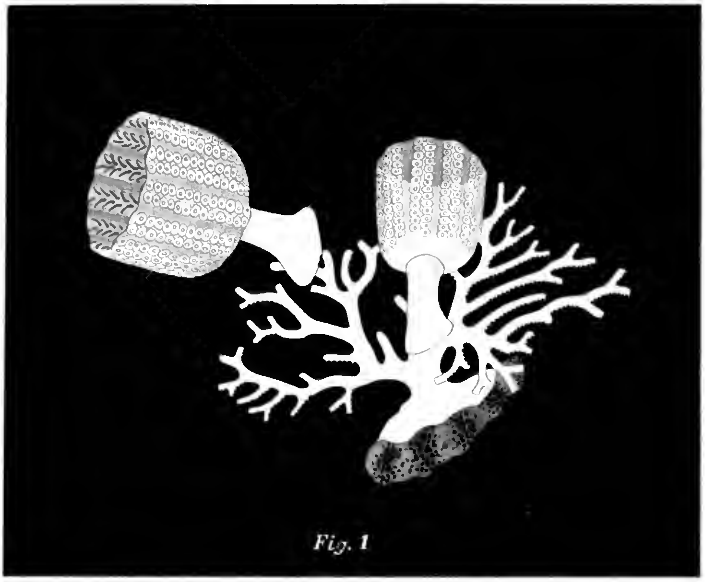


Fig. 1

Fig. 2.

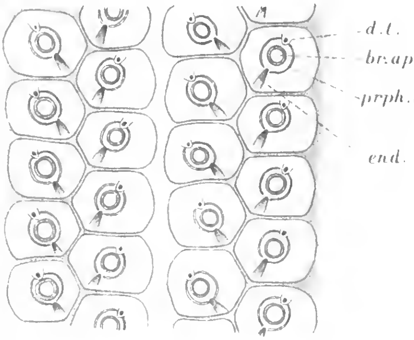
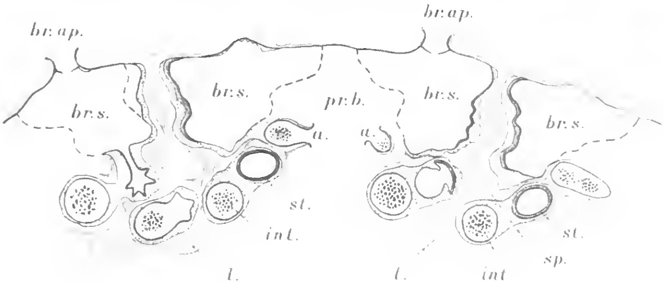


Fig 3



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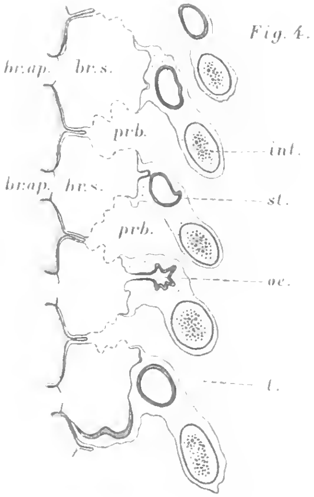

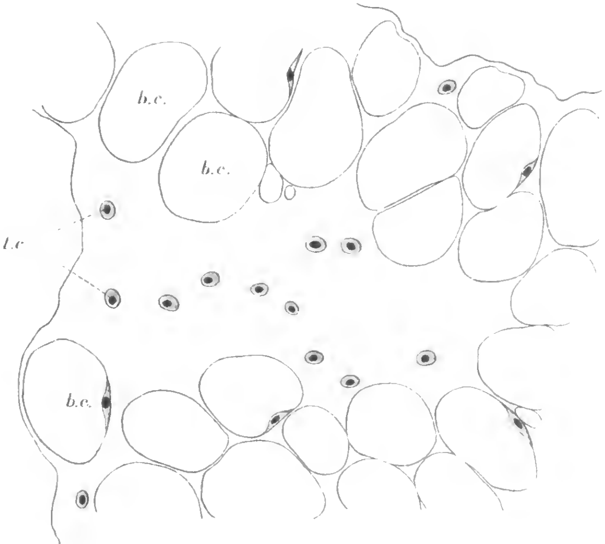

Fig. 5

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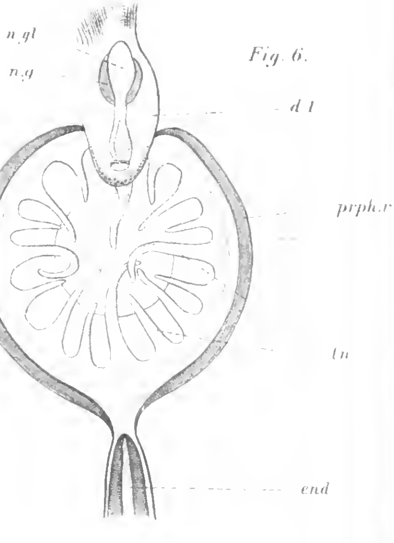


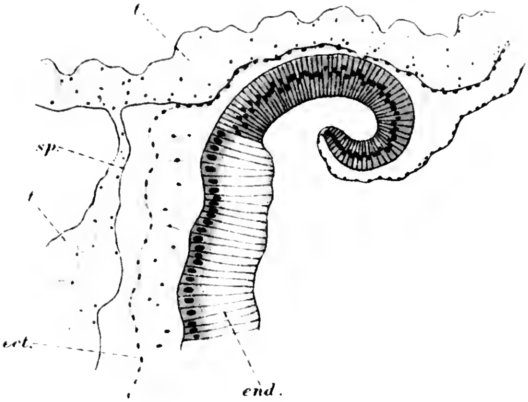
A. Oka: *Cyathocormus mirabilis.*

Plate II.

PLATE II.

Fig. 7. Longitudinal section through endostyle. 200/1.
Fig. 8. Longitudinal section through thorax. 40/1.
Fig. 9. Longitudinal section through the wall of branchial siphon. 200/1
Fig. 10. Longitudinal section through dorsal tubercle. 200/1.
Fig. 11. Cross-section through dorsal tubercle. 200/1.
Fig. 12. Part of branchial sac. 200/1.
Fig. 13. Cross-section of longitudinal vessels. 200/1.
Fig. 14. Cross-section of endostyle. 200/1.

Fig. 7.



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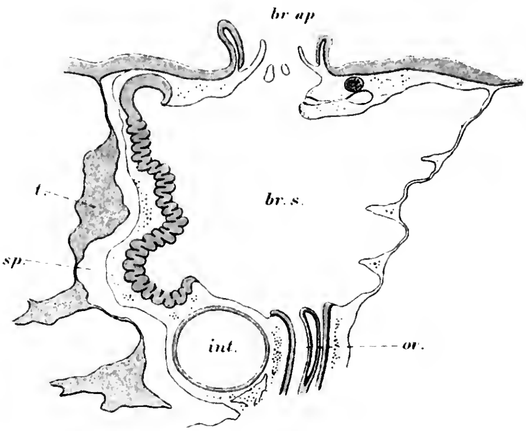

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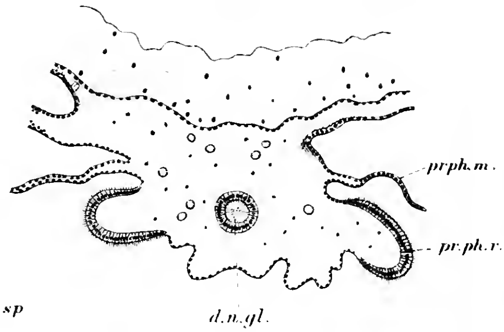

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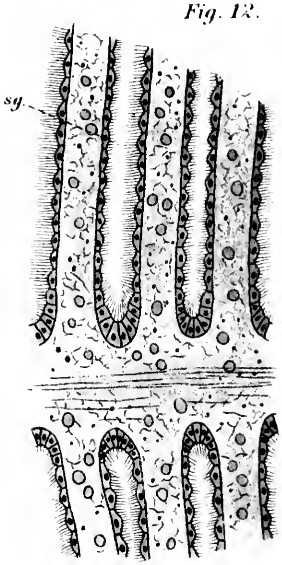

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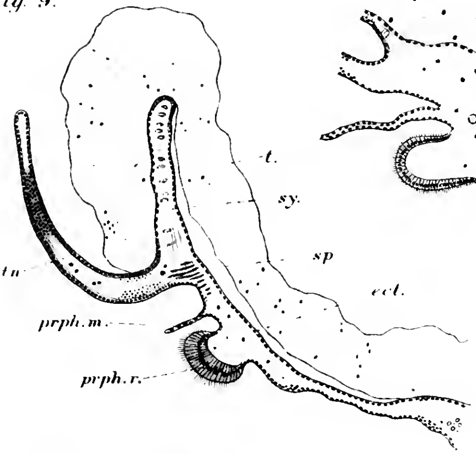

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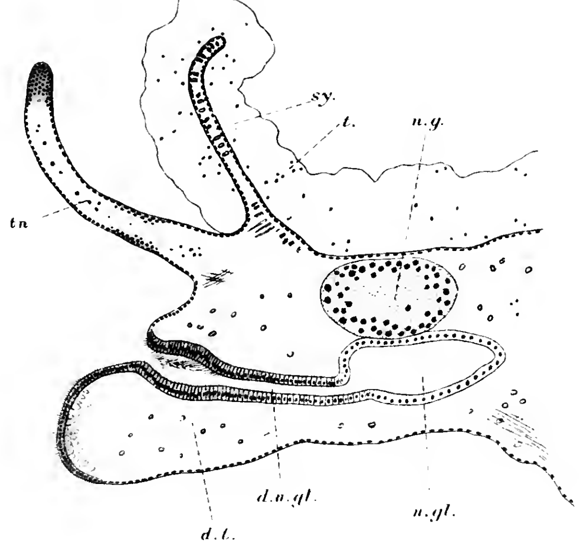
Fig. 10.



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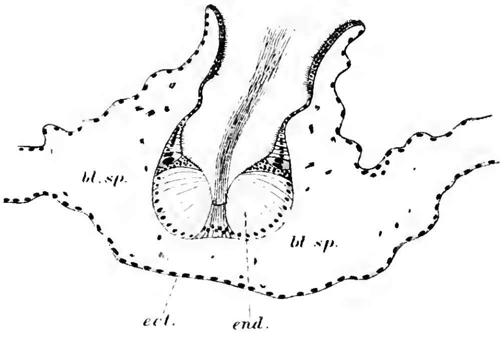


A. Oka : *Cyathocormus mirabilis.*

Plate III.

PLATE III.

Fig. 15. Alimentary canal. 25/1.

Fig. 16. Longitudinal section through oesophagus, stomach, and intestine. 40/1.

Fig. 17. Longitudinal section through rectum. 80/1.

Fig. 18. Longitudinal section through oesophogus. 80/1.

Fig. 19. Opening of intestinal gland into stomach. 200/1.

Fig. 20. Cross-section through abdomen. 80/1.

Fig. 21. Section through intestinal wall with gland. 200/1.

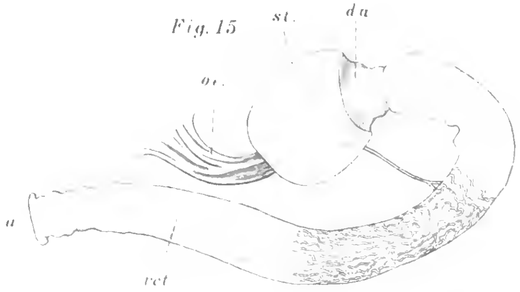
Fig. 22. Section through genital duct. 200/1.

Fig. 23. Blood cells. 400/1.

Fig. 24. Blood vessels in test. 200/1.

Fig. 25. Section through heart and pericardium. 200/1

Fig. 15



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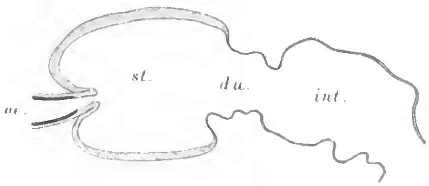

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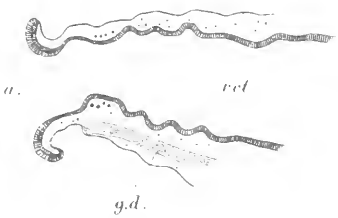

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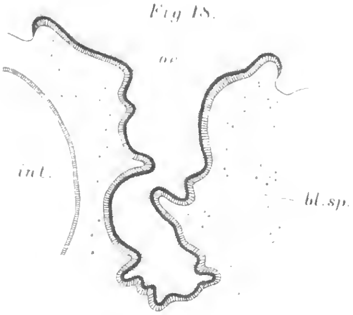

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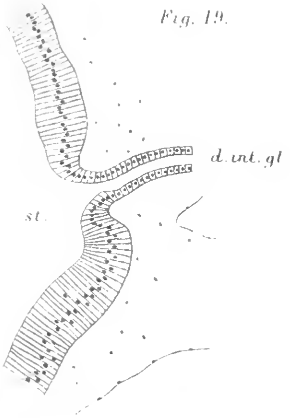

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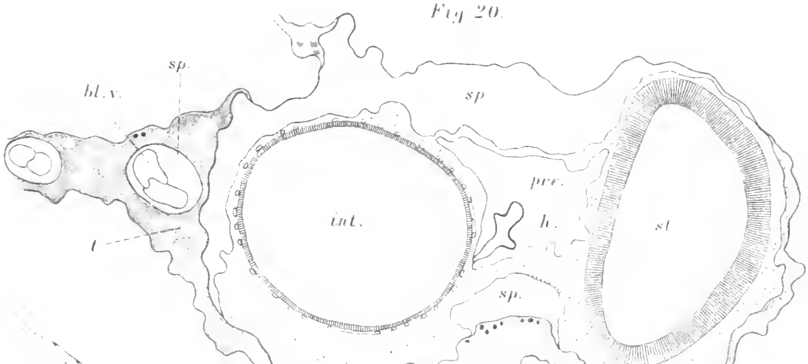

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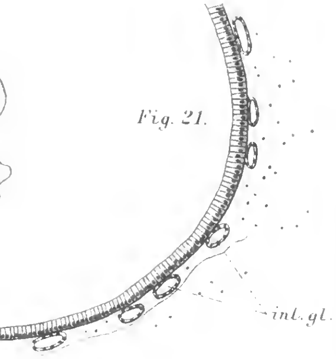

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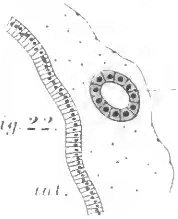

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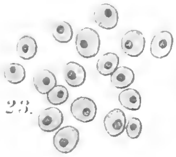

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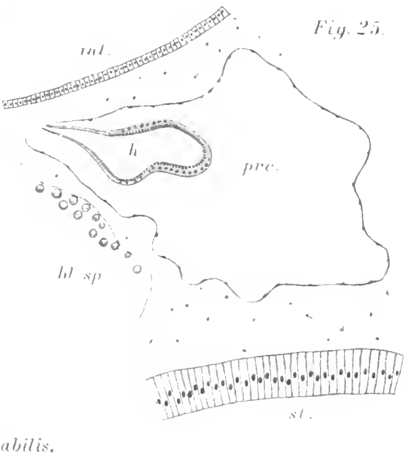
Fig. 25.



A. Oka : *Cyathocormus mirabilis.*