writer in an earlier number of this Journal.[10] Recasting the two analyses above by allotting FeO to TiO_2 to form ilmenite ($FeO.TiO_2$) the mineral composition in terms of rutile and ilmenite is:

	I	II
Rutile	94.80	59.92
Ilmenite	4.71	39.67
Rest	.62	.44
	100.13	100.03

The analysis in column II clearly shows a mixture of rutile and ilmenite, in which rutile is in largest amount. Although a thin section of this particular specimen was not examined, it is not improbable that some of the ilmenite may have been secondary.

BOTANY.—*The genus* Culcita.[1] WILLIAM R. MAXON, National Museum.

The tribe Dicksonieae, one of the three groups of Cyatheaceae or tree ferns, is usually regarded as consisting of three genera: *Dicksonia*, *Cibotium*, and *Balantium*, all represented in both hemispheres. The distinctions between *Dicksonia* and *Cibotium* are fairly pronounced, and both names are currently applied in their proper sense. *Balantium*, though showing indusium characters similar to those of *Dicksonia*, is habitually very different from either, and its recognition as a valid genus is general. The name *Balantium*, however, is technically a synonym of *Dicksonia* and must be supplanted by *Culcita*, as shown below. The distinctive characters of the genera of Dicksonieae were stated briefly by the writer a few years ago in a popular article on the tree ferns of North America[2] and the name *Culcita* was there employed in the present sense, without, however, a statement of the reasons for substituting it for *Balantium*.

The genus *Dicksonia* was described by L'Héritier in 1788 [3] with two species: *D. arborescens*, from St. Helena, and *D. culcita*, from San Miguel, one of the Azores, both being proposed as new. The former is an arborescent plant and, except for its temporary reference to *Balantium* by Hooker in 1838, has been consistently retained as the

[10] WATSON, THOMAS L. This JOURNAL **2:** 431–434. 1912.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received October 9, 1922.

[2] Report Smiths. Inst. **1911:** 463–491. *pl. 1–15*. 1912.

[3] Sert. Angl. 30. 1788.

typical member of a group of species now numbering more than a score, under the generic name *Dicksonia*. The second species, *D. culcita*, became later the type of *Culcita* Presl.

The genus *Cibotium* of Kaulfuss, though sometimes credited to his *Enumeratio Filicum* (1824), was actually published four years earlier in a little known pharmaceutical journal.[4] The type and only species mentioned at the original place of publication is *C. chamissoi*, of the Hawaiian Islands. There are about ten recognized species, most if not all of them treelike. The North American members of the genus have been discussed by the writer.[5]

The genus *Balantium* Kaulf., was proposed in 1824,[6] with two species: *B. auricomum* Kaulf. (p. 228) and *B. culcita* (L'Hérit.) Kaulf. (p. 229). Kaulfuss' redescription of *B. culcita* is only two lines long and omits all mention of the sori; but of *B. auricomum* there is a long and detailed description (agreeing very closely with the generic diagnosis) and a figure, which indicate clearly the importance of this species in the describer's mind and seem to justify the acceptance of this, rather than *B. culcita*, as the generic type. There is every reason to suppose that the material of *B. auricomum* supplied the major data for his generic description. *Balantium*, thus typified by *B. auricomum* (= *arborescens*), becomes a synonym of *Dicksonia*, founded on the same species. Since in recent years *Balantium* has been tacitly regarded as typified by *B. culcita*, the genus *Balantium* of authors must receive another name. Fortunately, *Culcita* is available.

The genus *Culcita* Presl dates from 1836,[7] and is founded on a single species, *Culcita macrocarpa* Presl, a change of name for *Dicksonia culcita* L'Hérit. and *Balantium culcita* Kaulf. It is thus exactly the equivalent of the genus *Balantium* of recent writers.[8]

The species of *Culcita* are as follows:

1. **Culcita macrocarpa** Presl, Tent. Pter. 135. *pl. 5, f. 5*. 1836.
   Dicksonia culcita L'Hérit. Sert. Angl. 31. 1788.
   Balantium culcita Kaulf. Enum. Fil. 229. 1824.

[4] Berl. Jahrb. Pharm. **21:** 53. 1820.

[5] Contr. U. S. Nat. Herb. **16:** 54–58. *pl. 30–32*. 1912.

[6] Enum. Fil. 228. 1824.

[7] Tent. Pter. 135. *pl. 5, f. 5*. 1836.

[8] It is interesting to note that Presl applies the name *Balantium* in the sense of *Dicksonia* with the exception of a single species, and further that he takes up the name *Dicksonia* for the genus of Polypodiaceae that we now call *Dennstedtia*, omitting therefrom both of the species originally described under *Dicksonia* by L'Héritier!

The generic type; known from Madeira, Teneriffe, and several of the Azores; originally described from San Miguel. The very large sori at once distinguish this species, of which the following specimens are at hand:

MADEIRA: San Vicente, June 21, 1850, *Lowe* 31. Without special locality *Mandon* 300; *Mason* in 1857.

AZORES: San Miguel, *Trelease* 1143. Pico, *C. S. Brown* 317.

2. **Culcita coniifolia** (Hook.) Maxon, Report Smiths. Inst. **1911:** 488. *pl. 13, f. c.* 1912.

Dicksonia coniifolia Hook. Sp. Fil. **1:** 70. *pl. 24. A.* 1844.
Dicksonia martiana Klotzsch; Hook. Sp. Fil. **1:** 70. *pl. 24. B.* 1844.
Balantium martianum Fée, Vasc. Crypt. Brés. **1:** 155. 1869.
Culcita schlimensis Fée, Mém. Foug. **10:** 47. *pl. 36, f. 3.* 1865.
Balantium coniifolium J. Sm. Hist. Fil. 258. 1875.

Variable in several characters, but perhaps no more so than to be expected in a plant occupying so wide an area. Its nearest ally is *C. macrocarpa.* Hooker's type was from Caracas (*Linden* 538). The following specimens are in the National Herbarium:

JAMAICA: John Crow Peak, alt. 1,650 to 1,800 meters, *Harris* 7336; *Underwood* 3258; *Maxon* 1333, 1333a; Blue Mountains, alt. 1,800 meters, *Hart* 132.

CUBA: Near summit of Pico Turquino, Sierra Maestra, *Léon* 11155.

COSTA RICA: San Cristóbal, *Werckle.* San Jerónimo, alt. 1,500 meters, *Werckle* (Jiménez, no. 578). Without locality, *Brade* 142.

PANAMA: Humid forest between Alto de las Palmas and top of Cerro de la Horqueta, Chiriquí, alt. 2,100 to 2,268 meters, *Maxon* 5459, 5459a. Cordillera above "Camp I," Holcomb's Trail, 10 miles above El Boquete, Chiriquí, alt. 2,100 to 2,150 meters, *Killip* 5326, 5328.

COLOMBIA: Medellín, *Bro. Henri-Stanislas* 1714. Murillo, Tolima, alt. 2,100 to 2,500 meters, *Pennell* 3181. Camino de Gachetá, *Bro. Ariste-Joseph* A483. Guasca, *Bro. Ariste-Joseph* A217. Without locality, *Bro. Ariste-Joseph* 198; *Triana* 179.

BRAZIL: Serra do Itatiaya, *Dusén* 170; same locality, alt. 2,000 meters, *Rose & Russell* 20490.

Reported also from Hispaniola, Mexico, and Ecuador.

3. **Culcita javanica** (Blume) Maxon.

Dicksonia javanica Blume, Enum. Pl. Jav. 240. 1828.
Dennstedtia javanica Christ, Bull. Herb. Boiss. II. **4:** 617. 1904.
Balantium javanicum Copel. Phil. Journ. Sci. Bot. **4:** 62. 1909.

Described from Java and attributed only to that island. Not seen by the writer. Listed by Christensen as valid, and so regarded by recent writers.

4. **Culcita formosae** (Christ) Maxon.

Dennstedtia formosae Christ, Bull. Herb. Boiss. II. **4:** 617. 1904.
Balantium formosanum Christ, Geogr. Farne 155. 1910.

Founded upon specimens collected on Formosa by Faurie (no. 676). Said to be a close ally of *C. javanica,* but listed by Christensen as valid. No material has been seen.

5. **Culcita copelandi** (Christ) Maxon.

Dicksonia copelandi Christ, Phil. Journ. Sci. Bot. **2:** 183. 1907.
Balantium copelandi Christ; Copeland, Phil. Journ. Sci. Bot. **3:** 301. 1908; **4:** 62. *pl. 19*. 1909.

A very distinct species, separated by Christ from *C. straminea;* apparently confined to the Philippines. The true indusium is somewhat membranous, erose-dentate, and provided with occasional cilia. In these respects and in its pronounced hairy covering the plant shows less alliance with *C. straminea* than with *C. dubia* and the new species here described as *C. blepharodes*. The following specimens are in the National Herbarium:

LUZON: Vicinity of Baguio, Province of Benguet, *Elmer* 6025 (co-type), 9000; *Topping* 196, 241; *Bartsch* 241; *Loher* 1304. Province of Abra, *Ramos* 7158. Mount Tonglon, *Loher* 965.
NEGROS: Dumaguete (Cuernos Mountains), Province of Negros Oriental, *Elmer* 9694, 9899, 10394.

6. **Culcita straminea** (Labill.) Maxon.

Dicksonia straminea Labill. Sert. Austr. Cal. 7. *pl. 10*. 1824.
Dicksonia torreyana Brack. in Wilkes, U. S. Expl. Exped. **16:** 278. *pl. 38, f. 2*. 1854.
Dennstedtia straminea J. Sm. Hist. Fil. 265. 1875.
Balantium stramineum Diels in Engl. & Prantl, Pflanzenfam. **1**[4]**:** 119. 1899.
Not *Sitolobium stramineum* Brack. 1854.

Described and figured by La Billardière on specimens from New Caledonia; attributed by Christensen to Polynesia generally. The following specimens are at hand.:

NEW CALEDONIA: Koghis, alt. 250 meters, *Franc* 477. Yahoué, alt. 250 meters, *Franc* (*Rosenstock*, no. 63).
FIJI ISLANDS: Sandalwood Bay, *Wilkes Exped.* (type of *Dicksonia torreyana* Brack., 3 sheets). Without special locality, *Prince* in 1898.
SAMOAN ISLANDS: Savaii, *Reinecke* 143a (2 sheets, both labeled "*Davallia moluccana* Bl. var. *amboynensis* Hook."). Upolu, *Betsche* 119 (as *Dicksonia dubia* Gaud.); *Reinecke* 97 (2 sheets, both labeled "*Davallia moluccana* Bl., normale Form."); *Reinecke* 190 (labeled "*Davallia dubia* R. Br."). Tutuila, just below top of Matefao, *Setchell* 389. Island not indicated, *Powell* 117 (as *Dicksonia straminea*).

These plants agree well among themselves and represent a single species that must be regarded as referable to *Culcita*, notwithstanding their arborescent habit; the trunk is described by Brackenridge as "8 to 10 feet high, its surface rough, owing to the base of the old stipes remaining attached to it," in this character resembling *Dicksonia*.

The sori, though very small in comparison with those of *C. macrocarpa* and *C. coniifolia*, are similar in structure; the receptacle is elongate transversely; the outer valve of the "indusium" is formed of a slightly modified, but deeply saccate, recurved lobule of the leaf margin, with pale thin borders; the inner lip, or true indusium, is similar in form to the outer, being vaulted,

ample, subcoriaceous, and subentire, and closes against it, as if hinged on the transverse receptacle.

In these particulars the resemblance of *Culcita straminea* to the Australian plant described as *Davallia dubia* R. Br. is slight, yet the two have been greatly confused. The original description of *Davallia dubia* reads as follows: "Frondibus supradecompositis, foliolis 2-3-pinnatis pubescentibus, pinnulis linearilanceolatis incisis, involucris subrotundis fimbriatis subaxillaribus lobulo saepe reflexo semitectis. (J. D.) *v. v.*" The specimens were from Port Jackson (New South Wales) and Tasmania. The numerous Australian specimens at hand (cited hereafter) agree perfectly with Brown's description in having the marginal lobule opposite to the sorus often reflexed and sometimes partially protecting the sori; but the sorus is relatively distant from the margin, the marginal lobule is not at all modified and is never saccate, and the true indusium is membranous and conspicuously dentate-ciliate, is early thrust back against the leaf surface, and in form, structure, texture, and position is so unlike the marginal lobule that it can hardly be regarded as forming any part of a "double" indusium. In these respects *C. dubia* differs so definitely from *Culcita* proper that it ought at least to be regarded as the type of a new subgenus. The details of structure are shown fairly well in Hooker's plate 24, figure C.[9]

The Fiji plant listed by Brackenridge in 1854 as *Sitolobium stramineum* is not *Culcita straminea*, but a new species very closely allied to the *Davallia dubia* of Robert Brown. It is described below.

Not all of the Reinecke plants from Samoa distributed as *Davallia moluccana* Blume or one of its varieties pertain to *C. straminea*. The following numbers, as represented in the National Herbarium, belong to *Saccoloma moluccanum* (Blume) Mett., regarding that species in its usual widely collective sense: *Reinecke* 71 and 97a, 4 sheets, from Upolu; *Reinecke* 143, from Savaii.

7. **Culcita dubia** (R. Br.) Maxon.

Davallia dubia R. Br. Prodr. Fl. Nov. Holl. 157. 1810.
Dicksonia dubia Gaud. in Freyc. Voy. Bot. 367. 1827.
? Balantium brownianum Presl, Tent. Pter. 134. *pl. 5, f. 4.* 1836.
Sitolobium dubium Brack. in Wilkes, U. S. Expl. Exped. **16:** 273. 1854.

As noted under the last preceding species *Davallia dubia* was founded on material from New South Wales and Tasmania. Luerssen[10] cites four collections from the Fiji group as *Dicksonia dubia*, but they doubtless pertain to the next species, *C. blepharodes*. As represented in the National Herbarium *C. dubia* is confined to Australia, the specimens being as follows:

AUSTRALIA: Vicinity of Sidney, New South Wales, *Wright; Dämel* (ex herb. Bot. Mus. Hamburg); *Wilkes Exped.* (2 sheets, as *Sitolobium dubium*).

[9] Sp. Fil., vol. **1,** 1844, as *Dicksonia dubia* (R. Br.) Gaud.

[10] Fil. Graeff. 233. 1871.

"Eastern coast," *Verreaux* 135 (as *Dicksonia davallioides*). Without special locality, *Verreaux* 290 (2 sheets, as *Davallia dubia*). Gippsland, Victoria, *F. von Müller*. Without special locality, *Schomburgk*.

The sorus characters of this species and of *C. straminea* have been discussed under the latter species. Since *C. blepharodes* is somewhat intermediate in sorus structure, *C. dubia* may best be regarded as the type merely of a new subgenus, **Calochlaena,** the name being chosen in allusion to the distinctive character of the delicate true indusium.

A good deal of doubt exists as to the proper reference of *Balantium brownianum*. This name was proposed in 1836 by Presl, who cited as synonyms *Davallia dubia* R. Br. and *Dicksonia fallax* Kaulf., and published an illustration (*pl. 5, f. 4*). The name *Davallia fallax* had been given by Kaulfuss to an Australian plant distributed by Sieber. Luerssen, who has examined this, refers it to *Dicksonia dubia;* but the highly conventional figure shows sori like those of *C. straminea*, as Hooker has remarked, and bearing very little likeness to those of *C. dubia*, whether or not it was drawn from Australian material. Brackenridge has pointed out the same discrepancy, and until the Sieber plant has been re-examined critically the correct disposition of *Balantium brownianum* must remain doubtful.

8. **Culcita blepharodes** Maxon, sp. nov.

Frond (incomplete) 1 meter long or more, the stipe about one-third as long as the blade, sulcate, ochraceous from a darker base; blade tripinnate, the pinnae subopposite, ascending, about 30 cm. long, 5 to 8 cm. broad, narrowly deltoid-oblong, the rachis firm, brownish-stramineous; pinnules distant, alternate to subopposite, oblique, deltoid-oblong, acuminate; segments 10 to 15 pairs, slightly oblique, linear or linear-oblong, cuneate at the inequilateral base, abruptly acuminate, distant, faintly connected along the ventral groove of the tertiary rachis, deeply lobed throughout; lobes of the larger segments 5 to 7 pairs, mostly with 2 lobules or crenations on the distal side, the apical one sterile and curved upward, the other broader and soriferous; sorus about 1 mm. in diameter; fertile lobule invariably concave, but not saccate; true indusium ample, delicately membranous, long-ciliate, born upon a narrowly oblong, transverse receptacle, early thrust backward against the leaf surface and exposing the numerous sporangia; paraphyses many, slender, brown; under surface of blade freely villous-hirsute, the hairs extending abundantly to the veins; upper surface slightly hirsute, glabrescent.

Type in the U. S. National Herbarium, no. 1,094,080, collected at "Lomo-Lomo" or "Somu-Somu," Fiji Islands, by the Wilkes Expedition (1838–42). There is a second, smaller specimen of the same collection.

This is the plant which Brackenridge, having mistakenly redescribed the *Dicksonia straminea* of La Billardière as a new species of *Dicksonia* (*D. torreyana* Brack.), listed as *Sitolobium stramineum*. He properly compares it with *Sitolobium dubium* Brack. (*Culcita dubia*) and notes several points of distinction.

Culcita blepharodes belongs to the subgenus *Calochlaena*, and is closely

allied only to *C. dubia*. From that it differs in having the receptacle nearer the margin, the marginal lobule regularly though not deeply concave (not recurved or reflexed, as in *C. dubia*) and approaching somewhat the "accessory indusium" form of typical *Culcita*, and the true indusium larger and more freely long-ciliate. The specimen selected as the type is very incomplete, and the measurements are thus not dependable. As noted previously this is doubtless the plant listed by Luerssen as *Dicksonia dubia* on Fiji specimens collected by Graeffe (nos. 151, 490) and *Dämel* (nos. 31, 32).

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

867TH MEETING

The 867th meeting was held in the Cosmos Club auditorium Saturday, May 20, 1922, with President CRITTENDEN in the chair and 42 persons present.

R. C. TOLMAN: *Some remarks on the Quantum Theory.* This paper was illustrated by charts and figures, and was discussed by Messrs. BEAL, C. A. BRIGGS, FAIRCHILD, FOOTE, HAWKESWORTH, MOHLER, PAWLING, SOSMAN, TUCKERMAN, WELLS and WHITE. This paper has been published in full in 1922, number of the Journal of the Optical Society.

The speaker first reviewed the steps by which the Classical Dynamics was led to expect that there would be an equipartition of energy between the different modes of vibration in the hohlraum. The modifications in the Classical Dynamics which are proposed by Quantum Theory to meet the contradiction between this prediction of the Classical Dynamics and the experimental facts were then discussed.

The equations given by Quantum Theory for the possible steady motions of simple oscillators and rotators and for the distribution of elements at thermodynamic equilibrium were then developed. It was shown how these equations account for the photoelectric effect, the inverse photoelectric effect, the relation between the frequenceis of absorbed and phosphorescent light, the energy distribution in the hohlraum, the Debye theory of the specific heat of solids, the theory of rotational specific heat of gases, the theory of the rotational spectra of gases, and the theory of the emission spectra of the elements.

The Quantum Theory was then criticised from the point of view of its arbitrariness, its conflict with the facts concerning the undulatory nature of light, its apparently unnecessary abandonment of the Classical Dynamics in solving the problem of the distribution of energy in the hohlraum and the unsatisfactoriness of its atomic model. A model which contains some features which it might be desirable to incorporate in the final model of the hydrogen atom was then exhibited.

W. R. GREGG, *Recording Secretary, Pro Tem.*

869TH MEETING

The 869th meeting was held in the Cosmos Club auditorium Saturday, October 7, 1922.