tympanum over it, while the thicker, more fibrous, outer membrane is attached to the bone around the mouth of the opening. The air-bladder is further anchored anteriorly by a stout Y-shaped ligament firmly attached to the basioccipital. The otolith chamber opens above into the brain chamber at about the middle of its length by a rather small (as compared with other fishes) foramen through which the sacculus communicates with the utriculus and the other auditory elements.

Peculiarly *Holocentrus suborbitalis* Gill, a hitherto supposedly closely related species, has no posterior opening from the otolith chamber, the chamber does not form a tube-like prominence at the side of the cranium, the otolith is comparatively small, and the air-bladder does not extend forward to the cranium. These characters seem of sufficient importance to make *suborbitalis* the type of a distinct genus, for which the name *Adioryx* is proposed.

In a prepared dry cranium of *Nematistius* there appears no long tube-like otolith chamber at the side of the cranium, but at each side and just below the occipital condyle there is a sudden bulging of the basioccipital bone containing the wide-open mouth of a long tunnel leading upward to the brain chamber, and opening into the latter in the same way and at the same place that the otolith chamber of *H. ascensionis* opens into it. In a dissection prepared from an alcoholic specimen a small otolith is found in the upper end of the tunnel. Into the lower part of the tunnel the air-bladder projects, lining it with a delicate membrane; and near the middle of the tunnel, at its narrowest part, the air-bladder closes it, thus forming a delicate membranous pocket.

The auditory connection in the case of *Nematistius,* where a special tunnel is opened through the bone to accommodate it, is obviously of a deeper-seated nature than in any of the other examples where advantage is taken of interossified areas even though these areas have become somewhat specialized. The small taxonomic value of the connection of the air-bladder to the ear is illustrated in *Adioryx* and *Holocentrus,* where in one case the connection is absent while in the other it is present and with the cranial bones modified to accommodate it. It can probably be used only in showing relationship between species or genera at the most. The condition as it exists in *Nematistius* may prove of greater value in this respect.

Edwin Chapin Starks

A NEW SOIL SAMPLER

A laboratory study of the physical characteristics of soils has come to be considered of primary importance in soil investigations. Much has been done within recent years toward studying soils from this standpoint with air-dried samples. Comparatively few attempts, however, have been made to study samples which possessed the texture, structure, moisture content and other features found under field conditions. For many reasons, investigators can not materially add to our knowledge as long as data are secured only from air-dried samples. Real progress in research can begin only with the use of apparatus designed to take samples of adequate volume and of such character as will enable the investigator to deal in the laboratory with samples which possess essentially the same physical properties as are possessed by the soils in the field.

Many devices and methods have been introduced for soil sampling.[1] For general physical and chemical analytical work the standard methods of sampling are all essentially the same and each of them has proven more or less satisfactory for the purpose for which it was devised.

However, with one or two exceptions none of the methods of sampling which have thus far been introduced makes it possible to bring to the laboratory a sample of soil in the condition in which it rested in the field.

In the method of sampling proposed by the investigators at Rothamsted, a steel or brass frame, fitted with a keen cutting edge and open at top and bottom is driven into the soil by repeated blows with a wooden or iron

[1] See Wiley's "Principles and Practise of Agricultural Analysis," Vol. I., pp. 61–85, for a discussion of methods for sampling soils. See, also, Hall's "The Soil," pp. 45–48.

hammer to any desired depth or until its upper edge is level with the surface of the soil. This method has objections. For example, the core of soil within the frame is generally more or less compacted during the process of sampling. For this reason, the sample of soil does not possess unchanged physical characteristics, and hence it can not be used to advantage in a study of many of the more important physical properties of the soil.

A method of sampling which more closely meets the requirements of the soil physicist, who desires to determine the permeability of soil to water or air and to study other physical properties, has been proposed by Whitney, and is described by Wiley in the following words:

> An excavation two feet square and eighteen inches deep is made in the soil. On one side of this hole the sample of soil or subsoil is secured by means of a narrow saw blade and a sharp carving knife. The sample of soil should be two inches square and from three and a half to four inches long. It is placed in a brass cylinder three inches long and three and a quarter inches in diameter. The open space in the cylinder is filled with paraffin heated just to its melting point.

This method, also, is open to objections. In the first place, it is often difficult to secure an unbroken core of soil to a considerable depth, and, further, the sample which is taken by this method is too small for many lines of study.

The writer with the assistance of M. W. Pullen, of the Engineering Division, Iowa State College, has devised a sampler by which he has largely overcome each of the objections referred to in the preceding paragraphs, and is enabled to take, in a comparatively short time, a core of soil, three inches in diameter and of any desired depth up to about fifteen inches, which possesses every physical characteristic of the soil in the field. This apparatus makes it possible for the operator to quickly and easily secure a large sample of soil for mechanical and chemical analyses. For this purpose it promises to prove more useful than some of the devices which are now employed. However, the new sampler is especially adapted for taking samples of soil for the determination of volume weight, moisture content, water-holding capacity, permeability to water or air, capillary movement of water and other physical characteristics. The sampler has been tested in many different types of soil. No particular difficulty has been encountered except in coarse gravel and in heavy soils which were very wet. When the soil is in a condition favorable for crop growth, a sample of soil three inches in diameter and ten or twelve inches in length may easily be secured by two operators within six or eight minutes. A single operator finds it somewhat difficult to get a sample. However, an experienced man, by using a spade two or three times to remove the soil from the sides of the machine, has secured samples without undue exertion.

The total weight of the sampler, exclusive of the wooden frame, is twenty-six pounds and it may be transported from one point to another with little difficulty.

During the past year a large number of laboratory determinations have been made with samples of soils which were taken with the new sampler. The data secured are for the most part very satisfactory and are of such a nature as to justify the conclusion that the sampler will prove of value whenever a study is made of the physical properties of soils.

The new soil sampler is not complicated and may be made by any first-class mechanic in a well-equipped machine shop. The sampler consists of an outer cylinder of steel, fitted at the lower end with two sets of cutting teeth of tool steel; spiral grooves are milled on the outer side of this cylinder which serve to give increased cleaning capacity to the sampler.

A steel cylinder, with an inside diameter of a little more than three inches and with a guide rod nineteen inches in length, fits snugly within the outer cylinder. This inner cylinder does not turn with the cylinder which carries the cutting teeth, but is held rigidly in place by a key. If this cylinder were to turn, the core of soil would be broken and would thus be rendered useless for a determination of certain physical properties of the soil. A cylinder made of heavy galvanized sand screen with eight meshes to the inch is placed inside of the inner steel cylinder. The screen or wire cylinder should fit into position perfectly and there should be no open space between this cylinder and the inner steel cylinder. As the outer cylinder bores into the soil and separates a core of soil from the soil mass, the inner steel cylinder, carrying the wire cylinder is carried downward at a rate uniform with that of the outer cylinder and the core of soil is pushed with but little friction and in an unbroken condition into the wire cylinder. When a sample of soil has been secured to the desired depth, the sampler is withdrawn and the wire cylinder which contains the core of soil is removed from the machine. When the soil sampler is in operation, it is held rigidly in position by a wooden frame which is supported on four legs.

In conclusion it may be said that the advantages which the writer thinks should commend this new apparatus for taking soil samples and particularly those which are used for the determination of the physical characteristics of the soil, are the rapidity with which samples can be secured, and the unchanged physical condition of the core of soil.

The claim is not made for this method that the samples duplicate closely when tests are made regarding the physical properties of a soil type. However, it is the opinion of the writer that the variations are due wholly to factors other than those connected with the operation of securing the samples of soil, and it is not probable that these factors can be eliminated.

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NOTE ON THE CRYSTAL FORM OF BENITOITE

Of the thirty-two possible crystal classes deduced mathematically from the empirical law of rational indices by Hessel in 1832, three have no known representative up to the present time. They are the tetragonal bisphenoidal, trigonal bipyramidal and ditrigonal bipyramidal classes. The writer believes that the last-mentioned class, the ditrigonal bipyramidal, has a representative in the new gem mineral, benitoite ($BaTiS_3O_9$) recently described by Louderback.[1]

Several crystals of this interesting mineral obtained through R. M. Wilke were examined and measured, with the following results. The dominant form is a trigonal bipyramid, which determines the habit. If this is taken as the positive unit form, $10\bar{1}1$, the other forms (taking the axes of reference diagonal to the planes of symmetry as in tourmaline) are: $0\bar{1}11$ and $01\bar{1}2$ trigonal bipyramids; 1010 and $011\bar{0}$, trigonal prisms; and 0001, pinacoid. Of these $0\bar{1}11$ is small, $01\bar{1}2$, a narrow form truncating the polar edges of $10\bar{1}1$ and only found on one or two crystals. Of the two prisms $10\bar{1}0$ is invariably the more prominent, but $01\bar{1}0$ measures a little more in the direction of the $\dot{c}$-axis. The pinacoid 0001 is a small triangular face and on one crystal there were triangular markings parallel to its edges.

Although the general form, $hk\bar{i}l$, ditrigonal bipyramid, is absent, it is pretty certain that the crystals belong to the class mentioned as there is a horizontal plane of symmetry in addition to three vertical planes of symmetry and three axes of two-fold symmetry as well as a single axis of three-fold symmetry.

Another possibility is that the crystals may belong to the trigonal bipyramidal class in which case the dominant form would be an $hk\bar{i}l$ face, but limit forms are much more common among crystals than general forms. It may also be urged that the crystals may be supplementary twins of the ditrigonal scalenohedral or of the ditrigonal pyramidal class, but as the prism faces show no grooves, nicks, striations or seam through the center, it seems reasonable to regard them as simple crystals.

Sufficient angles were measured to establish the forms as given above. The average of ten values for the angle ($0001 \wedge 10\bar{1}1$) varying from 40° 0′ to 40° 22′, gave 40° 10′ as compared with Louderback's value of 40° 14′.

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Stanford University, Cal.,
September 19, 1908

[1] *Bull. Dept. Geol. Univ. Cal.*, Vol. 5, pp. 149–153, 1907.