If the two leads of the junction are now connected through a spring switch to a single dry cell, one very quick tap of the switch will usually melt down the silver plating which rounds up by surface tension to form a neat solid ball in which the two wires are embedded (Fig. 1f). This makes a strong junction which can be readily inserted into tissues or cells with no change in electrical resistance. The comparatively low melting-point of silver is an advantage in this process of melting down. Its comparatively high coefficient of exapnsion causes it to contract tightly onto the wires when cooling.

Because of the low melting-points and lack of cohesion of Bi and Bi-Sn, it is practically impossible to melt down the plating on junctions of these metals without also melting and destroying the cores. This is so even when tin is used in plating (melting-point 232°) and even when heat is applied with a small filament. Junctions of these metals which are joined by unmelted silver plating maintain constant resistance if carefully handled and if only minute currents pass through them. With frequent calibration they may be satisfactory for use when mechanical strength is not required. The plating is not stable enough for inserting into cells. More rigid junctions of these metals may be made with somewhat more difficulty by bending the wires, which are much less brittle than large wires, into mechanical contact and melting them together under the microscope by means of a small filament held in the manipulator.

PROPERTIES

The resistance of the junctions varies greatly with size (inversely more or less as the square of the diameter), steepness of taper (or length), success of joining at the tip, and with the metals used. Iron and platinum junctions which are ten microns in diameter have a resistance of around ten or fifteen ohms (including two short leads of thirty-five gauge wire). Bismuth and bismuth-tin junctions have considerably greater resistance.

The temperature lag is negligible because of the minute mass of the junctions.

With a high sensitivity galvanometer such as the Leeds and Northrup all copper circuit type HS, with proper external critical damping and with a four-meter beam, the temperature of a Bi and Bi-Sn junction ten microns in diameter can be measured directly, without thermal relay, to less than 0.0005° C. (provided the rest of the system is constant within this limit).

OTHER APPLICATIONS

If both cores are platinum, the tips may be left unjoined (Fig. 1c) to form a minute bipolar electrode which may be lightly coated with platinum black. Such tips when joined with platinum form a filament which may be used as a minute source of light or heat. When the tip in air is white hot the cores within the quartz are red hot.

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SPECIAL ARTICLES

THE EARTHWORM FAUNA OF THE UNITED STATES

"THE fauna of this country is well known; only relatively insignificant questions of minor detail remain to be worked out." This is a dictum frequently expounded to-day by zoologists. Perhaps certain classes have been exhaustively studied, but at least one group of common animals has been neglected. The particular group to which reference is made is the Oligochaeta and especially that section of the class which includes the forms commonly called earthworms.

Survey of zoological literature shows that Frank Smith is the single American to make an extended investigation (1895–1924) of these animals. He worked out, perhaps fairly completely, the earthworm fauna of a smallish region centering in Illinois. A Swede, Gustaf Eisen, published a series of papers (1874–1905) on North-American oligochaetes, but except for some half dozen forms from the state of California, practically all of the species described were Mexican or Central American. Papers by Garman, J. P. and H. F. Moore, Smith and three foreign oligochaetologists—Michaelsen, Perrier and Ude—containing descriptions of single species or reports on random collections from widely separated localities complete the bibliography on the earthworms of this country.

In a large portion of the glaciated area of North America we can not, of course, expect to find indigenous species of earthworms. This part of the continent is inhabited only by peregrine Lumbricids presumably introduced by man. It should not be without interest, however, to know what species have been so introduced, or more accurately, have been able to "occupy the land" after introduction, and how they have distributed themselves in the new regions. Comparatively little information of this sort is available. To illustrate: a student in the graduate school of Harvard University, while smoking an after-lunch pipe, on a pleasant May day a year ago, picked up seven species of earthworms from under leaves on the grounds of the Museum of Comparative Zoology. The worms in this small collection have been identified as follows:

Helodrilus caliginosa typica
" " *trapezoides*
H. (Eisenia) foetidus
H. (Dendrobaena) subrubicundus
H. (Bimastus) tenuis
Lumbricus castaneus
L. rubellus
L. terrestris

Only three of these species are known to be common: *L. terrestris* is usually known as *"the common earthworm,"* although *H. caliginosus* and *Eisenia foetida* can be secured, so far as the writer's experience is concerned, in larger numbers and with much greater ease than the so-called common form. The remaining species, judging only of course from the published records, are much rarer. None have been previously recorded from the state of Massachusetts: only one, *B. tenuis,* has been previously reported from any New England state (Maine). *L. castaneus* has been hitherto recorded only twice from this continent, once from New York State, once from Canada.

The glaciated areas of the continent are not, however, entirely devoid of the more interesting indigenous forms, for endemic species of earthworms have penetrated northwards since the last retreat of glacial ice. The extent of this penetration is yet to be discovered, and when related to the time during which the movement has taken place will doubtless offer valuable evidence towards a solution of other more complicated and perplexing problems of earthworm migration.

In the unglaciated regions of the United States there have been found endemic species belonging to three important subfamilies of the Oligochaeta. Some of the questions of minor detail that yet remain to be worked out may be best indicated perhaps by merely listing the endemic species together with the records of their distribution.

Subfamily Megascolecinae

Plutellus. The genus founded for *P. heteroporus* from Pennsylvania by Perrier in 1873. The type species has not been seen since. A letter to the editor of *Nature* (1890) by the English oligochaetologist, Benham, pointing out the need for further study of the species and urging the collection of further specimens was without result. Four other American species of the genus have been found in California.

Megascolides. M. americanus was described in a preliminary note by Smith (1897). It has not been seen since. The worms were 180 to 190 mm long, with a diameter of 6 to 7 mm, and were obtained in a road cutting near Pullman, Washington. The absence of additional records may possibly be explained by the fact that the burrows of this worm extend into the ground to a depth of at least fifteen feet.

Subfamily Diplocardiinae

Diplocardia. The most characteristic American genus, confined to the United States with the exception of two species, one of which is limited to Mexico, the other occurring in both Lower California and Chillicothe, Texas. *D. communis* has been found in Illinois;[1] *D. singularis* in Illinois, Indiana and Raleigh, N. C.; *D. eiseni* in Florida and Savannah, Ga.; *D. riparia* in Illinois and Indiana; *D. verrucosa* in Omaha, Illinois and Nebraska; *D. michaelseni* in Raleigh, N. C.; *D. udei* in Indiana and Raleigh; *D. longa* in Pulaski County, Georgia; *D. floridana* in Monticello, Florida; and *D. mississippiensis* in McNeill, Miss.

Subfamily Lumbricinae

Helodrilus

Eisenia. H. (E.) carolinensis, founded for a single specimen obtained at Hamburg, Germany, in a shipment of plants from Fayetteville, N. C., in 1903. It has not been seen since. *H. (E.) lönnbergi* has been found in Savannah and Raleigh. The writer recently found unidentified specimens of this species from Mount Vernon in the collections of the Smithsonian Institution in Washington.

Bimastus. The subgenus is probably limited to the United States. *B. palustris* has been collected in Pennsylvania, New Jersey and Raleigh; *B. tumidus* in Mount Lebanon, New York; *B. giesleri* in Savannah, Florida, Ohio, Illinois, Kansas and Texas; *B. zeteki* in the Susquehanna River, New York; Douglas Lake, Michigan, and Urbana, Illinois; *B. welchi* (one specimen only) in Manhattan, Kansas.

Incertae Sedis

Hypogaeon hirtum Savigny 1820, from Philadelphia. This very interesting form has nine parallel rows of spinelet covered setae. The original specimens were given to Savigny by Cuvier. The species has not been seen since. Vaillant wrote (1889) rather plaintively that "il est singulier que dans le pays d'ou proviendrait ce ver, alors que les recherches zoologiques y sont poussees avec tant d'ardeur, on ne paraisse pas l'avoir encore retrouve."

Perchance in future intervals between the elaborate and costly expeditions to far distant tropic or arctic shores some of our zoologists may find time to attempt the exploration of our own backyards.

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[1] The name of the state is given when the species has been recorded from two or more localities therein.