Pressed specimens of all the above plants have been deposited at the Academy of Natural Sciences of Philadelphia.—GEORGE R. PROCTOR, University of Pennsylvania.

THE USE OF FORMALDEHYDE IN PLANT COLLECTING[1]

RICHARD EVANS SCHULTES[2]

The preparation of plant specimens for the herbarium is not a difficult task. The usual procedures, however, are sometimes awkward to apply or unsatisfactory under certain conditions. Such is the case, for example, in unfavorable tropical climates or when treating certain groups of plants in which immediate and rapid drying causes undesirable changes in the plant tissues, resulting in the disintegration of the specimen upon subsequent handling.

As is well known, the general procedure is to dry plant specimens in the field. Some botanists are accustomed to use gasoline pressure stoves, in which case the plant press, with the specimens between blotters and corrugated metal or cardboard sheets, is suspended above the source of heat so that currents of hot air pass up through the corrugated sheets. The position of the press is changed from time to time, and the specimens dry rapidly, requiring from two to forty-eight hours, depending upon the texture and fleshiness of the tissues.

Other botanists prefer to dry more slowly, placing the press of corrugated sheets with plants in the sun so that the specimens dry gradually with solar heat and wind which circulates between the corrugates.

In my opinion, specimens prepared by these two procedures in the field can be of equally high quality. If the specimens be carefully prepared, one usually cannot distinguish those dried rapidly with artificial heat from those dried slowly with solar heat. The difference between the two methods is not in the

[1] Translation from the Spanish, by the writer, of an article entitled: "El uso de formol en la recolección de plantas" which appeared in the *Revista de la Facultad de Agronomía* (Medellín, Colombia) vol. vi, no. 22 (1946) 46–52.

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quality but in the quantity of specimens which can be dried in a given period of time.

For collectors who are accustomed to gather many specimens of each number or many numbers, it is necessary to use artificial heat in order to dry rapidly, thus avoiding the accumulation of too much material which, in moist and hot climates especially, rots in a very short time. Some plant collectors, however, gather few specimens and few numbers since they are specializing in certain genera of plants; these investigators can easily take advantage of solar heat to dry their limited material without the danger of an over-accumulation.

During my four and one-half years of botanical activity in the Amazon drainage-area of Colombia, I have experienced considerable difficulty in the use of artificial and solar heat for drying specimens. Nearly all parts of the Colombian Amazonía are heavily forested, completely uninhabited or, at most, only very sparsely populated, lacking in communication facilities linking it with the centers of the nation, and without even the most indispensable equipment for work of this type. As it is my custom to spend long periods in botanical exploration away from centers, I have very frequently been beset by insurmountable difficulties in plant preparation. Neither the use of solar heat nor the employment of a gasoline stove has been satisfactory, although my collections are never extensive.

In the Amazon jungles, the procurement of gasoline for stoves is a constant and serious difficulty. When it is available, it is usually of an inferior quality that rusts and clogs the delicate mechanisms of pressure stoves. These mechanisms are often impossible to replace, and their repair in the field is usually out of the question. Nor can one utilize solar heat in most parts of the Amazon Valley because in these regions, especially during the "rainy season", the sky is often overcast for a number of consecutive days or even weeks, thus making it impossible to dry specimens in a press before their putrefaction and disintegration.

For these and other reasons (especially the great danger of fires, as well as the inevitable difficulty of having to travel great distances in open canoes with the voluminous equipment required by botanical work—tins, blotters, newspaper, tripods,

stoves, presses, gasoline drums, etc.—which always must be protected from storms and water), I decided to abandon drying in the field and use the method of preserving the undried specimens, pressed, in formaldehyde and sending them to Bogotá that they may be prepared conveniently and carefully there with an electric stove.

This method, which I have employed now for more than two years and which was suggested to me by Mr. Paul H. Allen, is little used amongst botanists and plant collectors because it is apparently not widely known. Various colleagues have shown such surprise in the success and the simplicity of this procedure that I have decided to publish the present article to recommend it highly, hoping that its advantages may also be of help to colleagues who are working in tropical climates.

The specimens are prepared as though they were to be dried at once in the field: i. e., between double news-sheets of ordinary size (12″ x 18″). The plant specimens are arranged, one to a sheet, and then pressed in the standard botanical press made of iron and chains or of wood and canvas straps. The plant material is left under heavy pressure for a day; when time permits, it is taken out to be rearranged before applying formaldehyde. An enamel metal tray of rectangular form about 10″ x 15″ and 3 or 4 inches deep is convenient. Into this tray, a quart of commercial 40% formaldehyde and one and one-half quarts of water are poured and mixed thoroughly. The open plant press is placed at the side of the tray, and the pressed specimens are dipped into the solution one by one. After a few moments in the solution, they are replaced, still dripping, between the news-sheets. The news-sheets with the specimens are placed one above the other and immediately put under pressure as previously applied. No blotters or cardboards are required unless an occasional specimen be extremely woody or pulpy. During the bath or before, the specimens may be numbered in the manner used by the collector. One must bear in mind, however, that the writing of some colored pencils is obliterated by formaldehyde; this can be avoided by using a heavy indelible pencil.

Once all of the specimens are well arranged and sufficiently pressed, they are enclosed in a rubberized bag or in any airtight container and are not removed again (except when one desires

to add more specimens prepared on successive days). Under these conditions, the plants will be conserved without damage for a month or more.

If shipment to a center must be delayed, it may be necessary to add a bit more formaldehyde to each specimen. This is done simply by bathing the specimens again or by spraying with a small amount of the formaldehyde-water mixture, then replacing the bundle in the rubberized bag. If transportation is not to take too much time, for example, about fifteen days, the concentration of formaldehyde can be weakened and up to two quarts of water or more per quart of formaldehyde can be added. If the plants are to be sent by mail, it is best to remove the pressed specimens from the press and tie them tightly in a bundle with twine. Then they should be wrapped in a double canvas to avoid as much as possible evaporation of formaldehyde during the trip.[3] The canvas should be strongly sewn, and the address may be printed on it with indelible pencil.

If the collection of a plant specimen be of any scientific value, then it follows naturally that the best attention and care should be given to its preparation.

At the present time, I am having excellent success in the use of the method described above. I am sending monthly collections of plants by mail from various parts of the Colombian Amazonía to the Instituto de Ciencias Naturales in Bogotá where they are dried with great care by well prepared technicians who have good stoves and excellent equipment as well as time at their disposal.

In the tropical jungle regions of Colombia, the very conservation of plant specimens already dried is a problem. Humidity, fungi, rats, ants, termites, worms, cockroaches and numerous other destructive agents, not to forget man and his usual carelessness, are constant and tireless enemies. For the difficulty of keeping dried specimens until shipment, if not for the other reasons mentioned above, I consider highly advisable the use of formaldehyde in plant collecting.

[3] Writer's note: Since publication of this article in Spanish, I have experimented with the use of the impermeable rubber-paper commercially known as "pliofilm" in wrapping bundles of formaldehyde-dipped specimens. The results have been highly successful. This pliofilm is a paper which does not crack and which can be sealed completely with a hot iron, providing an absolutely evaporation-proof container in which the effects of the formaldehyde will last many weeks longer.

In herbaria and in zoological museums, it is customary to preserve large and fleshy specimens of fruit and animals in bottles with solutions of formaldehyde. There is said to be one disadvantage in the continual conservation of vegetable material in formaldehyde, and that is the hardening of cellular tissues and the consequent difficulty in making microscopic or macroscopic dissection. However, I have been able to show by dissections of *Hevea* material that the use of formaldehyde in collecting as previously outlined does not harden the plant tissues unduly. It is also evident from the collections that specimens which have been under formaldehyde treatment in a plant press for as long as three months dry with artificial heat as well as or better than specimens which are dried immediately in the field. I have used formaldehyde with varying percentages of ethyl alcohol, but it appears that this is in no way advantageous and that formaldehyde alone, diluted in water as explained above, is sufficient. One quart of commercial 40% formaldehyde, diluted, is sufficient for preparing about 200 specimens. It has afforded me considerable satisfaction to see how successfully plants which are usually difficult to prepare and which often discourage the collector can be dried after treatment with formaldehyde. Fleshy plants such as many species of *Ficus* and *Clusia* as well as the pseudobulbs of many orchids flatten and soften under the influence of pressure and formaldehyde. Various species of *Melastomaceae* and *Loranthaceae*, usually brittle and fragile when dried, are conserved strong and resistant if first treated with formaldehyde. Flowers as delicate as those of *Clusia*, of various species of the *Lecythidaceae*, *Leguminosae* and *Bombacaceae*, and, curiously enough, the marvellous aquatic flower of *Victoria regia* are prepared very neatly with this procedure. Numerous *Leguminosae* with finely pinnate leaves, whose leaflets almost always fall during drying, are preserved intact. We might also include many *Bignoniaceae* and *Convolvulaceae*, some *Solanaceae* as well as *Cucurbitaceae* and *Passifloraceae* and others with membranaceous or ephemerous flowers.

Lactiferous trees, such as species of *Hevea*, *Castilla*, *Sapium*, *Couma* and *Hancornia*, usually lose their leaves very rapidly due to fermentation of the latex and formation of an abscission layer. I have used the formaldehyde procedure with excellent

success in the preparation of hundreds of specimens of *Hevea*, in which the flower as well as the fruit is very susceptible to rapid putrefaction and in which the trifoliolate leaves very often disintegrate, even when subjected to immediate artificial heat shortly after collection.

One disadvantage in using formaldehyde is the damage it causes to the skin. Since it is a dehydrating agent, it cracks and blackens the hands after several days' contact and an acute pain is produced. This may be avoided by the use of rubber surgeons' gloves or by smearing the hands with vaseline or cold cream before bathing the specimens. Pincers may also be used to handle the plants. However, when one is collecting and preparing plants continuously and over long periods, my experience indicates that these precautions are very much more troublesome than the physical inconvenience caused by the chemical.

The formaldehyde method should be convenient not only for professional collectors who are working at great distances from their bases, but it should also prove of use to students who often make botanical excursions of a few days' duration, who have no time to prepare and dry their material during the trip, and who find it difficult to carry bulky botanical equipment. If one uses formaldehyde, one needs carry only a plant press, newspaper, a tray and a bottle of formaldehyde. This equipment is so light and easy to carry that it can be taken even by aeroplane. On occasional trips, the purpose of which is not strictly botanical, the formaldehyde "kit" would be useful because one might unexpectedly arrive at some remote locality where it would be possible to find plants of importance to phytogeographical investigations.

In the case of extensive collections, it might seem that the cost of formaldehyde would be excessive due the exorbitant cost of this chemical at the present time in Colombia. In reality, however, if one considers the conveniences it affords, the formaldehyde procedure is not costly even under present conditions. Where there are no facilities to use other methods of collecting and drying, it must be considered false economy to forego the use of formaldehyde for fear of its initial cost. It should be considered an insurance policy for work which requires so much

interest and sacrifice on the part of the naturalist-collector. Furthermore, although all of us ought to work as economically as possible, the time has come to insist that botanists do not have to carry out their expeditions and explorations in the traditional manner with microscopic budgets compelling them to travel about almost like beggars asking alms.

The best materials and the most modern methods ought to be available to the botanist (as in the case of most other scientists), for he is dedicated to one of the oldest, most profound and most fascinating of the sciences and one which is, at the same time, of fundamental economic importance for the progress of mankind.

Bogotá, Colombia

A NEW STATION FOR EPIPACTIS HELLEBORINE IN NEW HAMPSHIRE.—In view of the scarcity of stations in New Hampshire for *Epipactis Helleborine* (L.) Crantz, I am recording a station on the northeastern section of Bear Island in Lake Winnepesaukee in Meredith. The colony is small, about twenty plants, and the possibility of introduction from any near-by cultivated gardens is remote. The plants grow on a hillside of mixed trees in moist soil and there is evidence of a temporary brook in the spring. I found no plant over a foot high and most of them were smaller. One specimen has been sent to the Gray Herbarium, another to the Philadelphia Academy of Natural Sciences; and seeds have been retained for a trial on artificial culture media. The previous record for New Hampshire is of a small colony at Plainfield, somewhat farther west, noted by Alan W. Upham in RHODORA, xliv. 456 (1942).—ROBERT J. TITHERINGTON, Philadelphia 38.

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