have to be increased by about 200 kilometers, making the new depth about 300 kilometers. This depth seems to be most improbable. The difference in the behavior of crustal and subcrustal matter must be a function of pressure and of heat. Since the pressure at 96 kilometers below the sea level surface under the oceans and the land must be very close to equal, we have only the heat different. It is difficult to see how there could be very great heat differences at a depth of 96 kilometers under the sea and the continent. I think we should reject the greater depth of compensation explanation.

(3). Uncertainty in the values of gravity as observed. Earlier in this paper it is stated that the uncertainty is about 0.010 dyne. This is less than one-third the average anomaly. Even should the uncertainty be as much as that, it is likely that at some stations the error would be positive and at others negative. This explanation probably would account for some part of the isostatic anomalies.

(4). Densities of the materials in the pedestals, on which the islands rest, larger than those used in the computations. Should these densities be from 10 per cent to 15 per cent above normal, then the average anomaly, with regard to sign, could be reduced to about one-half of their present values. The islands are volcanic and it is probable that the density below them is greater than normal.

It may be concluded that the causes of the isostatic anomalies are probably due in part to errors in the observed gravity values, and to an excess of density of the material composing the island pedestals.

Five island gravity stations are not sufficient on which to base a definite conclusion regarding the isostatic condition of the Earth's crust under the oceans, but the evidence presented here is in close accord with evidence from land data and from those collected by Dr. F. A. Vening Meinesz on his submarine voyage from Holland to Java, when he determined the value of gravity at a number of places at sea.

BOTANY.—*Twelve new species of Valeriana from the Andes of South America.*[1] ELLSWORTH P. KILLIP, U. S. National Museum.

In the present paper twelve new Andean species of Valeriana are described. In nearly every case the specimens upon which these are based were taken to Europe last summer by the writer, and compared with material in the rich collections at Paris, Geneva, Berlin, and London.

[1] Published by permission of the Secretary of the Smithsonian Institution.

This difficult, widely distributed genus has been subdivided in various ways by Hoeck,[2] Graebner,[3] Briquet,[4] and others, numerous subgenera and several segregated genera having been proposed. A thorough revision based on collections in the United States as well as in Europe is greatly needed. It was not practicable for me in the time at my disposal to do more than make the comparisons referred to. In the discussion following the formal description of each species in the present paper reference is made merely to its nearest relative and the principal points of difference are pointed out.

Valeriana trichiata Killip, sp. nov.

Climbing herb; stem terete, glabrous, pilosulous at the nodes; leaves simple, oblong-ovate, 5 to 7 cm. long, 1.5 to 2 cm. wide, acute at both ends, sessile or the lower short-petioled, entire at margin, triplinerved, above glabrous, beneath glabrous or sparsely hirsute on the nerves, bright green when dry; bracts similar to the leaves, decreasing to about 1 cm. long, sessile; inflorescence paniculate, diffuse, about 25 cm. long, the branches glabrous or sparsely hirsutulous toward ends; bractlets oblanceolate, about 3 mm. long, acute, densely ciliate, otherwise glabrous, green throughout; corolla white, funnelform, 1.5 mm. long, 5-lobed, the lobes orbicular, 0.5 mm. long or less; fruit oblong-ovate, 3-nerved on one face, 1-nerved on other.

Type in the U. S. National Herbarium, no. 1, 143,768, collected in forest between Paletará and Calaguala, Department of El Cauca, Colombia, altitude 3000–3200 meters (Central Cordillera), June 17, 1922, by F. W. Pennell (no. 7103).

The densely ciliate bractlets distinguish this species from its near relative, *V. pavonii*, both belonging to the small group of scandent species.

Valeriana quindiensis Killip, sp. nov.

Shrubby vine; stem terete, woody below, herbaceous above, glabrous, pilosulous at the nodes, the internodes 1 cm. long, or less, below, longer upward; leaves ovate-oblong, 2.5 to 4 cm. long, 0.8 to 1.5 cm. wide, acute at apex, decurrent at base to a short (about 5 mm.) petiole, entire, subtriplinerved reticulate-veined (nerves and veins impressed above), dark green, sublustrous and glabrescent above, paler, dull, and scurfy-glandular beneath, often densely crowded on sterile axillary branches; inflorescence diffusely paniculate, twice-trichotomous, the branchlets repeatedly dichotomous, ferruginous-pilosulous; bractlets oblong-lanceolate, 2 to 3 mm. long, acutish; corolla turbinate-campanulate, barely 1 mm. long, 5-lobed, white or yellowish green; fruit lance-oblong, 3-nerved on one face, 1-nerved on other, thickened at margin, sparingly pilosulous, papposc, the pappus about 16-rayed.

Type in the U. S. National Herbarium, no. 1,191,839, collected on rocky cliff, Páramo del Quindio, Department of Caldas, Colombia, altitude 3800–4000 meters (Central Cordillera), August 15–20, 1922, by F. W. Pennell and

[2] Bot. Jahrb. Engler **3**: 38–44. 1882; Nat. Pflanzenfam. **4**[1]: 172–182. 1891.

[3] Bot. Jahrb. Engler **26**: 425–436. 1899; **37**: 464–480. 1906.

[4] Ann. Conserv. Jard. Bot. Genève **17**: 347–356. 1917.

T. E. Hazen (no. 10075). Two other specimens in the National Herbarium, from the Páramo de Ruiz, in the same general locality (*Pennell* 3084 and *Lehmann* 3164) belong to this species.

This species is related to *V. clematitis* H. B. K., *V. laurifolia* H. B. K., and *V. hispida* Turcz., Pennell's 10075 having been compared with the types of these three species in Europe. It differs from all of them in the closely crowded, proportionately narrower leaves which are densely scurfy-glandular beneath.

Valeriana tatamana Killip, sp. nov.

Erect herb, about 65 cm. high, thickened at base; stem simple, terete, shallowly grooved, glabrescent in lower half, finely pilosulous in upper; basal leaves lanceolate, 15 to 20 cm. long, 1.5 to 2 cm. wide, acute or slightly obtusish at apex, tapering to a broadly winged, retrorse-ciliate, sheathing petiole about 3.5 cm. long, 11 or 13-nerved (nerves prominent, with numerous cross-veins between the nerves), leathery-coriaceous, shining and dark green above, duller and olive-brown beneath, glabrous or finely pubescent on the midnerve above, sparsely ciliate at the subrevolute margin; cauline leaves about 4 pairs, lanceolate, 9 (decreasing to 2.5) cm. long, 1.5 to 1 cm. wide, cordulate at base, abruptly narrowed to a petiole 1 to 0.5 cm. long; inflorescence a contracted panicle about 12 cm. long, densely rufo-pilosulous, the terminal and axillary panicles twice or thrice-trichotomous, 3 to 5 cm. wide, the lowest panicles with well developed peduncles, the heads subglobose, about 1.5 cm. wide, densely flowered; bracts oblong, 7 to 8 mm. long, about 2 mm. wide, acutish, ciliate below, purplish throughout; bractlets lance-oblong, about 5 mm. long, 1.5 mm. wide, entire or with 2 small lobes just below apex, ciliate to apex, otherwise glabrous, purplish at center, pale at margin; corolla funnelform, about 1 mm. long, 5-lobed; stamens very slightly exserted.

Type in the U. S. National Herbarium, no. 1,143,788, collected on wet grassy páramo, Cerro Tatamá, Department of Caldas, Colombia, altitude 3400–3700 meters (Western Cordillera), September 8–10, 1922, by F. W. Pennell (no. 10582).

This is related to *V. plantaginea* and *V. longifolia*, differing from both in the glossy, acute, short-petioled, conspicuously nerved leaves and strongly ciliate bracts and bractlets. From *V. plantaginea* it is further distinguished by much smaller bracts, and from *V. longifolia* by a more contracted panicle with very densely flowered heads.

Valeriana asterothrix Killip, sp. nov.

Plant "1 to 1.5 cm.," straggling (or erect?); stem terete, densely short-hirsute, leafy to inflorescence, the upper leaves remote; leaves cordate, 3 to 6 cm. long, 1.5 to 3.5 cm. wide (upper leaves and those of sterile branches smaller), acute at apex, petiolate (petioles up to 2 cm. long, the upper leaves subsessile), dentate or crenate-dentate, short-hirsutulous above, densely stellate-pubescent beneath especially on the nerves; bracts oblong-lanceolate, 6 to 8 mm. long, 2 to 3 mm. wide, obtuse, subentire, free to base; inflorescence a contracted trichotomous cyme about 3 cm. wide (in flower); bractlets linear or slightly linear-spatulate, about 5 mm. long, obtuse, conspicuously 1-nerved, minutely ciliate; corolla white, funnelform, the tube 4 to 5 mm. long, the lobes ovate-oblong, 1.5 to 2 mm. long, rounded; stamens exserted; fruit lance-oblong, about 4 mm. long, 3-nerved on one face, 1-nerved on other, glabrous, apparently epappose.

Type in the U. S. National Herbarium, no. 1,196,436, collected in rich woods between Oña and Cuenca, Province Assuay, Ecuador, altitude 2700–3300 meters, September 10, 1923, by A. S. Hitchcock (no. 21629).

This plant very closely resembles the type specimen of *V. malvacea* Graebn., with which it was compared at Berlin. The leaves in both cases are quite similar and have the same characteristic stellate pubescence. In *V. asterothrix* the flowers are fully three times as large as in *V. malvacea*, the fruit is much larger, the inflorescence more contracted, the leaves more coarsely toothed, and the pubescence of the stem much different.

Valeriana renifolia Killip, sp. nov.

Erect, perennial (?) herb, about 65 cm. high; roots elongate, fleshy, up to 5 mm. thick; stems striate, straw-colored, pilose with whitish hairs below, glabrescent above, densely pilosulous at nodes; basal leaves subreniform or broadly ovate, 1.5 to 3.5 cm. long, 2.5 to 3 cm. wide, rounded at apex, coarsely, and often doubly crenate-dentate or repand-dentate, 5-nerved at base, petiolate (petioles 2.5 to 3 cm. long), glabrescent or sparsely subappressed-pilose, rather fleshy; cauline leaves oblong or lanceolate-oblong, about 1.5 cm. long 0.6 to 0.8 cm. wide (lower leaves), 1 to 0.5 cm. long (upper leaves), sessile, subamplexicaul, irregularly glandular-denticulate; inflorescence paniculate, up to 20 cm. long, 15 cm. wide, the primary branches 2 to 4 at a node, 5 to 7-dichotomous, the flowers borne singly but approximately at the ends of the ultimate branches; bracts linear, 5 mm. long or less, acute; bractlets linear, up to 2 mm. long, mucronulate, hyaline, with dark midrib; flowers very small, funnelform, 1 to 1.5 mm. long, 5-lobed, the lobes orbicular; fruit ovate, 1 mm. long, nerveless, pappose, the pappus about 8-rayed.

Type in the herbarium of the Field Museum of Natural History, no. 534169, collected on rock ledges, Huariaca, Peru, altitude 2900 meters, April 3, 1923, by J. F. Macbride (no. 3099).

The relationship of this new species is with *V. baltana* Graebn., the type of which I examined at Berlin. *Valeriana baltana*, however, is leafy up to the inflorescence, the cauline leaves being only slightly narrower than the basal; the panicle is much larger; and the fruit is twice as long as in *V. renifolia*, and more oblong in shape.

Valeriana melanocarpa Killip, sp. nov.

Erect herb, 40 cm. high or more; stem subterete, pilosulous or glabrescent; leaves (only upper cauline seen) up to 8 cm. long, unequally pinnate, subsessile, the leaflets ovate-oblong or ovate-lanceolate, acute, shallowly repand-dentate or nearly entire, finely appressed-pubescent above, white-tomentose beneath, membranous, the terminal leaflet 4 to 5.5 cm. long, acutish at base, the lateral leaflets two pairs (upper pair 2.5 to 3.5 cm. long, about 1 cm. wide, the lower pair about 1 cm. long, 0.6 to 0.8 cm. wide), oblique at base, decurrent; inflorescence cymose-paniculate, terminal and in the axils of the upper leaves, the cymes rather compact, the branches arcuate-ascending, up to 10 cm. long, trichotomous, the branchlets repeatedly dichotomous, the flowers borne in clusters of 3 to 7 at the ends of the branchlets; bracts linear, up to 7 mm. long, pilosulous; bractlets linear-oblong, 2 mm. long, mucronulate, ciliate; fruit oblong-lanceolate, about 2 mm. long, 3-nerved on one face, 1-nerved on other, appressed-pilosulous, black, pappose, the pappus about 10-rayed.

Type in the U. S. National Herbarium, no. 604495, collected in the Lucumayo Valley, Peru, altitude 1800-3600 meters, June 18, 1915, by O. F. Cook and G. B. Gilbert (no. 1311).

The dense long-peduncled cymes and black fruit distinguish this species from its nearest relative *V. decussata* R. & P.

Valeriana macbridei Killip, sp. nov.

Plant herbaceous, 60 cm. high or more, woody at base, pilose or pilosulous throughout, the stem slender (about 5 mm. in diameter), terete, shallowly grooved; basal leaves crowded, up to 20 cm. long (including petiole), unequally pinnate (or those of the sterile shoots occasionally simple), the leaflets obtuse at apex, entire or remotely denticulate, subcarnulose, the terminal leaflet much larger than the lateral leaflets, ovate-cordate, 6 to 10 cm. long, 4 to 7 cm. wide, the lateral leaflets 2 pairs, ovate, 1.5 to 4 cm. long, 1 to 2.5 cm. wide (decreasing in size toward leaf base), sessile or subsessile, rounded and often oblique at base; cauline leaves similar to basal, decreasing to about 2 cm. long; inflorescence diffusely paniculate, up to 40 cm. long, twice-trichotomous, the branches dichotomous, the flowers borne singly or in two's and three's; bracts and bractlets linear, acute; corolla cylindric-funnelform, about 1.5 mm. long, 5-lobed; fruit narrowly oblong, about 2 mm. long, 3-nerved and glabrous on one face, 1-nerved and minutely pilosulous on other.

Type in the herbarium of the Field Museum of Natural History, no. 534750, collected on steep grass-shrub hillside, Piedra Grande, near Santo Domingo River, Peru, altitude 1500 meters, May 14–19, 1923, by J. F. Macbride (no. 3686). Duplicate in the U. S. National Herbarium.

Related to *V. paniculata* R. & P., this species is differentiated by obtuse leaflets and particularly by the much larger, ovate-cordate terminal leaflet.

A second collection from the same general locality (*Macbride* 4240) probably belongs to this species. Some of the leaves are fully 30 cm. long, with terminal leaflets up to 14 cm. long.

Valeriana hirsutissima Killip, sp. nov.

Plant herbaceous, with rootstock, tuberous-thickened at base, densely hirsute-pilose or the inflorescence and upper leaves glabrescent; leaves of sterile shoots simple, ovate-oblong, up to 2.5 cm. long, slender-petioled; basal and cauline leaves unequally pinnate, up to 25 cm. long (including petiole), the leaflets acuminate, glandular-serrulate, subcarnose, the lateral leaflets 2 to 5 pairs, up to 5 cm. long, 2 cm. wide, acutish and usually oblique at base, sessile or subsessile, the terminal leaflet ovate or ovate-oblong, up to 8 cm. long, 3.5 cm. wide, rounded or acutish at base; inflorescence diffusely paniculate, up to 40 cm. long, the branches divaricate, trichotomous, the branchlets dichotomous, the flowers distichous along the ultimate branchlets; bracts and bractlets linear, acute, mucronulate; corolla globose-campanulate, about 1 mm. long, 5-lobed, the lobes ovate; fruit oblong, about 2 mm. long, 3-nerved on one face, 1-nerved on other, pilosulous, pappose.

Type in the herbarium of the Field Museum of Natural History, no. 536168, collected on open brushy hills, Pampayacu, at mouth of Chinchao River, Peru, altitude 1000 meters, July 19–25, 1923, by J. F. Macbride (no. 5118). Duplicate in the U. S. National Herbarium.

This species also is similar to *V. paniculata* R. & P. in leaf shape and general habit. The distichous arrangement of the flowers on the branches, more like that of *V. urticaefolia*, at once distinguishes the species from *V. paniculata*. In addition, the lower leaves are strongly hirsute.

Valeriana bambusicaulis Killip, sp. nov.

Plant herbaceous, about 3 meters high, woody at base, the roots fibrillose; stem stout, up to 2 cm. thick, terete, glabrous, smooth or finely striate or shallowly grooved; leaves of sterile shoots simple, ovate, 2 to 5 cm. long, 1 to 3 cm. wide, long-petioled, the petioles slender, up to 7 cm. long; basal leaves unequally pinnate, up to 25 cm. long (probably longer), the petioles quadrangular, glabrous, dilated at base, the rachis quadrangular, finely pubescent above, the lateral leaflets 4 or 5 pairs, the terminal and lateral leaflets subequal, oblong or oblong-lanceolate, up to 6 cm. long, 3 cm. wide, acute at apex, rounded or acutish at base, petiolulate (petiolules up to 1 cm. long), entire at margin, finely puberulent or glabrescent, subcoriaceous, dark green above, paler beneath; cauline leaves linear-lanceolate, simple, 2 to 4 cm. long, acuminate, entire or glandular-serrulate toward apex; inflorescence diffusely paniculate, the branches divaricate or arcuate-ascending, 4 or 5 times trichotomous, the flowers 1 to 4 at the ends of the branchlets; bractlets linear-lanceolate, about 2 mm. long, acute; corolla globose-campanulate, 1 mm. long, 5-lobed, the lobes orbicular-ovate; fruit oblong-lanceolate, about 2 mm. long, usually curved, 3-nerved on one face, 1-nerved on other, glabrous,pappose, the pappus about 6-rayed.

Type in the herbarium of the Field Museum of Natural History, no. 535549, collected on a wet shrubby slope, Tambo de Vaca, Peru, altitude 3800 meters, June 10–24, 1923, by J. F. Macbride (no. 4463). Duplicate in the U. S. National Herbarium.

This species is related to *V. warburgii* Graebn. It differs in its much thicker, entire, proportionately longer leaflets.

Valeriana tenella Killip, sp. nov.

Slender herb, about 30 cm. high; roots tuberous; stem subquadrangular, glabrous or sparingly pilosulous, the internodes 2 to 4 cm. long; basal leaves not present on type specimen; cauline leaves up to 3 cm. long, unequally pinnate (terminal leaflet subrhombic, up to 1 cm. long, 0.6 cm. wide; lateral leaflets 1 or 2 pairs, oblong-lanceolate, smaller), the leaflets acuminate, sessile or subsessile, irregularly glandular-serrate, finely pubescent on nerves, membranous; flowers in trichotomous cymes 1 cm. wide or less, borne on filiform peduncles (up to 1.5 cm. long) in the axils of the much reduced upper leaves; bracts linear, 1.5 cm. long; bractlets linear-spatulate, 1 mm. long or less; corolla cylindric-campanulate, about 1 mm. long, white, the 5 lobes green.

Type in the U. S. National Herbarium, no. 1,118,526, collected at Palmira, Mérida, Venezuela, altitude 2100 meters, September 1, 1921, by A. Jahn (no. 564).

Comparison of this specimen with the type of *V. sorbifolia* H. B. K. in the Humboldt Herbarium, Paris, shows a close relationship between the two species. *Valeriana tenella*, however, is a much more slender plant, with one or two, not five or six, pairs of lateral leaflets. The leaflets are more finely toothed, and are pubescent on the under side of the nerves.

A plant in the herbarium of the Jardin Botanique, Geneva, collected by Brother Apollinaire near Bogotá, Colombia, is probably this new species.

Valeriana isoetifolia Killip, sp. nov.

Plant perennial, cespitose, the caudex about 5 mm. thick, woody, branched above, basal leaves rosulate, numerous, narrowly linear, 1.5 to 2.5 cm. long, up or 2 mm. wide, acute, sessile, dilated to a sheathing base, scabrous at margin, 3 or 5-nerved, fleshy, russet brown or blackish when dry; scapes up to 11 cm. long, finely pubescent, bearing at or above the middle a cluster of three leaves similar to the basal leaves; bracts linear, about 7 mm. long, 2 mm. wide, 1-nerved, hyaline at margin; inflorescence a dense, subglobose or broadly ovoid head 1 to 1.5 cm. in diameter; bractlets spatulate, 3 to 4 mm. long, truncate and subemarginate at apex, purplish at center, pale at margin; corolla cylindric-campanulate, about 3 mm. long, white, 5-lobed, the lobes ovate; fruit 2.5 mm. long, 1-nerved, glabrous, pappose, the pappus 6-rayed, white.

Type in the herbarium of the Field Museum of Natural History, no. 535510, collected among rocks at the summit of range, near Tambo de Vaca, Peru, altitude 4000 meters, June 10–24, 1923, by J. F. Macbride (no. 4424). Duplicate in the U. S. National Herbarium.

Apparently this species is nearest *V. romanana* Graebn. The scapes are much longer, the flowers are borne in a single larger, globose head, the leaves are acute, not rounded at apex, and the caudex is much branched.

Valeriana ligulifolia Killip, sp. nov.

Plant acaulescent, from a slender taproot, the crown bearing numerous persistent enlarged bases of leaves; leaves narrowly linear-spatulate, 9 to 10 cm. long, 3 to 4 mm. wide toward apex, about 2 mm. wide below middle, abruptly enlarging to a sessile base about 10 mm. wide, obtuse, conspicuously 3-nerved, fleshy, glabrous, bright green when dry; peduncles subequal to the leaves and of similar texture, the flowers borne in a single dense terminal head; bracts lanceolate or ovate-lanceolate, unequal, 5 to 8 mm. long, 4 to 5 mm. wide at the connate base, acutish, minutely ciliate; bractlets linear, 2 to 3 mm. long, obtuse; flowers not developed in type specimen.

Type in the U. S. National Herbarium, no. 1,143,789, collected on wet, grassy páramo, Cerro Tatamá, Department of Caldas, Colombia, altitude 3400–3700 meters (Western Cordillera), September 8–10, 1922, by F. W. Pennell (no. 10583).

This species belongs to the small group, perhaps generically distinct from *Valeriana*, in which the plants are acaulescent and the bracts connate, of which the best-known Colombian species is *V. bracteata* Benth. From that *V. ligulifolia* is distinguished by longer, more slender, 3-nerved (not 5 or 7-nerved) leaves, and ciliate bracts.