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MINISTRY OF ECONOMIC AFFAIRS

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ERRATUM

Page 129—7th line from below omit the whole sentence and insert the following passage: "Transfer into a graduated 102 cc. measuring flask, rinsing the beaker with little water. Add a slight excess of 25% solution of lead acetate (about 4 gms. of lead acetate for Chandu and Indian opium, 2.5 gms. for Persian opium). Make up the solution to 102 cc. accurately (2 cc. are allowed for volume of tannic acid precipitate).

Substitution of Gasoline for Ether in Morphine Determination in Opium Dross.

BY

Ua Rasmidatta

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Affairs, Bangkok, Thailand.*

INTRODUCTION

For almost 15 years the Department of Science (formerly known as the Government Laboratory) has taken over the task of determining the morphine content of opium and opium dross by means of quantitative analysis. The prevailing analytical method was brought over from the Straits Settlement of Malay. By opium is here meant prepared opium stuff which is ready for consumption. Opium dross is the remnant of smoked opium, the greater part of which is ash mixed with a small quantity of unburnt opium.

The method employed at present is quite satisfactory in so far as its execution and results are concerned. An enormous number of samples both of opium and opium dross pass through the Opium Section of the Department of Science annually. The highest mark attained was in B. E. 2479 when the total opium dross samples alone numbered 19,380.

MALAY (F. M. S.) METHOD.

The method employed is as follows. Weigh out 5 grams of opium dross or chandu in a beaker and disintegrate, using heat if necessary, with about 50 cc. of water. Transfer into a graduated cylinder and dilute to 102 cc. (2 cc. are allowed for volume of tannic acid precipitate). Shake and filter into a 100 cc. graduated cylinder.

Take 80 cc. of the clear filtrate which is equivalent to 4 grams of the sample, warm and precipitate the excess lead acetate with hydrogen sulphide gas. Filter and wash the precipitate once or twice with hydrogen sulphide water. Evaporate the filtrate to a few

cc. Transfer into a 50 cc. conical flask using as little water as possible.

Add 3 cc. of alcohol, 2 cc. of strong ammonia and 25 cc. of ether. Stopper the flask securely with an India rubber stopper, shake for an hour and set aside over night. Filter by pouring the ethereal layer through a small filter, wash the aqueous solution and crystals 3 times with ether using 8 cc. each time and allow the ether to evaporate from the filter paper. Transfer the aqueous solution and crystals to the same filter paper and wash with a saturated solution of morphine.

Dry the precipitated crystals in a hot air oven to remove ammonia. Place the filter paper with crystals in a beaker and add to it 25 cc. of standard sulphuric acid (i. e. 1 cc. N/10 H_2SO_4 = exactly 0.0285 grams of anhydr. morphine). Leave the solution standing for at least 2 hours and titrate it with standard sodium hydroxide solution, using methyl red as indicator.

PURPOSE OF MODIFICATIONS

It is internationally conceded that no one method of analysing opium should be accepted as applicable or suitable for all countries as even the method of mixing opium varies in each country. The analytical method of the F. M. S. differs from ours when both were recently compared. Scientific methods change with the time and place, so that scientists are always working to find out the most suitable method to solve a problem. The Opium Section, in accordance with this tradition, is ever working out new procedures which give better results and at the same time are both convenient and economical.

The Malay method of determining morphine in opium and opium dross, though very satisfactory, involves the use of some expensive chemicals. After due deliberation it seemed necessary to choose one of the following alternatives.

- a. Adopting an entirely different method.
- b. Using the same method but substituting some chemicals for others.

EXPERIMENTAL.

The first alternative has been tried with no success, as no method could be discovered that would be suitable for prevailing conditions. So the latter alternative had to be taken into consideration. A close examination of the chemicals involved revealed the fact that some could even be omitted altogether e. g. lead acetate and hydrogen sulphide, and gasoline could be substituted for ether. In a preliminary trial the acetate and sulphide were omitted from the process and the results were favourable.

TABLE I.

Comparison of Results of the Malay and the Modified methods.

Lab. No.	Malay method % morphine	Modified method, not using lead acetate and hydrogen sulphide % morphine	Differences %
83/923	5.8	5.8	—
924	6.6	6.5	-0.1
925	5.5	5.5	—
926	6.7	6.7	—
927	7.1	7.2	+ 0.1
928	6.5	6.5	—
929	5.7	5.8	+ 0.1
930	6.3	6.3	—
931	5.6	5.8	+ 0.2
932	6.5	6.5	—
933	6.0	6.1	+ 0.1
934	7.1	7.1	—
958	8.7	8.7	—
959	8.0	8.1	+ 0.1
960	6.4	6.3	-0.1
961	9.1	9.2	+ 0.1
962	8.0	8.0	—
963	7.3	7.3	—
964	2.4	2.5	+ 0.1

The results obtained, when lead acetate and hydrogen sulphide were omitted, compared quite favourably with those of the old routine method. It will be observed that the two processes yield somewhat different results. But this fact cannot be attributed to any fault inherent in the new process. Even with an identical sample and an identical process, successive results may be different. This is because for each procedure there are unavoidable varieties in the operation so that it is impossible that one result should be identical with another. The reason why lead acetate is not used with opium dross here are that the dross is composed mostly of ashes and only a little amount of opium. Hence the use of lead acetate is unnecessary.

After thorough examination of the whole process of opium dross analysis, it became evident that most probably a change of solvent would also give good results.

Ether is used for the collection of morphine precipitate which separates from opium dross, as the precipitate is practically insoluble in the said liquid (1 : 5000 appr.). When the experiment was conducted to ascertain the solubility of morphine in gasoline it appeared that morphine was not at all soluble. This result led to the experimentation with an aim to substitute gasoline for ether, using the Malay process with the omission of lead acetate and hydrogen sulphide.

SPECIFICATIONS OF GASOLINE USED IN THE METHOD OF ANALYSIS

Sp. gr. of gasoline 64° Be' (0.7238) $\frac{60^\circ}{60}$ F.

Distillation test indicates the presence of the following hydrocarbon fractions.

Initial drop 36.1°C.

TABLE II.

Fractions of Gasoline used.

At Temperature (°C)	Total Distillate % by volume
68.0	10.0
80.0	20.0
88.5	30.0
96.0	40.0
102.0	50.0
108.5	60.0
116.0	70.0
126.5	80.0
140.5	90.0

Vapor pressure = 6.8 lbs. per sq. inch.
 End point = 160.5°C.
 Total distillate = 96.5 %
 Loss = 2.7 %
 Residue = 0.8 %

TABLE III.

Determination of Morphine Contents in Opium Dross.

Lab. No.	Modified method using gasoline % morphine	Modified method using ether % morphine	Differences %
83/488	7.7	7.8	+ 0.1
489	6.6	6.6	—
508	1.1	1.2	+ 0.1
512	4.7	5.0	+ 0.3
513	6.2	6.3	+ 0.1
514	7.0	7.2	+ 0.2
515	6.5	6.7	+ 0.2
516	5.9	6.1	+ 0.2
83/517	6.5	6.7	+ 0.2
518	6.2	6.3	+ 0.1
616	5.8	5.8	—
617	8.0	7.9	- 0.1
618	8.0	7.8	- 0.2
619	6.6	6.3	- 0.3
620	7.4	7.4	—
621	6.9	6.8	- 0.1
622	5.6	5.6	—
623	5.2	5.1	- 0.1
624	6.3	6.2	- 0.1
625	6.9	6.9	—
626	8.2	8.1	- 0.1

From the above data it is evident that the results obtained through the use of either solvent, are very close, the difference in favor of gasoline is up to 0.3%. Careful comparison of results shows that in most cases the quantity of morphine is found to be greater, when using gasoline instead of ether. The experiment was repeated using redistilled gasoline in order to ascertain whether commercial gasoline may contain impurities which would affect the result.

TABLE IV.

Comparison of Results using Redistilled and Common Gasoline.

Lab. No.	Modified method using redistilled gasoline % morphine	Modified method using commercial gasoline % morphine	Difference %
83/764	6.4	6.6	+ 0.2
765	7.2	7.5	+ 0.3
766	5.6	5.8	+ 0.2
767	7.4	7.5	+ 0.1
768	6.3	6.5	+ 0.2
769	6.3	6.6	+ 0.3
770	5.9	5.7	- 0.2
771	5.1	5.1	—
772	8.0	8.3	+ 0.3
773	6.3	6.2	- 0.1
821	6.8	6.6	- 0.2
828	6.2	6.4	+ 0.2
829	8.5	8.8	+ 0.3
830	7.4	7.7	+ 0.3
831	5.5	5.6	+ 0.1
832	6.9	7.2	+ 0.3

The use of either commercial or redistilled gasoline makes no difference in the results. Both commercial and redistilled gasoline yield up to 0.3% of morphine in excess over those obtained with ether.

DISCUSSION.

The use of gasoline instead of ether is not only practical in opium dross analysis but may be suitable for the extraction of other alkaloids which are now extracted by ether. Long experience has shown that gasoline and ether have the following properties.

Use of ether	Use of gasoline,
<ol style="list-style-type: none"> 1. Expensive. 2. Greater loss during distillation : 3 parts out of 5 are recovered. 3. A number of chemicals must be used for recovery. 4. Highly inflammable hence more dangerous. 5. Morphine precipitate not so white. 	<ol style="list-style-type: none"> 1. Comparatively cheap. 2. Smaller loss, more than 4 parts out of 5 recovered. 3. No chemical used for recovery. 4. Less inflammable, less dangerous. 5. Morphine precipitate whiter in color, containing less impurities.

In substituting gasoline for ether in the analytical method of determining morphine in opium dross, economy is not the only consideration. A careful examination of the process reveals no marked disadvantages.

The use of ether is for collecting morphine precipitate as it is almost insoluble in ether. Since morphine is not soluble in gasoline it is therefore even a better precipitating agent for morphine.

SUMMARY.

The advantages of the new procedure may be summarized as follows:

1. The quantitative determination of morphine in Thai opium dross may be carried out without employing lead acetate.

2. Omission of lead acetate results in saving of time and other chemicals such as sulphuric acid and iron sulphide.
3. Hydrogen sulphide fume is eliminated.
4. Gasoline may be used instead of ether in morphine determination.
5. Use of gasoline instead of ether results in a morphine precipitate, whiter in colour, as well as in greater economy.
6. The gasoline used in this process had the following specification: at 144°C. the total distillate amounted to 90% by volume.
7. Recovery of gasoline by distillation is simpler and less costly than that of ether.

Preparation of Wet Soil Profiles with Thai Adhesives.

BY

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INTRODUCTION.

Taking soil samples from the field in monolith (one block) has been undertaken by many workers by various means and procedures. Soil sampling by monolith has also always been a problem because of the difficulty in making the samples firm and intact when taken from the original position and preserving the natural structure of the various depths of the profile. Diverse methods have already been applied by many soil investigators to upland or dry soils, but so far there has not been any method given definitely for the preparation of soil profile samples from wet soils. This paper is presented for the object of describing a method of preparing permanent soil profile samples from poorly drained regions with the use of a new sticking mixture. The materials used in this new sticking mixture are found very abundantly and can be secured very cheaply in Thailand. Its distinct advantage over other adhesives or cements is that it is capable of being used and is effective in soils which are extremely wet.

IMPORTANCE OF SOIL PROFILES.

The importance of soil profiles is not only recognized in the study of soil itself but is obvious also to other branches of sciences. For example in engineering, plans for the construction of roads, bridges, dams and wall retainers have often been drawn up with the knowledge of the soil profile of the particular locality where such constructions are to be undertaken.

The sampling of soil profiles in monolith block is especially of great aid in recent times when soil classification and mapping are being undertaken by many countries. There is not sufficient guarantee that the soils classified by one country would be given the same name, as adopted for the same soil type in another country, in as much as there is as yet no universal standard method of soil classification. Any man engaged in the classification of soils may forget his knowledge about certain soil types that had been already described and established, but one can save time and expense by having samples of soil profiles right in the laboratory for reference. Incidentally, using this method, there can be no possible departure or deviation in the classification, and any duplication in soil type nomenclature in future work is avoided.

The science of geology never denies the fact that the knowledge of the soil profile gives a clue to the ages of rocks under a certain set of climatic conditions. Other sciences such as botany also deal with the soil profile as demonstrating the anchorage of plant as well as providing a clear means of interpreting the intake of water and plant food elements from the soil. But most universities of the world do not possess soil profiles in their laboratories for demonstration purposes because taking a soil profile from the field and preserving its natural condition is not an easy task to accomplish.

Of course there are other benefits derived from samples of monolith soil profiles, such as studies of the chemical profile, the pH value and some studies on the extent of translocation of the clay fractions or the movement of various salts in either up or down processes.

According to Robinson, the earlier generations of soil investigators considered that the individual soil meant a sample of soil generally from the layer occupied by the roots of plants. But now we can only have an adequate conception of the soil from the study of the horizons down to the parent rock, and a complete picture of laboratory analysis can only be obtained when supplemented by the studies of the profile from the field. The soil profile gives a sum-

mation of all the processes of soil formation, including physical and chemical weathering and vertical translocation of soil constituents by water movement.

REVIEW OF LITERATURE.

The first sampling of soil profiles by monolith was undertaken by Glinka and other Russian soil investigators, who used wooden or metal containers. A similar method has been used by the Bureau of Soils of the United States Department of Agriculture (1927), by using a wooden box with 3 sides lined with galvanized iron sheet which is forced into the soil by means of an automobile jack or other similar device. The box was provided with steel on each side as cutting edges. When brought to the laboratory, sphagnum moss was placed at the bottom of the profile and kept moist by a device of water bottle. The box was then covered with glass to prevent evaporation. The objection in the method as used by the Russian soil investigators and by the Bureau of Soils of the United States Department of Agriculture is that the box is difficult to handle because a large bulk of soil is sampled and the material easily breaks during transportation on account of the enormous weight of the whole profile sample.

To minimize the excess weight included with the sample, Chapman (1928), utilizing the same method as those used by Glinka and the Bureau of Soils of the United States Department of Agriculture, applied a shallow metal trough of such dimensions as 2 inches deep by 4 inches by 40 inches against the prepared surface of the soil profile and cutting it away through the sides of the trough. The objection to this method is that the depth of the profile is very shallow and may not represent much of the characteristics of the profile.

The idea obtained from the criticisms against excess weight of soil brought along with the sample gives rise to thinner sampling of the soil profile which has to be mounted to some form of rigid container. But when thin soil is placed in the box, there is the probability that the sample cannot be placed in an upright position without the chances of breaking. This leads, therefore, to the use of

adhesives and cements. Many soil investigators have tried to find out the best type of container and the best type of adhesive to suit the type of soils under different conditions.

The first adhesive material used in soil monolith sampling was presented by Dr. Sigmund Pinkert of the Royal Hungarian Geological Society at Budapest, and exhibited at the First International Soil Congress held in Washington, D. C. in 1927. There were certain objections to the adhesive material used because it shrank after 3 years and shattered the material in the profile.

Schlacht, as cited by Harper (1932), followed the method of Pinkert by using a special lacquer which is a condensation product of urea and formaldehyde, soluble in water, that will penetrate in the moist soil. When the lacquer has been applied to the smooth surface of the soil profile, a strip of celluloid is attached to the treated surface. When the cementing material dries, a layer of soil 1-3 mm. adheres to the celluloid. Then the soil with the celluloid back is attached and fastened to a flat board so as to expose the profile in a rigid position. But for good study this method is hardly recommendable, because with a 1-3 mm. layer of soil, structural formations cannot practically be shown.

Bushnell (1930), worked out a method using pad glue to hold soil particles in natural position upon a firm background. But in the same way as the method suggested by Schlacht, the soil layer is thin and lacks structural significance, and in sandy soils the sand particles do not adhere.

Collison and Harlan (1930) proposed two methods for collecting soil profiles for study. In the first method, they collected soil profiles in a galvanized iron box similar to Chapman's metal trough and the galvanized iron lined box of the Bureau of Soils of the United States Department of Agriculture, except that the box is provided with a special cover to protect and hold the soil sample in the box. The advantage of the additional glass cover is very little and does not really eliminate the objections against the original method. In the second procedure, they suggested taking cylindrical profiles similar

to Bushnell. It is however possible that, with this second procedure, the structure of the soil is destroyed when the celluloid is being fitted to the surface of the profile.

A method of taking soil profiles has been worked out at the Illinois Agricultural Experiment Station similar to Chapman's but with a Nurex Tapping Compound applied inside the trough, 5 inches wide, 1 inch deep, and 50 inches long. The objection to the use of a metal trough is that upon handling, the metal container easily twists which may shatter the fragile column of soil in the trough.

Then Russel, as cited by Harper (1932), of the Nebraska Agricultural Experiment Station has devised a steel tube, 3 inches square and 36 inches long, which is slightly reduced at one end with the edge sharpened so that penetration is easier. This tube is forced into the ground vertically through a specially constructed frame. This method can be used only with soils without stones to hinder the penetration of the tube.

Horace J. Harper (1932), of the Oklahoma Agricultural Experiment Station and Mechanical College, studied a number of methods for the preparation of permanent soil profiles. He found that a dilute lacquer solution containing one part of lacquer thinner was most satisfactory. In moist soil, he suggested the use of a metal trough and then transfer to a suitable container at the laboratory. For sandy soils, he suggested filling up of cavities created by removed stones and, in case the cavities are large, the depth of the box could be increased. The objection to this method is that, in sandy soils and soils that are dry with numerous natural cracks, the lacquer may penetrate to the exposed face of the profile. And when moist soil is sampled in a metal trough and then transferred to a suitable container in the laboratory, there is the probability of destroying the structure of the soil, if not a total breaking up of the whole soil mass.

Morwick (1932) used asphalt tar as a sticking material, but the use of asphalt is only practicable with samples of shallow depth because of the difficulty in keeping the asphalt tar melted both in the face of the soil profile and on the board.

Description of New Method.**MATERIALS USED IN THE PREPARATION.**

1. Wooden box made from teak wood, 126 cm. long, 20 cm. wide, and 5 cm. deep, weighing approximately 4.5 kgms., having the following parts (see Plate I. Fig. 2):

Backboard—2.5 cm. thick, 18 cm. wide,
and 126 cm. long.

Side boards (pair)—1 cm. thick, 7.5 cm. wide,
and 126 cm. long.

End boards (pair)—1 cm. thick, 7.5 cm. wide,
and 18 cm. long.

Among wooden materials found in the market, teak (*Tectona grandis*) seems to be the only wood best suited for the purpose of mounting soil profiles. Teak wood is comparatively light but very strong and durable, and unusually resistant to attack of insects and decay. In Thailand, teak is found very abundantly and is one of the country's chief exports. Other wooden materials may be used for boxes but they must possess sufficient lightness and durability especially to moisture. All the boards used must be properly seasoned to heat in order to prevent shrinkage subsequently.

2. Materials for sticking are composed of powdered dipterocarpus resin, dipterocarpus oil, and lime. The powdered resin and the oil are obtained generally from the sap of four species of tall trees known locally as *yang*, namely, *Dipterocarpus alatus*, Roxb., *Dipterocarpus turbinatus*, Gaertn., *Dipterocarpus pilosus*, Roxb., and *Dipterocarpus incanus*, Roxb. (see Plate II. Fig. 4).

a. *Powdered Dipterocarpus resin.* Dipterocarpus powdered resin is obtained from the pulverization of the dried resin which is commonly sold in the market in the form of chunks of various sizes. These chunks are results of the dried sap which oozed from the injured part of some branches or tree trunks. The continuous oozing out of the sap and following gradual drying leads to the formation of a large amount of excretion similar to the stalactites in caves,

These dried resins are usually gathered after a storm or heavy wind which often breaks the "stalactites" down. This raw dried resin usually has two colors, one of light smoky yellow and the other of a transparent dark greyish brown color.

b. *Dipterocarpus oil.* The dipterocarpus oil is the undried sap from the above species of trees obtained by cutting a pocket at the base of the trunk; the juice is induced to come out through repeated burning of the cut portion. If viewed against light, the color of the oil in a beaker is lilac but, when viewed down, it is dark reddish grey to almost black. But in general appearance, it resembles crude fuel oil. The dipterocarpus oil has an average density of 0.92.

PREPARATION OF THE STICKING MIXTURE.

The powdered dipterocarpus resin is placed in a basin and the oil is added, a little at a time, with constant stirring until a mixture of a hard paste consistency is obtained. Then lime is added to the mixture and worked out thoroughly. At this stage of the mixing, it is almost imperative to use the hands in rolling and folding the hardening mixture. The addition of lime should cease when the sticking mixture assumes a state similar in character to just above that of the sticky point in clay loam soils.

The proportion of powdered resin, resin oil, and lime in the mixture, according to the materials used, is 15 grams powdered dipterocarpus resin, 7 cc. dipterocarpus oil, and 4 grams of lime. This proportion could be multiplied by any number depending upon the total bulk of mixture to be desired. However, variations from the above ratio may happen according to the density of the oil and the purity of the lime which is used as a dehydrating agent. But generally, the sticking mixture hardens sufficiently in two hours after its preparation. Because the sticking mixture dries naturally fast, it is almost always advisable to prepare it when the digging of the sample pit and the fitting of the board to the face of the soil profile is almost complete.

For very wet soils, a slow hardening mixture is desirable because it is soft and yields easily to the readjustment of the soil, in the sample box. On the other hand, a quick hardening mixture is adapted to soils that are only slightly moist or dry and whose shape does not alter any more after sampling.

The implements used in the sampling operation, as shown in Plate I, fig. 3, are crow-bar, hoe, post digger, spade, and bucket.

Procedure Used in the Collection of the Profiles.

The first consideration in every sampling procedure is the selection of the site typifying the soils of the locality. A pit 50 cm. wide and 100 cm. long was dug vertically down to a depth of 126 centimeters. The excavated soil was placed on the long sides of the sample pit while one of the short sides was designated as the side from which the sample was to be taken. When the excavation was completed, the pit appeared in cross section as in fig. 1, where *a*, represents the side to be sampled and *b*, a bowl-shaped dug-out at the bottom of the pit. Water is allowed to accumulate in *b* and then bucketed out from time to time. This is important as there should be no standing water in the sample pit during the whole sampling operation. The back board of the box was very closely fitted to the surface of the soil profile to be sampled.

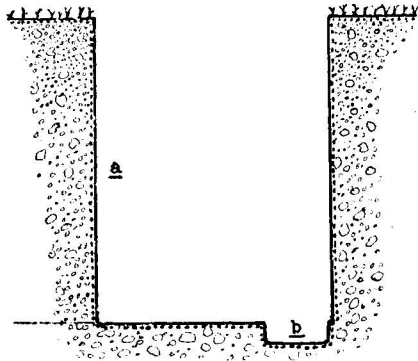


Fig. 1. Showing X-section of a sample pit.

The board, after being fitted to the soil, was taken out and the freshly prepared sticking mixture was thoroughly and uniformly smeared to the board while, at the same time, the dipterocarpus oil was smeared unto the fitted surface of the soil. When the soil was very wet, one application of the oil was sufficient to fill the larger pores without water. Having smeared the board thoroughly with the sticking mixture, it was again fitted to the soil and gently tapped from the back. The board was held on top by hands and at the bottom by sinking a crow bar or sharpened wood in a slanting position which pressed the board closer to the soil and gave freedom of space for the workman to excavate the soil from the sides of the box.

The soil along the outside of the board was slowly cut away in order to fit the sides of the box, which was done either by carefully nailing small 1-inch nails or by the use of screws. The use of screws was found preferable to nails because the possibility of the soil being knocked off or loosened during the process of nailing was prevented. When all the sides of the box were fitted, the soil along the vertical sides was carefully dug out and worked in diagonally towards the middle until the excavation from each side nearly met. When the soil was either sandy or too moist, great care was observed during this part of the operation. In both cases, when digging from each side almost met each other, from top to bottom, the box and attached soil should not be given the slightest move, for any shock given to the box may cause the collapse of the whole column of soil inside. When roots were absent or the profile was devoid of stones, the soil in the box was cut away from the main soil by passing a thin knife from top to bottom and at the same time pressing the box firmly to the soil as much as the knife can be allowed to be pressed down. In this manner the danger of collapsing in the process of separation of the sample was minimized. In this method of sampling, it was found convenient to include excess soils with the box, as much as 1 to 2 inches thick only. When an unnecessarily large amount of soil is cut away with the sample, it often leads to collapse of the soil from the box especially in very wet and sandy soils.

The withdrawal of the sample from the main soil requires a sudden fast pull away and bringing the box into a slanting position as quickly as possible. By this manipulation, the possible collapse of the soil sample was generally prevented. Whenever an unavoidable collapse occurred, a refitting of the board had to be made and the sticking mixture was wiped out and smeared with fresh mixture.

When the ground water table was within one meter, as was usually the case in most of the sampling, it was necessary to complete the operation immediately in order to escape any difficulty arising from the constant flow of water into the pit. This was particularly guarded against in the case of sandy soils where, when the water was allowed to accumulate in the sample pit, the sides soon crumble away, entailing extra labor in the digging the soil and refitting of the board. The water in the sample pit was bucketed out to keep the bottom of the pit sufficiently free from water during the process of fitting until the sample had been taken away.

HANDLING OF PROFILES.

After the profile sample was taken from the pit it was laid flat on the ground at once. This was observed especially among soils that were either loose or saturated with water. The extra soils were removed to prevent excess weight. The samples were in a horizontal position all the time, when in a moist state, and during transport from the field to the laboratory. In the laboratory, the samples were placed in the shade in order to dry them gradually. When the samples were thoroughly dry, they were trimmed in level with the box and then brought to a vertical position and placed in piles in racks. Some of the samples which were placed on exhibit were provided with glass covers to protect them from dust and also from the hands of curious spectators. And when these samples were stored for further reference, they were wrapped in cellophane to protect them principally from boring wasps and ground ants as well as from dust.

DISCUSSION.

In the preparation of a permanent soil profile, there are two important considerations, namely, the container and the sticking material. The container, to be ideal, must be rigid but at the same time light enough for convenience in handling and transportation. In this investigation, the container is described in the materials used and complies with the distinction of being light and rigid. The sticking mixture as a part in the preparation of a permanent soil profile sample is probably the most important because it is from the effective hold of the sticking mixture on which the permanency of preservation of the sample depends. With the knowledge acquired from various investigations conducted along this line, so far, there seems to be no material better than the sticking material used in this investigation with regard to ease of handling and its effectiveness when used with any kind of soil, either dry or wet to a degree of being saturated with water.

The soil after sampling soon adheres to the box by means of the soft sticking mixture although not probably throughout the whole soil column; but when the sample is laid flat on the bottom of the box, a sort of automatic readjustment takes place. The weight of the soil exerts pressure upon the bottom of the box and upon the sticking mixture. The soil, being soft in the moist state, fills itself in the spaces where there was no contact between the soil and the board, while at the same time the sticking mixture which is also still soft, creeps to find in the soil masses where there was no sticking mixture at all. In this case, therefore, even when there was no complete contact between the sticking mixture and the soil during the process of fitting, there would be an eventual fitting up as soon as the soil is laid flat on a horizontal position. There would not be any possibility of air being trapped between the soil and the box because the weight of the soil would exert a constant pressure, strong enough to liberate the air through the spaces between the soil particles. The sticking mixture, therefore, becomes completely effective because the adhesive mixture remains soft for some time and

permits the most soil to set wholly on the bottom of the box and allows the mixture to creep into the minute spaces of the soil.

The use of the new sticking mixture is easy. No extra apparatus are required when the sticking mixture is smeared to the board or when the oil is applied to the fitted surface of the profile. A piece of stick could be used to aid both operations but the use of bare hands¹ is quicker and more effective. This sticking material has practically the same effective hold to the soil as the asphalt tar but the result is better because of its capability to creep into the minute crevices of the soil mass. It is used without the aid of heat, yet it dries very fast depending upon the quantity of lime added.

The dipterocarpus oil, after passing through the minute pores of the soil, serves as "roots" of the sticking mixture and holds the soil firmly to the board, when dry. Where the ground water table is below the depth of sampling, this method even works more satisfactorily because the resin oil and the sticking mixture can penetrate deeper into the soil and attach the soil more strongly to the board than when the soil is moist.

In dry soils, the board with the sticking mixture, after being placed against the soil, can be left to stay untouched for 20 minutes to allow the sticking mixture to harden sufficiently. When the board is allowed to stay overnight, the sticking mixture becomes perfectly hard the next day. In this case, the box and soil were found to be very easy to detach from the main soil, the chances of collapse as in the case of wet soils having been eliminated.

DESCRIPTION OF SOME SOIL PROFILES.

For lack of color differentiation of the profiles shown in Plate I. Fig. 2, the following descriptions supplement this presentation and give the geologic and economic background of these profiles. Soil profiles Nos. 1, 2, 3, and 4 were obtained from Amphur Ban Pong (อำเภอ บ้านโป่ง) regions, Changwad Kanchanaburi, (จังหวัด กาญจนบุรี) during the height of the flood in 1938.

¹ The hands are oiled with the dipterocarpus oil to prevent the mixture from sticking to the hands.

Soil profiles Nos. 5 and 6 were obtained from Amphur Ta Mai, Changwad Chantaburi, (อำเภอท่าใหม่ จังหวัดจันทบุรี) where the soils are better drained and dry during most part of the year.

Soil profile No. 1. Taken about 5 m. north-east of a point 19.3 km. from Nakorn Patom (นครปฐม) along the Nakorn Patom-Ban Pong (นครปฐม-บ้านโป่ง) road. Ban Pong itself is 20.4 km. from Nakorn Patom. The general topography of the land is flat and low but the place from which the profile was taken was slightly elevated with a fair amount of drainage. The small strips of depression near by are waterlogged.

The surface soil is dark brown loam ; slightly granular and the structure broken down by cultivation to a depth of 20 centimetres. A transition of 4 cm. below it, is slightly dark greyish brown and of the same texture. The subsoil beginning from 24 cm. down to 70 cm. greyish brown heavy loam to very light clay loam. The substratum begins from about 80 cm. below the surface of the ground. It is characterized by few small dark brown mottlings interspersed in its generally light greyish brown color. The texture is heavy loam with a rather loose consistency. During most part of the year, this portion of the profile is within the reach of the ground water level.

The texture of the whole excavated profile is generally light and the only very noticeable variation along the vertical section is the color, probably due to the organic matter which gives a darker color to the surface soil and which grades into a lighter to medium greyish brown in the second horizon, with almost none of its effect in the substratum. Another quite noticeable difference in the profile is the probable translocation of the fine aggregates and clays into the subsoil which makes it slightly heavier in texture than the surface soil or the substratum.

Because of the generally light character of the whole soil profile, the retention of water is practically small so that although the ground water table is about 80 cm. below the surface of the ground, there seems to be no effect produced by a condition of poor soil drainage on the crops grown.

The crops best suited for this type of soil are bananas and coconuts and sugar cane when there is ample fertility present, and when planted at the proper season.

Soil profile No. 2. Located 100 m. north-east at a point 17.2 km. of the Nakorn Patom-Ban Pong road (นครปฐม-บ้านโป่ง). The topography of

the surrounding vicinity, from which the sample was taken, is generally flat with only a few slightly elevated portions. The sample site was situated on a slightly elevated topography where the land was dry and fairly drained on the surface portion.

The surface soil is dark greyish brown, very fine loam to a depth of 30 cm., structureless and firm with a gradual transition of 8 centimeters. The subsoil which is also structureless, begins from a depth of 38 cm. down to 95 cm., a light brown to buff of fine sandy loam texture with slightly loose consistency. The texture below 1 m. is loamy sand, more or less buff in color with few glistening particles of quartz. At the time of sampling, this portion of the profile was wet, the ground water level was about 80 cm. deep.

The place of sampling, a slightly elevated portion, must have been a part of the old flood plain of the Kanchanaburi River in its earlier stage of development. At that time, there was actually no deep channel for a permanent and stable course of the river water. As a result, all the lower regions of Kanchanaburi are, until the present time, more or less alluvial in nature and the soils resulting from such formation are almost in all cases light in texture. This characteristic alluvial formation is very clearly shown in this profile. A large amount of materials carried down with the water and deposited on the whole flooded region is more or less uniform in depth, but as the flood water began to recede or reshaped its course, then the amount of water decreased in the regions around Ban Pong. In the later stage of the flood, the river water might probably have separated into small distributaries forming small channels all over the flooded region, as shown by the present land surface of Amphur Ban Pong (อำเภอบ้านโป่ง), which is composed of small ridges of uplands which are dry, and expanses of depressions which are poorly drained and sometimes swampy.

Soil profile No. 3. The sample was taken 250 m. north to northwest of the point 4.2 km. near the irrigation gate crossing the Ban Pong-Kanchanaburi (บ้านโป่ง-กาญจนบุรี) road. The topography is very gently sloping away from the bank of the river. Drainage is at most only fair.

The surface soil is light buff to light greyish buff very fine sandy loam to a fine loam. The whole surface soil is distinctly alluvial resting on an older residual formation at 53 cm. below the surface of the ground. The color is fairly uniform with a slightly loose consistency and devoid of any structural formation. The second layer is dark greyish brown, light clay

loam, which gradually grades into its substratum from 108 cm. to 114 centimeters. The substratum is a light greyish brown heavy loam with a slightly loose consistency and slightly mottled with brown coloration in the form of irregular spots.

How long the formation of the alluvial over-laid surface soil has taken place is unknown. Only one thing is certain, that the kind of alluvial material is uniform in color and texture in its whole range of surface soil section. It may be possible that this amount of material has been deposited in one single flood. That this assumption is apparently true is shown by the uniformity of the deposited material. When the alluvial material is assumed to have been laid in more than one flood occurrence, then, with the difference in velocity of the current, the amount and kind of materials would have been shown in the surface soil profile. But as actually shown in the sample, the materials in the whole surface soil are of a uniform character both in color and texture. It is therefore probable that the whole alluvial surface soil had been laid in one single flood. Subsequent floods must have occurred, but they never had any material effect upon the amount of alluvial deposit already formed.

The capacity of the surface soil for water is very low and most of the percolated water goes down at a comparatively rapid rate into the heavier residual subsoil. At the time of sampling, the upper portion of the subsoil was found to contain the most amount of water in the whole profile. The land represented by this sample possesses good fertility due probably to the recently formed alluvial material. Because of the light character of the surface soil, its cultivation is comparatively easy. Vegetables were found to grow well on this type, but in this region bananas have been the dominant crop raised by the farmers with good profit.

Soil profile No. 4. Located 50 m. east of a point 2.6 km. north of Ban Pong railway station (สถานีบ้านโป่ง) along the Ban Pong-Kanchanaburi road. The topography is flat and low with very poor drainage conditions.

The surface soil is a dark greyish brown, light loam with single-grained or massive structure, firm, and brittle in consistency to a depth of 14 centimeters. The subsoil is slightly granular, greyish brown with a few dark brown mottlings, down to a depth of about 1 m. below the surface of the ground. The substratum, which is loose and slightly granular, is light greyish brown, light clay loam. During most part of the year, this portion

of the profile is within the reach of the ground water table. At the time of sampling, water was generally high in all the low places especially in the rice fields. In this locality, the soil has been probably formed in place, as there has been a gradual development of the soil profile especially in color formation, that is, from a dark greyish brown, fairly drained surface soil to a light greyish brown subaqueous substratum.

This type of soil is low and flat and is subject to flood during times of extremely heavy rainfall. So that for optimum utilization, it can be cultivated only for some staple crops such as legumes, corn and some vegetables, which can be planted part of the year when there is not much excess moisture in the soil. Its extent is rather limited, situated mostly along the marginals of the lowland rice soils. Because of its proximity to these lowland rice fields, the soil is almost always moist throughout the year. But the light character of the surface soil eliminates the possibility of having too much moisture in the soil to be detrimental to cultivated staple crops.

Soil profile No. 5. Located 10 m. outside the middle portion of the south-western boundary of the Pepper Station of the Thai Department of Agriculture and Fisheries at Amphur Ta Mai, Changwad Chandhaburi (อำเภอท่าใหม่ จังหวัดจันทบุรี). The topography is very gently sloping with good drainage.

The surface soil is light brownish red heavy loam, slightly loose in consistency and with very fine granules. The surface soil grades very gradually into a brownish red clay loam subsoil which is very granular, ranging in size of granules of from 1 to 3 millimeters. The subsoil extends the whole range from 25 cm. down below the depth of sampling without any change in color, structure, and texture.

This sample represents the typical level or gently sloping, brownish red soils of Chandhaburi. The examination of the water wells in this same type revealed that the depth of the subsoil extends from 6 to 8 m. below the surface of the ground, gradually grading into a greyish brown slightly mottled and moist substratum, which is underlain by a gray, partly cemented well-weathered andesitic rock at a depth of 14 m. from the surface.

The red soils of Chandhaburi, which are equivalent to the "terra rosa" of the Mediterranean, have great capacity for water and are very deeply weathered. According to preliminary mechanical analysis, the amount of clay present is as high as 60 per cent. But although it contains a high per-

centage of clay, the soil is very easy to handle and cultivate. The granular structure is excellent and therefore allows water to penetrate down very readily. This character coupled with its very deep extent is quite detrimental to the conservation of plant food in the feeding zones of most cultivated plants, for, if percolation is great, then the rate of leaching of plant nutrients is also great. It is partly for this reason that the red soils of Chandhaburi, which are thoroughly weathered, are very poor in plant food. The farmers in this locality can only maintain and grow crops through a very liberal application of organic fertilizers as well as the use of burned soil to increase the fertility of the land.

Soil profile No. 6. Located in the north-eastern part of the village of Nong Kar (หนอง กา), Amphur Ta Mai, Changwad Chandhaburi, (อำเภอท่าใหม่ จังหวัดจันทบุรี). The topography is flat, and drainage fair.

The surface soil, which is dense, dark gray loam, extends to a depth of 20 cm. under natural condition with small trees as the vegetative cover. In cultivated grounds, the surface soil is light greyish brown or sometimes light brownish gray. The subsoil, which extends from a depth of 20 cm. down to 50 cm. below the surface of the ground, is light greyish brown sandy clay loam, very firm and compact. The change in color from the surface soil to the subsoil is very gradual; the subsoil, on account of its texture being the same as the substratum, might be called a transition into the more pronounced substratum, which is very slightly reddish brown sandy loam to gravelly loam extending beyond 1.25 metre. The substratum is more compact and denser than the subsoil.

The soil represented by this profile seems to have originated from a quartzitic sandstone rich in iron and seems to be the prevailing soil in the lowlands around the hills of brownish red soils. New excavations from wells of 6 m. deep indicated that the soil in the lower part of the profile was purplish brown, very fine sand.

In the Chandhaburi region, this type of soil is considered the poorest soil agriculturally. The reasons why the people of this locality have assumed it to be a poor soil are due probably to the fact that the soil, being very shallow and underlain by a compact sand subsoil, is difficult to cultivate. The insufficient amount of moisture is another factor which lowers its usefulness to agriculture. The insufficiency of moisture is due to the compactness and sandy nature of the substratum which prevents capillarity during the dry

season. And because of the compactness of the subsoil and subsoil and substratum, excess rain water stands on the surface of the soil which may be detrimental to crops when found at this state for an extended duration. When rain stops, standing water soon evaporates leaving the zones, in which plants may acquire water, dry. In other words, the peculiar characteristic of this soil lies in its compactness, sandy nature, and very small clay content.

SUMMARY AND CONCLUSION.

1. A new preparation of permanent soil profiles from wet soils with Thai adhesives was found very satisfactory. The method can be applied to dry soils with even more gratifying result.

2. Dried resin, resin oil, and lime which are used as a sticking mixture are easy to handle and to prepare. These materials are found abundantly in Thailand and are cheaper than any other adhesives or cements, and more effective in extremely wet soils.

3. Directions for preparing the sticking mixture and the excavation of the sample pit in poorly drained soils are given in detail.

4. The use of light wooden receptacles, resistant to moisture and decay as teak, for mounting soil profiles was found very convenient in the process of sampling, handling during transportation, and in the exhibits.

5. A description of some profile samples refers to samples obtained by this method from the poorly drained areas of Amphur Ban Pong, Changwad Kanchanaburi, and from the well drained soils of Amphur Ta Mai Changwad Chandhaburi.

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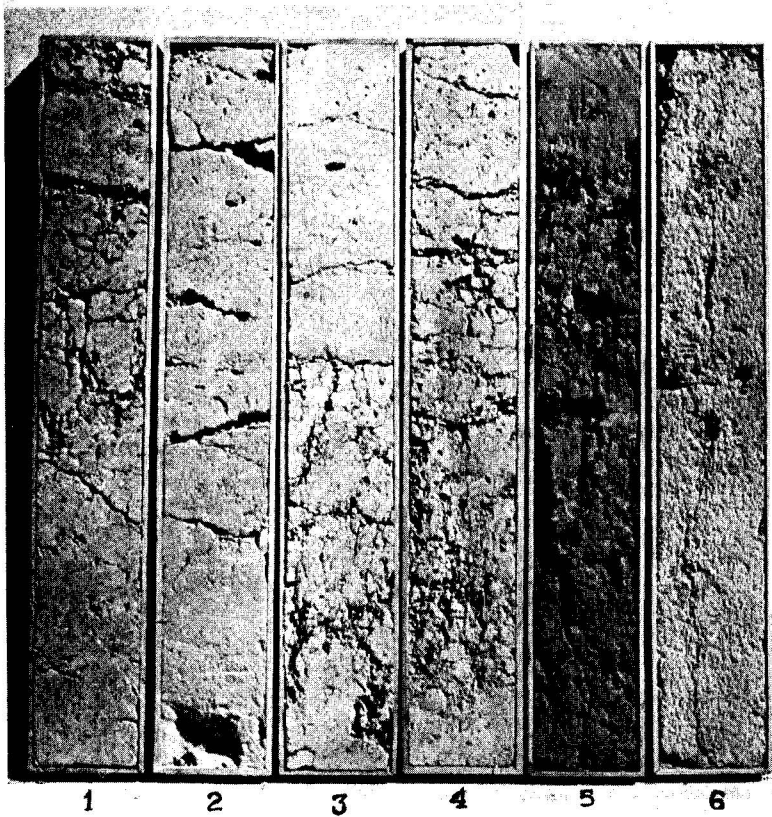


Fig. 2. Soil profiles in wooden boxes, 1.26 m. long, 20 cm. wide, 5 cm. deep, and showing natural cracks.

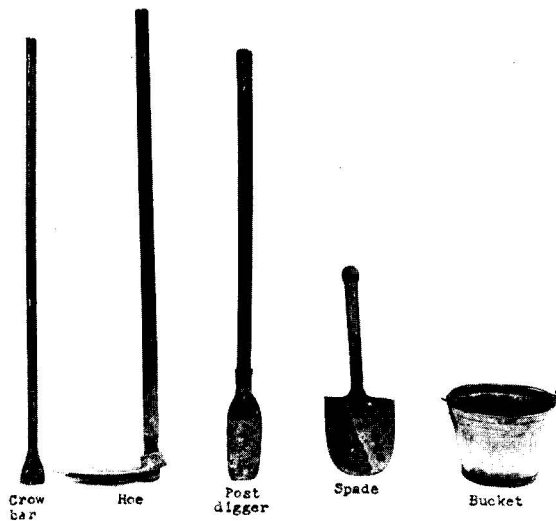


Fig. 3. Implements used in sampling.
(Photos by Industrial Chemistry Division, Dept. of Sci.).



D. Resin

D. Powdered resin

Fig. 4. Ingredients of the Sticking Mixture.
(Photo by Industrial Chemistry Division, Dept. of Sci.)

The Internal Mechanism of Life.

BY

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Until rather recently, in fact less than 200 years ago, it was considered sinful—at least in the Western World—to pry into the intricacy of life. We may recall here an old solemn warning: Do not tempt, mere man, the wrath of gods. Of special interest is also the conviction, expressed by Kant, possibly the greatest western philosopher and leading sage of his time (in the 18th century), that the limitations for study are drawn at the outer borderline of life and that the understanding of its mechanism would likely for ever be closed to the human mind.

But man would not be stayed, neither in dreams nor in action, in his attempts at least to understand,—if not to master—, life and its mechanism. With the realization and comprehension, that blood flows in most animated forms of life, the gate was opened for further inquiry into the nature and working of body organs and tissues.

PHYSICAL MEANS.

The greatest single contribution, permitting internal visibility of cell structures, is the application of X-rays to medicine. (I like to think back to a thrilling experience of my younger days, when my right hand, by a lucky coincidence, served the discoverer of the rays, Professor Roentgen, in one of his lectures to demonstrate the penetrating character of these rays to the student body). In spite of all attempts, however, the visibility of internal tissues remains but a contrast of shadows, which requires—in disease—the interpretation of the experienced specialist. The advantage of X-rays is greatest in locating bone fractures, foreign bodies, as pins in stomach or lung, and calculi such as kidney or gall stones in bladders or ducts. Its use is always limited by the danger of tissue destruction through over exposure, and by the high cost of the special equipment needed. With strong lights,

suitably mounted, some tissues, such as fingers, ears and especially also embryonal units, will disclose a certain amount of internal organisation such as capillaries and bloodflow, (as in the toe membranes of frogs). Especially photography with infra-red and ultra violet light has been a helpful tool in increasing the visibility of some internal living structures.

As a further aid in observing internal organs or tissues directly, a flexible spyglass, called "gastroscope" has recently been developed by Dr. Schindler,⁽¹⁾ Professor of gastroscopy at the University of Chicago. This new instrument is said to permit the close inspection of the inner stomach wall, to assure positive diagnosis of the most common stomach disease, gastritis, and to assist in the detection of certain lesions, as well as of cancer of the stomach (the latter held responsible for the death of annually 30,000 people in the United States of America alone. The gastroscope consists essentially of a special flexible, 2 1/2 feet long tube with a tiny electric bulb, inserted above a finger-like rubber tip; the tube is inserted through the anesthetized throat into the stomach, after its contents are siphoned out. A front lens, called eyelet, collects the images, reflected from the wall of the air-inflated stomach, and transmits the images by means of 48 additional lenses, set at short intervals in the tube, to an eye piece for study.

CHEMICAL MEANS.

Organs and tissues may be made visible by means, such as the one elaborated by Professor Spalteholz, University of Leipzig, who worked out the most successful procedure as follows: The animal, if alive, is chloroformed; the skin with hair is removed, unless a young embryo without hair development is used. The tissue is hardened in formaldehyde; if necessary, freed from the lime of the bones with dilute acid; then bleached with hydrogen peroxide; dehydrated with alcohol of increasing concentration; then placed in anhydrous benzol, and finally in a clearing mixture of wintergreen oil and benzylbenzoate. These liquids, with the refractive index of the animal tissues, permit permanent mounting of any animal tissue

and organ of so-called higher animals, as well as especially of whole embryos and of older animals of all stages of development. For quick temporary effects of clearing of animal and vegetable material anilin and phenolic acid have proven useful.

But, alas, by these chemical means,—as life is extinguished, only the location of organs, and the distribution, as well as certain structural differences, may be observed and demonstrated,—never the actual mechanism.

PHYSIOLOGICAL MEANS.

Plasma Motion.

Hoping to find a living unit in nature, suitable for the study and demonstration of the internal mechanism of life, I began a rather elaborate search, recorded in a survey on "Transparent Life," published almost 10 years ago ⁽²⁾. I found no ideal representative, thus far in plant life. Waterplants of simple internal structure permit visibility of certain functions such as eelgrass (*Valisneria*), showing protoplasmic movement best in the wide elongated internal cells of the leaf. *Elodea* shows this movement of plasma and of the chlorophyll-grains and the nuclei, carried along with the stream, most distinctly in the elongated cells of the midrib leaf area.

Blood Motion.

The streaming of blood may readily be observed in the web of frog legs and in the tails of many fish (e. g. gold fish), disclosing in favorable specimens even the corpuscles moving by.

Windows in Living Tissues.

Dr. and Mrs. Clark, anatomists of Philadelphia, Pa (U. S. A.) succeeded in making windows in rabbit ears for the observation, (—though restricted in scope—) of certain dynamic living reactions in living tissue ⁽³⁾. As a result of well over 1,000 experiments I finally succeeded in preparing windows in leaves of ornamental house plants. Thus the process of tissue regeneration was made visible.

DAPHNIA MAGNA, REMARKABLE TRANSPARENT ANIMAL.

In my search for a living animal creature, comparatively highly organized, and yet with a visible internal mechanism, I found very

few transparent forms, that might well be called freaks of nature. Among these the crustacean *Daphnia*, and among them the species *magna*, the largest known, stands out as a unique representative.⁽⁴⁾ Increased familiarity through breeding and study for a period of 15 years has strengthened my confidence in the usefulness of this organism as a reagent in following the internal mechanism of life.⁽⁵⁾ (See Plate I).

Breeding: *Daphnia magna*, with its body 3-4 millimeters long, and, with outstretched antennae or swimming arms, even approaching 1/2 centimeter in length, is a scavenger. It abounds in water, rich in organic matter and polluted with protozoa, algae and bacteria, serving it as food. It can be readily bred on the principle of a moderate but steady and suitable food-supply of organisms, living in a culture medium-like environment. A drop of blood or serum added daily to a quart of chlorine free-water, kept alkaline with marble, and inoculated with the desired flora of the above organisms or of another daphnia culture, will suffice 100-200 daphnia a day and permit their growth and reproduction. Equally soybean, cottonseed meal or dilute suspensions (0.1%) of manures will, under careful control, permit the propagation, always providing that 1. an excess of gases as chlorine, hydrogen sulphide and carbon dioxide is removed, that 2. oxygen is available and that 3. the reaction remains slightly alkaline, 4. the osmotic pressure of the medium is kept low, 5. other water animals such as hydra and worms are removed, should they occur in the water-supply, 6. that the strain used is adjusted to the temperature, selected for standardized cultures, and 7. that the daphnia are frequently (at least once a month) transferred into a freshly made culture medium.

By the process of parthenogenesis we can assure the availability, every 6-7 days, at the temperature of 30° av. prevailing here, of new young, reaching motherhood, and bearing from about 10 to over 50 (in the older animals) of young, followed within 2-3 days by another brood, until, after approximately 18 broods, life is terminated. *Daphnia* provides us thus with an unusual number of uniform experimental units of uniform age, sex, size, and vitality.^(6,7,8)

Organs and Functions: *Daphnia* possesses well developed muscular, nervous, and glandular systems, permitting the visualization of body functions, as the entire animal is transparent. Qualitative and quantitative reactions may be observed *in vivo*, as produced by the minutest amounts, by therapeutic, toxic, critical, and fatal doses of medicinal products. The physiological mechanism of their action may be studied, as well as the influence of temperature, oxygen pressure, light and other biophysical influences. The effect of such biochemical factors as food elements, minerals, vitamins, hormones, and enzymes, may be observed directly or shortly after introduction into the culture medium or the animal by injection. As apparatus have been developed and adapted to permit great magnification of the image of organs, a close and comprehensive, as well as a detailed view of the mechanism, many times enlarged, is readily available.

Records: With Micro-motion pictures we have recorded the normal, intricate life functions,⁽⁹⁾ as well as the striking effects to specific causes, to which all higher biological units, including man, are subject. Thus convulsion of the muscular organs as swimming arms in *daphnia*, accompanied by a progressive depression of the respiratory and circulatory systems, and the final paralysis of the gastro-intestinal tract may be observed as stages in the progressive debility resulting from strychnine poison.^(10,11) Certain death may be prevented by the administration of barbiturates, now also found effective in human cases of poisoning with strychnine.⁽¹²⁾

The usually filled food canal can be quickly evacuated, the speed of evacuation depending obviously upon the efficiency and concentration of evacuants⁽¹³⁾ as cascara⁽¹⁴⁾, aloes,⁽¹⁵⁾ rhubarb,^(16,17) podophyllum,⁽¹⁸⁾ bitter salts and phenolphthalein. The heart depression caused by substances as veratrum,⁽¹⁹⁾ yohimbine and chloroform, can be prevented or removed by administration of digitalis and^(21, 22, 23) and its preparations, and their efficiency judged by this non-toxic method.⁽²⁴⁾ The sexual system has been studied with the fertility vitamin E,⁽²⁵⁾ responsible for the reproduction, and with aphrodisiacs or local irritants such as cantharidin and others, exciting the male sex

organs, to a varying degree.⁽²⁰⁾ The nervous system has been studied with the use of anesthetics,⁽²⁶⁾ hypnotics, alkaloids, and narcotics as morphine and cannabis,⁽²⁷⁾ toxin and venins; the breathing system with nicotine etc.; the glandular system, other than the sexual, with adrenalin and others. A host of additional substances has been tested, qualitatively and quantitatively, e. g. glucosides like amygdalin,⁽²⁸⁾ enzymes,⁽²⁸⁾ adsorbents, disinfectants, stimulants and insecticides,⁽²⁹⁾ foods, like calocasia or puak, feeds and products of unknown physiological value.⁽³⁰⁾

Remarkable also are the results from actions of differential vital stains, of antagonists, and antidotes to poisons and narcotics, with the typical manifestation, in many instances corresponding to those in cold-and warm-blooded animals of the vertebrates.^(19, 30-35)

Observations made by other workers on *Daphnia* and its internal mechanism, as recorded in world literature, in general, agree with or confirm our findings. While an extended critical survey will be published subsequently, it may be of interest to point out here, that daphnids were probably first observed almost 400 years ago by the Dutch naturalist Jan Swammerdam (1637-80), who illustrated some of the internal organs in action.⁽³⁶⁾ The Russian physiologist Metschnikoff (1884) observed the injection of fungus species in the intestine of daphnia and based on this discovery his classical views of "phagocytosis" as the basis of disease resistance and long life,⁽³⁷⁾ The surgeon de Fouché recently concluded from preliminary experiments that human carcinoma can be transplanted into *Daphnia magna* and encourages their further use in the study of cancer.⁽³⁸⁾ Anderson used *Daphnia magna* in observing regeneration of body tissue and swimming organs.⁽³⁹⁻⁴⁰⁾ He and other American and Canadian biologists such as Banta, Ingle, Wood, and MacArthur and Baillie used *Daphnia magna* and related species in genetic studies and in observing the effect of food on growth, reproduction, vitality and longevity.⁽⁴²⁻⁴⁾ Most recently the zoologist Obreshkove found the eggs deposited in the brood sac self-sufficient in nutrients-and thus could raise the isolated embryos on tissue culture slides, and minutely study their growth to the fully developed animals.

OUTLOOK.

Our results have further been checked with the transparent prawn (*Palaemonetes*), also found by me in the local klongs of Bangkok, and certain translucent ⁴⁶, so-called scaleless fish with visible gall-bladder, heart and intestines (see Plate 2), such as *Carassius auratus* and *Carnegiella stregata*, or transparent fish like *Gobiella*, which we have thus far studied physiologically only in comparatively limited numbers. The fullest possible utilization of these, esp. also of the transparent fish for the observation and study of internal life reactions, will come with our success, now sought, of breeding them in sufficient numbers and in sufficient speed. With our stethographone, (a device recording the heart impulses and breathing rate of vertebrates, including man), we can now check many observations made on the simpler mechanism of transparent organisms as *Daphia magna*.^(19, 24, 46)

Viewing closely the transparent creatures of nature, we gain an inside look; crossing thus the outer borderline of life, we envision (without disturbing it) the intricate mechanism; this appears ever ready to respond to inner and outer influences, unto—and even beyond—the last beat of its heart.

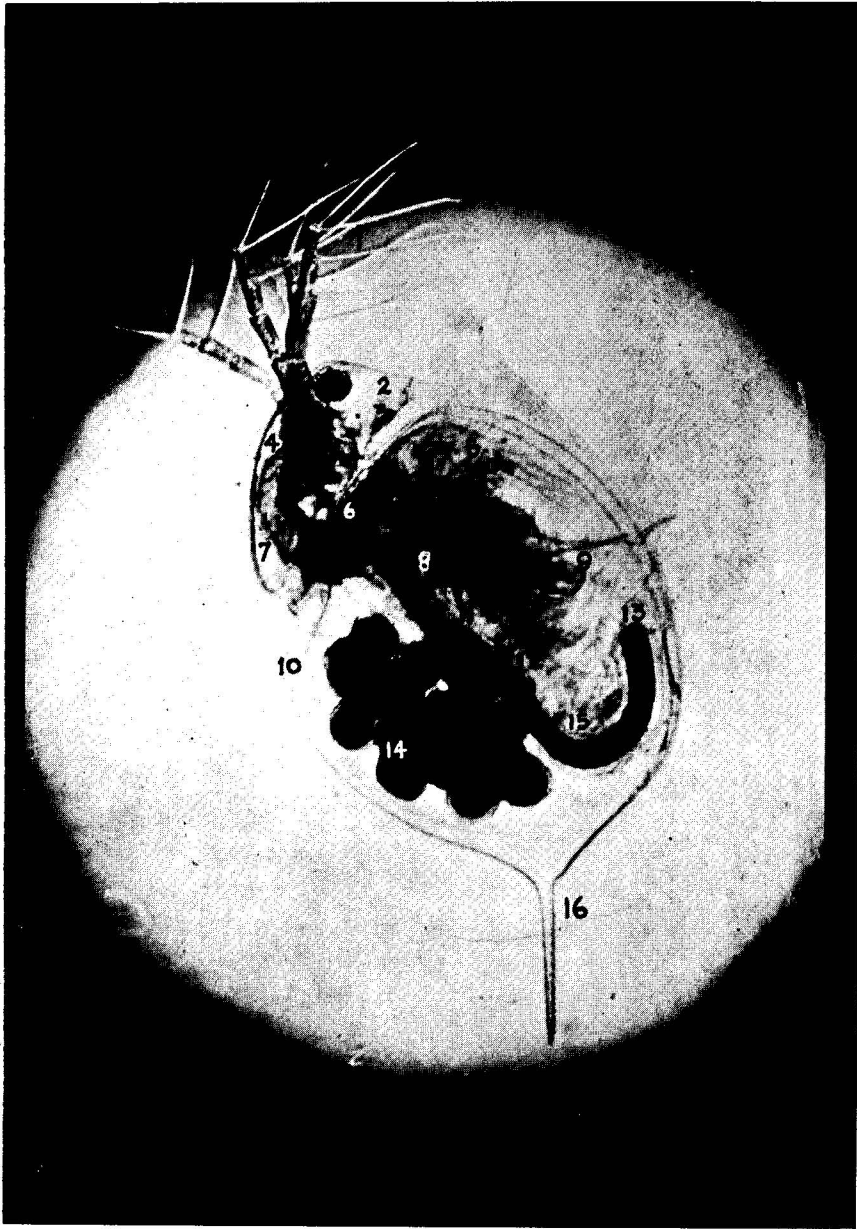
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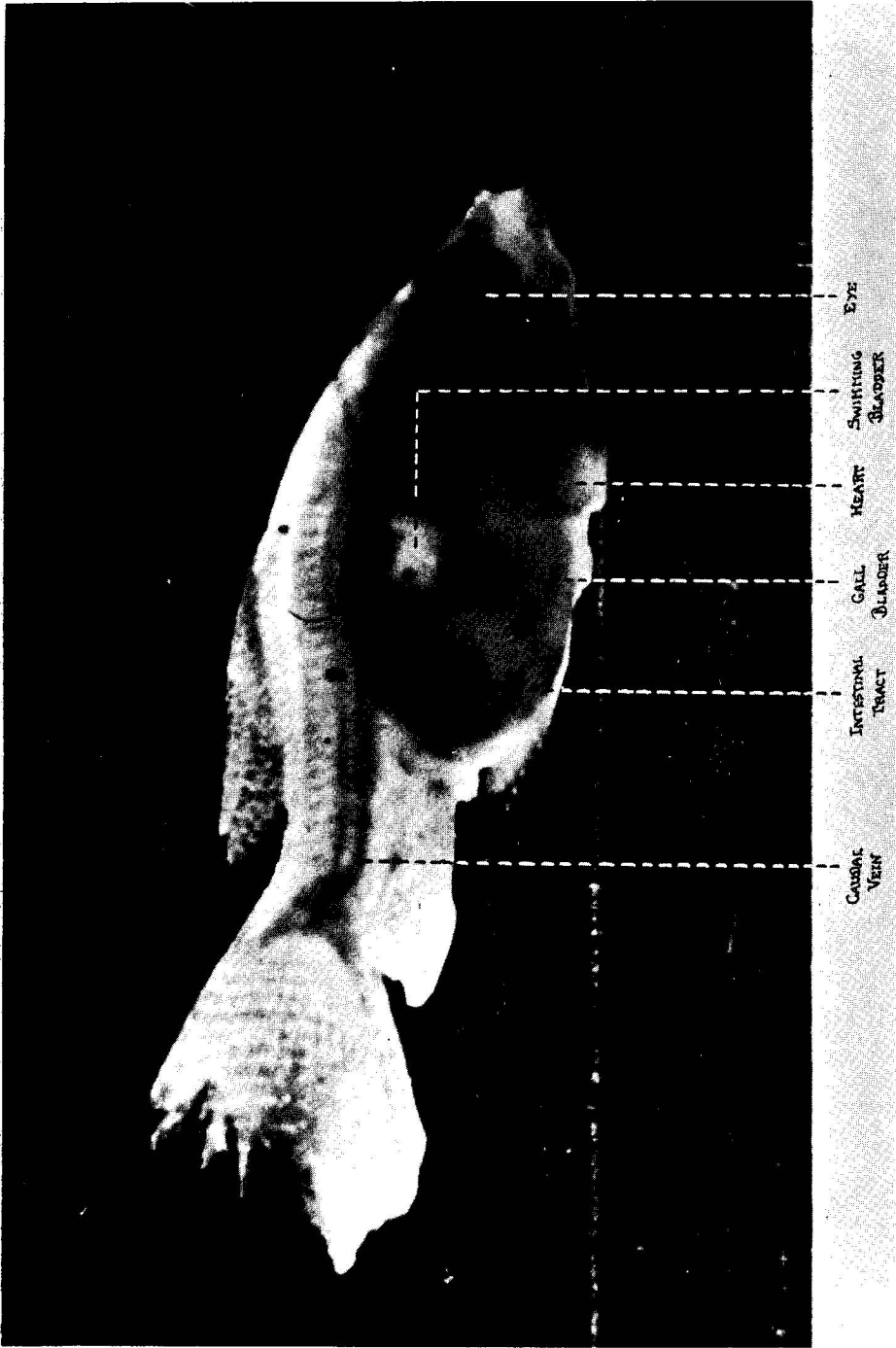
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Daphnia magna Strauss, (Crustaceae).

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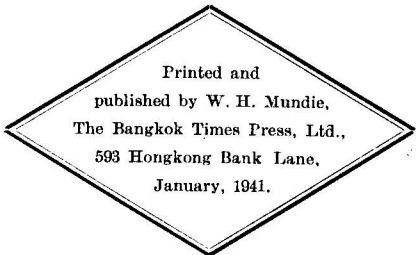
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