"The role played by insects in the destruction of the dead body, and its Medico Legal application."

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This subject has scarcely received any notice in the English language, but is of sufficient importance to merit a place in medical science, and in addition there is an absorbing interest attached to it. Amongst Continental writers, Mignin may be noted as the chief student of the fauna of the corpse. Brouardel, the noted French Medico Jurist has referred repeatedly to the work of Mignin, and has even gone so far as to state that if any misadventure befell Mignin it would be impossible to replace him, or to get anyone who was as well up in this subject.

For many centuries a common belief existed that if a dead body is left exposed to the open air numerous worms and maggots are spontaneously developed therein.

Shakespeare alludes to this in Hamlet, "For if the sun breeds maggots in a dead dog", and numerous writers of all ages have noted this.

Until recent years putrefaction was looked upon and described as being a spontaneous process.

The following definition is taken from Taylor's
"By putrefaction we are to understand those chemical changes which take place spontaneously in dead animal matter, during which offensive gases are evolved".

This "theory of spontaneity" was entirely refuted by Pasteur, who placed blood and urine in separate tubes hermetically sealed. After many months these had undergone no apparent change, and Pasteur arrived at the conclusion "that organic material derived from the healthy animal, and excluded from air, does not putrefy".

Virgil knew that worms came from flies, but he thought these flies were bees.

In Scripture (Judges XIV. 2. et seq) we have bees mentioned as invading the carcase of the lion slain by Samson.

Of recent years this has been the subject of much controversy, some asserting that they were bees, whilst others maintain that the invaders were flies. Bucton "Bees and Dead Bodies".

Virgil decorated his observation by asserting that "Bees born in the entrails of the lamb were more docile and industrious than those born in the entrails of the lion". It was left to Redi,
Entomologist of the Renaissance to first point out that the worms of dead bodies were nothing more or less than the larvae hatched from eggs deposited by flies, and that these larvae eventually became flies themselves. He proved that the worms are not developed spontaneously.

He experimented as follows:-

Taking a number of boxes he placed a portion of meat either raw or cooked in each, so that the odour might attract flies, and cause them to deposit their eggs in the flesh. He used not only the flesh of the domestic animals, but also the flesh of the rare animals which he obtained from the menageries of the Grand Duke of Tuscany. He also experimented with the flesh of birds, reptiles, and fishes.

He carefully noted the flies attracted by the various odours, he watched them deposit their eggs, and larvae hatch out and in their turn become flies.

He described four variations of these flies:

(1) Blue flies, - Musca Vomitoria.

(2) Black flies, with white markings - Sarcophaga Carnaria.

(3) Flies similar to house flies - Musca Domestic.

(4) Greenish Gold flies - Lucilia Caesar.
Redi after these experiments made a further series, which he varied by placing the meat in boxes as before, but he now covered the open tops by means of muslin fine enough in the mesh to prevent flies passing through, though they would still be attracted by the odor. He noted female flies trying to push their abdominal extremities through the meshes to deposit their eggs on the meat, but they were not successful in doing so, and no worms resulted.

Macquart observes "that flies seek a suitable place for their eggs in order to ensure their posterity".

We note a twofold purpose being served, the posterity of the fly, and the destruction of the corpse.

Redi thought that bodies which had been interred were not the prey of worms, but we shall see presently that both interred and immersed bodies nourish the larvae of flies, as well as those left to decompose in the open air.

Megnin was the first to notice that the various kinds of flies followed each other in definite order, that each prepares the way for his successor, and that the common belief that putrefaction is a series of fermentations is in a certain sense correct.

Each insect has a definite role to play, and a
definite work to accomplish. We shall see presently that this is dependent on the regular sequence of the bacteria of putrefaction, and that the role of insects occurs in regular manner until the words of the Scripture are fulfilled, and the complex organism is reduced to mere earth. "Dust thou art and to dust thou shalt return".

Redi's primary object in making his experiments was to refute the teaching of the clergy of his time, that man became the food of worms after death. He proved that earth worms were not carnivorous, and did not live on human flesh, but only extracted nutritive juices which had been formed. Interesting as the foregoing facts may be one naturally asks, how is the study of "maggots in a dead dog" going to further the interests of living man. It is chiefly in the medico-legal application of the study that the answer is to be found. If it can be shown that certain flies deposit their eggs at regular intervals, we are justified in assuming that if we discover the remains of larvae or flies corresponding to this stage, we can express in days, months, or years, the date at which the person died. In other words we can approximately arrive at the date of death.
Many factors have to be taken into consideration, such as temperature, season etc., but the probable date of demise, natural or otherwise, can be ascertained with a certain degree of accuracy, if not actual exactitude.

Before proceeding to review the various scavengers of death we must briefly consider the subject of putrefaction.

This process is concerned in the change of organic matter into that which is inorganic.

It is not a spontaneous process, but depends upon certain factors, amongst which may be noted —

A. Surrounding Media. — Earth, Water, Air.

(1) Earth. — Condition of soil, porous or otherwise, nature of the soil, ashes, clay etc.

(2) Water. — Salt or fresh, temperature of water.

(3) Air. — Temperature of air, season of year.

B. Tissue factors.

(1) Quantity of oxygen in tissues, rapidity of putrefaction is in direct proportion to the rapidity with which the intestinal gases circulate in the organism. In cases where murderers have dismembered their victims imme-
Immediately after the crime, the putrefaction has been very slow in the severed limbs, because there was no chance of intestinal gases circulating in them, but the trunk has undergone rapid putrefaction. Butchers without being able to furnish a scientific explanation, cut a carcass up as soon as possible, or at least remove the viscera, which amounts to the same thing. Experience has taught them that the meat goes bad very rapidly if this is not done.

We may also note that in stillborn children, and people dying from suffocation, the blood is charged with Carbonic acid gas, and putrefaction is slow.

(2) Diseases causing death – in cases where the tissues are weakened and devitalised by various diseases, putrefaction is rapid. In cases of poisoning by cadaveric alkaloids or ptomaines, putrefaction is rapid.

"In many cases putrefaction is associated with specific diseases of the intestines, more especially with Typhoid fever, Dysentry, and Tropical Diarrhoea!" (Allbut's System of Medicine. Vol 11. Page 792.)

It is possible therefore to have putrefaction begin in the intestines before death.

C. Internal Factors.

(1) Presence or absence of gas in the
abdominal cavity.

Here we must note the phenomena of Posthumous Parturition in women who have died pregnant; the mechanical action of the gases producing post-mortem delivery. The phenomena of posthumous circulation or bleeding from wounds made post-mortem is also due to the circulation of gas, and it is mechanical in its action. This condition may best be noticed in bodies that have been immersed in water during the summer months, and in this condition putrefaction is very rapid.

Grave diggers frequently hear terrifying sounds issuing from graves, and this is explained by the abdomen becoming distended with gases, which acting on tissues whose resistance is lowered by liquefaction, distends the abdominal walls until they burst.

Where bodies have been buried in ash-pits and privies, where there is little or no access of air, putrefaction is greatly retarded.

It may be noted here that putrefaction takes place chiefly through the alimentary canal.

The easiest method of studying putrefaction is by blood clot. Dr Bordas in his work on putrefaction remarks - "If one takes some blood clot in a glass globe into which the air can penetrate freely,
it quickly becomes clotted, and at the end of a few days, according to the temperature, the surface exposed to the air will assume a more or less green tint, while part of the clot will liquefy.

The liquification proceeds from the surface to the interior, and is accompanied by the formation of putrefactive gases. If one examines a drop of this liquid it will be found teeming with microorganisms.

After the lapse of several days the whole clot will be liquefied, and of a greenish black colour.

In the process of liquefaction we notice a sort of triple evolution.

(1) Aerobic micro-organisms appear, produce carbonic acid gas and disappear.

(2) Facultative micro-organisms appear which are at the same time aerobic and anaerobic. They form de-oxidised products such as carbonic acid gas and certain other gases such as Hydrogen, Sulphurated Hydrogen, and Hydrocarbons.


These organisms are what one is tempted to term "suicidal".
They bring about their own destruction by secreting substance in which they cannot live. The destruction of these organisms is hastened by various mucidinia, fungi and cryptogramic vegetation.

As our tissues contain oxygen it will be noted that the development of the first colony of microorganisms is thereby favoured, but in the case of persons suffocated we have the preservative phenomena of the carbonic acid impurity.

The gases produced by the first series are non-inflammable.

Those by the second are inflammable and the bullae of putrefaction may be pricked, and on applying a light the gas will easily burn.

Mortuary attendants know that in summer a sort of "Will of the Wisp" frequently runs over the bodies in his charge, and is explained by the formation of Phosphoretted Hydrogen. At a later stage in the putrefaction when the gas is in large bullae it is no longer inflammable.

From all this we see that there is first a fermentation accompanied by the production of gas, and later oxidation which leads to the return of organic matter to that which is inorganic. To summarise:

Whatever may be the mode of destruction there is
always a -

(1) Fermentation of the tissues.

(2) A production of gas.

(3) An oxidation more or less rapid according to method of destruction chosen, which lead to the return of the organism to the Mineral Kingdom.

Furthermore, the intervention of successive colonies of insects is absolutely necessary in order that the destruction shall be complete.

The nitrogenised matters tend to become fatty substances which in turn are evolved into binary compounds.

Let us examine the process from the moment of death.

At death the intestinal vibrios swarm invade the intestinal glands, destroy dead epithelium with which they come in contact, find their way into veins and peritoneum where they produce gas. They then secrete diastase or digestive ferment which liquefies the tissues.

During putrefaction cadaveric alkaloids or ptomaines are produced which are of two kinds, convulsive and narcotic.

These alkaloids may exist even before death as in cases of Ptomaine Poisoning. Melancholia has
also been ascribed to the absorption of these Toxic alkaloids. We see the various micro-organisms follow each other in definite order in the phenomena of putrefaction. The gas produced is perceived at a great distance by various insects and this brings us to the time when the work of destruction is taken up by the insects and flies.

Flies are endowed with a special and extremely delicate sense of smell, and are attracted by odours which are quite in appreciable to man.

At death, and in many instances before death, we have certain flies attracted by the body emanations. One has only to watch a case of say infantile Epidemic Diarrhoea to see the way the flies swarm round the body.

The flies endeavour to deposit their eggs, and after a time the larvae are hatched out.

Various flies succeed each other; each accomplishing a certain amount of work, and working in its own particular direction only.

By this means we are able to classify these flies, and we can estimate the period of dissolution arrived at by the stage reached in the destruction, and by the presence of various eggs or larvae or even flies as the case may be. We divide the periods
into four, for the purpose of description.

The first period lasts three or four months, the work is performed by flies belonging to the Diptera namely:

- Curtonevra Stabulans.
- Calliphora Vomitoria.
- Lucilia Caesar.
- Sarcophiga Carnaria.

The second period also lasts three or four months and contains:

- Coleoptera.
- Dermestes Carynetes.
- Lepidoptera.
- Aglossae.

The third period lasts four to eight months and contains:

- Diptera.
- Phora and Antonia.
- Coleoptera.
- Silpha, Hister, Saprinius.

The last period occupies six to twelve months and contains the Acaria.

- Thyrogllyphus.
- Uropoda.
- Anthrena.
Thus we can construct a cycle showing the duration of each period, and the entomological orders to which the works of that period belong.

During the first period the coffins may be literally crammed with the larvae of the various diptera. The soft parts during the third period are transformed into a black deliquium. The acaria in the fourth and last period exist as parasites, and eat whatever the others have left. During this last period the body undergoes a mummification which may last a variable time. The seasons exercise a definite influence on the production of these various insects.

We will now briefly examine the natural history of these flies in the order of their appearance, after which we will continue with those insects which are attracted by the butyric fermentation which takes place in the fat of the corpses. Then following up the insects which are attracted by caseous fermentation, we finally finish with a description of the insects and mites which are attracted by the final remains of the human corpse, and which devour the remains of the dried tissues still adhering to the bones, such as ligaments, tendons, aponeurosis; in fact the "mummified teguments". The flies which we
will now mention are not found simultaneously on the same body, but vary according to the locality, country, season etc., nevertheless they are always characteristic of one and the same period.

One often finds insects of two or three different zoological classes working together, especially towards the end of the decomposition of the corpse.

First Series. — Flies which belong exclusively to the order Diptera, and which work until the formation of fatty acids. Diptera or double winged flies were so named by Aristotle. They have six legs, five jointed tarsii, a proboscis, two palpii, two antennae, three ocellii, and two halteres or poisers.

Genus Musca according to Linnaeus contained everything that could be called a fly.

These flies are grey in colour, and resemble the house fly. They are essentially parasites and alight on men and beasts to suck the fluid substances excreted by the body such as sweat, and especially that of the sick or dying, the borders of wounds which are in any way exposed. These flies lay microscopic eggs which are oblong and open by the detachment of a longitudinal band which lifts up like the blade of a knife. The larvae develops rapidly, and in the summer attains its full size in eight days.
The larvae is white, in the form of an elongated cone, a little swollen in the middle with an oblique trunk at the back. The mouth is armed with two horned hooks and the head has two fleshy antennae.

The pupa into which the larvae is transformed is cylindrical, with two tough rounded extremities, brownish red and five to six m/m in length.

At the end of eight to fifteen days the perfect insect appears from the pupa.

The Musca Domestica may be described as being the most common. Length six to seven m/m speckled, surface black, sides yellow, front yellow with a black band, antennae black, thorax grey with black lines, abdomen marked with black above, pale underneath, with yellowish sides in the male, feet black, wings transparent with yellowish base.

Genus Curtonevra. - Comprises flies which have the same appearance as those just described, and which may easily be confounded with them.

They are only to be distinguished by the various characteristics:

The larvae and pupa of the curtonevra are not to be distinguished from those of the preceding genus.

Curtonevra stabulans. - Length eight to nine m/m, speckled, iron like feelers, surface and sides silver;
frontal band and antennae black. This fly has rural habits and is found in stables, pastures, and in the neighbourhood of domestic animals. It has been found in the mummified bodies of children who were murdered in the country.

Genus Calliphora. - Comprises large fat flies generally blue in colour, of which the blue meat fly is the type.

Calliphora Vomitoria. - Surface bordered with hairs, and they possess a feathery style. These flies look for fresh meat, and for corpses of recent date in order to deposit their eggs.

These flies of the first series are those which attack fresh corpses, and one finds an abundance of empty pupa in coffins of corpses that have been buried during the summer. These pupa are cylindrical brown in colour, and easily distinguished from all other pupa, which are yellowish and prismatic, and which belong to a fly appertaining to the third series, and which is found in myriads in corpses buried during the winter.

Second Series. - As soon as the odour of death becomes perceptible, a group of flies arrive of a beautiful metallic green. In size they are between an ordinary fly and a blow fly. Other flies also
arrive, larger than the former ones, of a greyish black colour, striped, speckled, and less attractive than the others.

The former belong to the Genus Lucilia, the latter to the Genus Sarcophaga.

The genus Lucilia contains about thirty varieties all having the same characteristics, and are attracted by bodies in which putrefaction has commenced in order to lay their eggs.

The eggs arrive at maturity in from fifteen to twenty days, after which the larvae seek refuge underground, and become transformed into nymphs, enclosed in a tough cylindrical cocoon with rounded ends, from which the perfect insect emerges at the end of fifteen or twenty days, according to the temperature.

The Lucilia Caesar is the most familiar fly contained in this genus. With the exception of details as to colour and size all the other kinds resemble it. Length seven to nine mm, brilliant golden green colour with metallic lustre. Feelers iron grey in colour. Surface and sides white with blackish markings. Antennae brown. Feet black.

Genus Sarcophaga. - Contains large flies with a long body, and is distinguished by the eggs being
hatched within the body of the mother and produced in the larval state.

This phenomena was observed and described by Reaumur. The matrix contains as many as twenty thousand young larvae each contained in an envelope of its own.

These larvae are successively deposited in corpses in a state of putrefaction. The perfect insect appears at the end of fifteen days, and almost at once commences his work of reproduction, so that in a warm season at least three generations of these flies succeed each other in the corpse. This genus contains about twenty five varieties, those most frequently found being the S. Carnaria, S. Arvensis and S. Laticrus.

The decomposition of corpses in the open air in our temperate regions where the atmosphere is almost more or less moist, probably represents the medium between that which takes place in corpses buried in cemeteries, and the rapid mummification which takes place in the deserts of tropical countries, or under the influence of cold dry winds such as are prevalent in Northern India. There arrives a time when the above described have finished their work. This is from three to six months after death.
A third Series of Insects.—with epicurian
tastes makes it appearance. These live in fatty
substances which have been subjected to acid ferme-
tation.

These are the Coleoptera of the genus Dermestes
and Lepidoptera of the genus Aglossa.

Dermestes or beetles are well known for the
havoc they cause to provisions, salted meats, and
fur skins.

Both the larvae and the perfect insect are car-

nivorous, and abound in badly kept pork shops.
During the first three months they gorge, and if
there is not sufficient food they devour each other.
The perfect insect takes about one month to develop.
Three kinds of Dermestes are of interest to us and
are found in corpses exposed to the air where the
fatty material has become rancid, which means it has
been subject to Butyric fermentation. These are the
D. Lardarius, D. Frichii, and D. Undulatus.

Aglossa are small butterflies neighbours to
the moth, which at night fly about lamps, and by day
repose under leaves.

These are interesting from the fact that their
respiratory organs are so arranged as to actually
permit them to live in fatty material in a state
of butyric fermentation.

This genus comprises the A. Pinguinalis or fatty aglossae and the A. Cuprealis or copper aglossae.

Both are found as larvae upon corpses in the state of mummification, but at different periods.

The first are found in company with the Dermestes and like them consume rancid fats. The second attack the membranes or dried cutaneous tissues in company with the Attagena of fur skins found in Natural History specimens.

The Aglossa pinguinalis is found during the month of July in kitchens and dull dirty places, where they lay their eggs, which take about a month to develop into larvae. They are then transformed into a Chrysalis from which the perfect moth emerges at the end of twenty days, providing the season be favourable.

It may pass the winter in the Chrysalis state should the season be cold, and eggs laid at the end of the season are not hatched out until the first warm days of spring.

The caseous fermentation follows the butyric and attracts insects similar to those found in cheese in this stage. The fly which gives mites to cheese is known as the Pyophila casei. The pyophila
petasiones is an analogous fly. In the recorded case of a hermit who died from the rupture of an Aneurism while sitting in his chair, and whose body was discovered ten months later: the larvae of this fly escaped in myriads and was easily recognised by its characteristic method of locomotion.

The fourth series of insects:— Consist of the pyophila petasiones and three varieties of the genus Corynastes.

Some of the larvae belonging to this group have been found in the living body, having been vomited or evacuated as the result of medicine taken, and in one instance it was found in the pus which escaped from an abscess of the jaws.

A possible conjecture as to their presence is that they were introduced into the system by means of meat which contained the eggs.

The butyric and caseous fermentations are followed by a compound ammoniacal liquefaction of animal matter which produces emanations which attract insects belonging to the Diptera and Coleoptera which bring us to the,

Fifth series. — These Diptera are small insignificant flies with definite Entomological characteristics. They belong to the genii Tyreophora, Lonchea,
Ophyra and Phora.

The species likely to be met with on the human corpse are the:-

Genus Tyraophora.
   T. Cynophila.
   T. Furcata.
   T. Anthropophaga.

Genus Lonchea.
   L. Nigrimana.

Genus Ophyra.
   O. Cadaverina.

Genus Phora.
   P. Aterrima.

The Coleoptera or beetles of the fifth series belong to the family of Sylphides and to the genii Ucraphora, Silpha, Mister, and Saprinus.

The family of Sylphides render great service in demolishing the corpses of moles, mice, rabbits and other small animals, whose bodies otherwise might be a source of infection.

The first insects deposit their eggs in the decomposing corpse, thus making sure of food for their progeny and the further destruction of the body.

These insects in their teeming millions devour
the corpses of dogs, sheep etc., and the Silpha littoralis attacks the carcases of horses and cattle upon which they are to be found in large numbers.

We must always bear in mind the prodigious rate at which flies multiply. "Given a temperature sufficiently high their numbers are only limited by the amount of food available for them". G.V. Poore. "Flies and the Science of Scavenging". Lancet, May 1901. Linnaeus asserted that three meat flies, by reason of their rapid multiplication would consume a dead horse quicker than would a lion.

The genus Silpha - S. Littoralis and S. Obscura.

Genus Hister.

H. Cadaverina.

Genus Saprinus.

S. Rotundalis.

Sixth Series. - The insects in this series succeed in absorbing all the humours of the corpse, the result being a complete dessication or mummification of the organic parts which have resisted the various fermentations.

The insects of this series are all Acaria, working at all ages, and especially when the female is ovipositing. The action of certain Acaria is such that should circumstances cause them to arrive on the
body at the same time as insects of the first series; those that work in the body cavities penetrate below the skin into the muscles, multiplying indefinitely, absorbing the liquids and organic tissues and reducing the corpse to a mummified condition without its having passed through the butyric, caseous, and ammoniacal fermentations, and preserving it in a condition better than that of an Egyptian mummy. The teguements have the consistence and sound of parchment, and are of an orange brown colour.

These Acaria belong to the family of Gamasides and the Genus Urapoda.

Seventh series. — We have now reached the stage where the corpse or certain of its members, teguements and membranes are entirely mummified, and no longer give access to the microbes of fermentation. The membranes are parchment like, the ligaments and tendons have been transformed into hardened resinous material, and there remains the hair which these insects devour.

After digesting this material they deposit their excrement which constitutes the powder found in the depression of the bones, in the place of the dried up tissues which were there before, and which have now disappeared under the action of their mandibles.
The workers of this series are akin to those which devour woollen materials, carpets, furs, and Natural History specimens.

There are certain Coleoptera analogous to Dermestes and named Attagenes and Anthrenes.

Micro lepidoptera of the genii Aglossa and Tineola.

Genus Tineola.

T. Biselliela.

Genus Attagene.

A. Pellio.

Genus Anthrenus.

A. Museorum.

Eighth and Last Series:— Contain only two kinds of insects which appear after the others and consume whatever they have left.

If they disappeared without leaving any trace it would be difficult to arrive at the date of death, but one could be certain that it had taken place at least two years previously, because one would find the remains of the insects of the seventh series completing their work which was prepared by their predecessors.

Genus Tenebrio.

T. obscuris.
Genus Ptinus.

P. Brunnus.

Having reviewed the insects which devour the body which is exposed to the air, we will now turn our attention to those which attack corpses that have been buried.

It is not possible to do more than mention the names of the various workers, and give a few particulars as to their habits and mode of life. To study each insect in detail and enumerate all their various points would mean filling a very large volume, and is not within the scope of the present Thesis. These insects can be minutely studied in the various Entomological works on the subject of Diptera, Coleoptera, etc, etc. As we have seen, the larvae of the Diptera, Coleoptera, Lepidoptera and Acaria are not vermiform, and further, they are almost invisible to the naked eye. We have seen that the deposition of eggs by these insects on dead bodies is not simultaneous; that each in its turn makes use of a certain stage of decomposition, and that the time varies from a few minutes to two or three years after death; but it is so constant with each kind, and their succession is so regular, that by the examination of the remains they have left, in much the same way that one studies
geological strata, one can appreciate the age of the corpse. In other words, one can indicate exactly the period of death, and this is a very important factor in legal medicine.

Corpses that are buried under ordinary conditions are devoured by worms in exactly the way that those are, which are abandoned in the open air; only there are fewer kinds.

In corpses that have been exhumed after certain known epochs, it is possible to make an ample collection of larvae, cocoons, nymphs, and even of adult members of various kinds of insects.

If the number of larvae which devour inhumed bodies is very great, on the other hand the variety is very limited, and in addition there are several kinds special to vaults, tombs and graves.

Four kinds of Diptera are recognised: the Coleoptera, Vomitoria, Curtonevra, Stabulans, Phora, Attermia and an Anthomyiside of the Genus Ophira.

Two kinds of Coleoptera, the Rhizophagus parallelocolis and the Philontus ebenus; two Thysanoureus, the Anchoratus armatus and the Templetonia nitida. The larvae of the Diptera and Coleoptera play a very active part in the destruction of bodies that are buried, but only appear in succession.
of the Phora are found in millions on corpses that have been buried for about two years.

How do these various insects reach the body? The dampness and weight of the earth speedily causes a seaming of the planks of which the coffin is composed. The eggs of the Diptera are deposited in the natural apertures, eyes, mouth, and nostrils, before burial, and are developed later on in the coffin. One knows how common these flies are in hospital wards and sick rooms during the summer. With regard to the Phora and Rhizophagus the larvae comes from eggs laid on the surface of the soil by these insects, which are attracted by the particular emanations from the corpse, which are perceptible to their delicate olfactory sense. The larvae hatched from these eggs crawl through the intervening layer of earth, perhaps using the small holes used by earth worms, and guided by their olfactory instinct, they finally arrive at the body.

A curious characteristic is revealed by Entomologists namely that the phora select thin corpses, while the Rhizophaga is only to be found on fat corpses; the larvae of the latter in fact only lives on the fat of dead bodies, and is found in fat which has trickled to the bottom of coffins as a result of
butyric fermentation.

The *Rhizophagus parallelocolis* is found exclusively in the grass of cemeteries, being there to deposit its eggs or perhaps having accomplished its subterranean voyage after its metamorphosis, and having come to the surface to pair.

There now remains to describe these insects which attack the bodies of the drowned.

The crustaceans which attach themselves to drowned corpses can be employed in determining approximately the epoch of death.

The clothing of persons who have been drowned, or of bodies immersed in water is found full of shells more or less firmly embedded.

There are the crustaceae cirrhipedes, which fix themselves to objects floating on the surface of the water during the months of April and May.

If these shells are of different dimensions one is able to conclude that they belong to successive generations.

This now brings us to the application of the Natural History of the cadaver to the question of legal medicine.

The phenomena of the decomposition of corpses according to whether they are exposed to the open
air or are buried, presents many differences, the role of the insects being much less marked in the case of buried bodies.

Therefore to keep a clear picture before us it is necessary to consider it under separate headings.

**Corpses in the open air.** If the temperature, humidity of the atmosphere, and succession of the seasons, were unvarying, and of absolutely perfect regularity, the law of invasion of the various insects concerned in the destruction of the body could be applied with mathematical accuracy; in so far at any rate as in bodies presenting the same weight. It has been proved that in the bodies of children, the post-mortem entomological invasions follow each other more rapidly than in the case with adult bodies. One must take into consideration not only the size of the corpse, but the various causes influencing putrefaction, because this influences the invasion of the various series of workers. The question is always the determination of the time of death in corpses in a more or less advanced stage of decomposition; or of mummification by means of insects, which have left traces of their sojourn.

We will now look at a specific instance of a
corpse exposed to the air; chronicle the various entomological specimens discovered; and see what deduction can be made.

Case R. — The body of a boy discovered in a packing case. The body was dried and mummified. Trunk clothed in a woollen vest, the rest of the body wrapped in the remains of an old skirt, and part of an old waterproof. The garments were saturated with a dry gelatinous liquid, and when removed were found filled with an innumerable quantity of the cocoon or chrysalis of Diptera. Every fold was full of them, and they were arranged side by side like the cells in a piece of honeycomb, to the number of many millions. The great majority of the cocoons were empty, thus proving that the perfected insect had come forth; but a few were still tenanted by nymphs, and by perfect insects which had died at the moment of escape; and one was thus able to determine the family to which they belonged. The largest of these cocoons had been left by the Sarcophaga Latitcrus, while the smallest had been tenanted by the Lucilia Cadaverina. We shall presently see what one is able to learn from the presence of these Diptera.

Deprived of its coverings the skin is seen adhering to the bones, the muscular substance having
been destroyed. The skin is to a great extent destroyed and pierced by a number of colander like holes filled with a yellowish powder.

The bones where bare are covered with this same powder, which is demonstrated by the microscope to be entirely composed of the remains of Acaria of the family Tyrogliphus longior and of their excrements. The viscera have entirely gone, and are replaced by a blackish granular material with a penetrating odour.

The interior of the skull is full of blackened material in the form of coarse powder with a mica like appearance produced by crystals of Cholesterine and other fatty acids. In this material are found insects of two different types, presenting the familiar characteristics of the larvae of the Dermestes and Anthrena.

The Dermestes Lardarius and Anthrenus Museorum were found in the adult state, and these had been responsible for the perforations in the skin described above. A portion of the hairy scalp still remains adherent to the calvarium and contains enormous lice and their eggs. Each hair was a veritable nest of nits, and adult specimens of the Pediculi Capitio were well developed. The death of these lice, followed in a few days that of their host, for one knows that these parasites only breed on the living subject.
A curious fact may here be noted with regard to lice. Practitioners in the slums who have been invited to view the bodies of dead patients a day or two after death, are often disgusted to see the features covered with crawling lice, when the sheet covering the dead has been drawn down; for the purpose of exposing the face to the Doctor's view.

What deduction can be drawn as to the length of time which must have elapsed since the death of the corpse: from the presence of the different entomological specimens enumerated above. We have seen that a body is first invaded by Diptera, whose larvae absorb the liquid parts. Then the Dermestes and their larvae appear and destroy the rancid fatty material, and finally the Anthrenae and Acaria arrive, and devour or almost devour the dry parts.

In the present case the body had not been altogether in the open air, but enclosed in a packing case, whose badly jointed boards left cracks, which were however, small enough to prevent large flies such as Genii Calliphora, Sarcophaga, and even Lucilia, from gaining entrance. Only two small Diptera, the Sarcophaga laticrus and the Lucilia cadaverina succeeded in reaching the body, and to their imnumerable larvae, the product of several generations
was the work of destruction due. To them belonged
the numerous envelopes of their nymphs which were
found in the body coverings. The larvae of these
Diptera develops very rapidly, less than a month
being sufficient for their arrival at the nymph
stage, and they require about the same time to
reach the perfect state. One generation has there-
fore from six weeks to two months of existence, and
those which follow increase geometrically in propor-
tion, and explain the innumerable quantity of remains
left behind during several months, as these insects
are only active during warm weather. Their meta-
morphosis is arrested with the arrival of cold.

In the garments enveloping the corpse the pupa
of the flies were all empty, with the exception of
the few examples of dead nymphs whose development
had certainly been arrested by cold.

The conclusion to be drawn from this, that the
carvivorous flies had been at work during all the
fine weather, and their work was almost terminated
by the time winter arrived, during which time the
insects are at rest. With the return of Spring, the
corpse, relieved of its watery acids, was invaded by
the Dermestes lardarius, whose deposits were pretty
considerable.
Entomologists know that these Dermestes remain in the larval state for four months before being transformed into perfect insects, therefore the absorption of the fat of the corpse had taken place at about four or five months.

Then came Anthrenae and Acaria of the Genus Tyroglyphus. The powder covering the various parts of the corpse is entirely composed of deposits from the succeeding moths of these Acaria, and of their corpses; of their hypopial larvae and their deposits. Some months are necessary for the perfection of these numerous generations of Acaria, although they reach maturity, and are capable of reproduction at the end of about fifteen days.

Therefore the Dermestes have been at work during an entire season, the Anthrenae and the Acaria.

Two successive summers must therefore have passed since the death, in fact two years until the discovery of the body.

The presence of the lice does not assist in any way in determining the date of the decease, but it proves that the unfortunate victim was not the recipient of elementary care during the last weeks of his life, and had been completely neglected.

Case F. - The corpse of a newborn child in a
mummified condition. The skin shows the impression of the linen in which the body was clothed, and which was saturated with a gelatinous liquid like that noted in the first case. In the folds of the clothing were cocoons of nymphs of the Sarcophaga flies, a greater number of cocoons of nymphs of the small Diptera, the Phora Atterima. On the neck of the corpse was a jagged aperture surrounded by colander like holes, communicating with the interior of the body, and emitting a strong odour. These holes were made by Sarcophaga larvae, and in this neighbourhood was found a cocoon of the nymph of the large Calliphora Vomitoria; and myriads of cocoons of the Phora Atterima. The surface of the body revealed the presence of many Acaria, which had not as yet established colonies, as their were neither traces of their deposits nor bodies to form the yellowish powder mentioned in the first case. Persistent search failed to reveal traces of either insects or deposits of Dermestes or Anthrenae.

From the above points we make the following deductions:—

The extreme rarity of Diptera of the Sarcophag-
deposits, proves that the period of death dates back to a season when these insects were rare; as at the beginning or end of winter. The abundance of Phora who only invade decomposing matter when it is half dried, indicates that the fine weather arrived during which they breed. The dessication of the body was sufficiently far advanced and remained under the influence of these Diptera during the rest of the season. Finally the rarity of Acaria, the absence of Dermestes and Anthrenae, who are especially the last workers of the second year, prove that this period had not yet arrived. Consequently the conclusion one arrives at is that the child's death took place about a year previously, and before the Spring. The mother of the child, a servant girl who had concealed the birth, confessed subsequently that the child was born and died in the month of February.

Case P. - The remains of a dead child found in a cellar. What appeared to be the larvae of insects adhered to the cardboard of the box in which the body had been placed, but on microscopic examination this was demonstrated to be sawdust of white wood. There were no remains of chrysalis, larvae, or deposit of any kind of insects or Acaria. This ab-
earth proved that the foetus had come from a
country where spring had already arrived. Subsequent
enquiries proved that the foetus had been sent from
the Riviera to a person in London who had been in-
structed to deposit it in a Station Cloak-room.

Case Z.Y. - The remains of a young woman found
in a dried and completely mummified condition in a
cellar. The body was enveloped in a cotton chemise,
in the glutinous folds of which were the remains of
an incalculable number of insects. On the corpse
itself were also found the same insect remains, but
in a much smaller number.

There were numerous pupa of Diptera, which were
all empty, so it was impossible to determine their
kind, but which belonged to the Genii Phora, Antho-
myia and perhaps Tachina. Numerous chenilles of
the Aglossa pinguinalis all empty. Numerous deposits
of Coleoptera of the Genus Anthrenus. Some remains
of the Ptinus Brunus. Moulds and mites of micro-
scopical Acaria mixed with the dust of the bones and
mummified parts. Now what can we deduce from the
above. There was nothing living and not a single
chrysalis was encountered, which goes to prove that
death had not been recent, and dates back to a more
or less distant period. Can we calculate this period?
sence of all signs of insects may from a medico-legal point of view be as important as their presence, if due attention be given to the season during which the body is discovered.

If it is noticed that during the cold season all insects disappear, then death cannot be dated back beyond the commencement of that season, and in fact it took place at about the time the first cold weather appeared.

**Case X.** — The examination of a foetus found in a railway cloak-room in winter.

This was in a fresh state and not very much decomposed owing to the cold weather.

It was packed in a litter, and a number of cylindro-conical white larvae were crawling in this, were recognised as the larvae of the Musca Domestica, which habitually develops in stable litter. This development only takes place if the temperature be favourable, and in the month of February the temperature was so low that not a single fly had appeared. Moreover, one knows that the first flies to appear in Spring are the fecundated females which have passed the winter asleep in holes in walls, and these by ovipositing, produce the first generation of flies of the year. The presence of larvae in the
The insects to arrive last were the Anthrenae, whose larvae consumes dried insects. If these larvae had lived in the course of the summer of 1903 we should have found not empty skins, but skins containing nymphs who would develop into perfect insects during the spring; therefore at latest these insects did not live after 1902, if not earlier than that.

These insects have completely demolished the remains of all Diptera and Aglossae, which makes it difficult to determine exactly the development of the Diptera.

We have however, very precise information regarding the Ptinus Brunnnus.

Mr Buckler in the Monthly Entomological Magazine of February 1884 says:— "This butterfly whose chenille eats leather, or meat which has become mummified or parchment like, is hatched in July, and lays its eggs in August. The chenilles pass the winter and become chrysalis in the Spring".

This would take us back to 1901. Therefore as this butterfly lays its eggs in flesh which has become mummified, the time necessary for the corpse to reach this condition must be taken into consideration. This would bring us back to 1900 at the
earliest. This opinion would be confirmed by the
dead Ptinus, for they too are devourers of mummified
flesh, and the remains of insects, and do not attack
a corpse until it is dessicated. Entomology is
therefore able to show us that we must go back at
least four years to fix the time of the death of this
body. This same science determines the season for us.

Flies do not fly in winter, therefore it was
during the fine weather that the woman perished,
and one may conjecture that for some days immediately
after death it had been exposed to the air outside,
for the species of Diptera of which the pupae were
found; the Phora, Anthomyia and Tachina, do not live
inside houses, so exposure to the outside air and
sun must have taken place before the body was secret-
ly removed to the place where it was discovered.

The remains of the Acaria found do not furnish
any particular facts.

From the above we summarize:—

(1) It is certainly four years since the death
of this woman.

(2) It happened during the warm season, either
summer or at earliest towards the month of May.

(3) Before being deposited in the cellar where
it was discovered, the corpse must have been exposed
to external atmospheric influences.

Having considered the insects of the body exposed to the open air, we will now look at those buried or inhumed. The difficulty is much greater here of accurately determining the period of death, because the number of insects which succeed in reaching the corpse, and evidence of whose visits are to be found, is much smaller than in the case with the body exposed to the open air. If the soil consists of compact clay it will be more difficult for the insects to reach the corpse, especially if buried at some depth.

If the soil is light and there is a layer of gravel underneath, the insects can penetrate with greater ease.

Finally the solidity of the covering of the body may completely prevent the arrival of insects, and so restrict one's information. For example, the coffin may be made of well soldered lead.

Again, if the subject dies during the summer months, it has probably been attacked by flies, which seek it out instinctively at this time, in order to lay their eggs on its surface, and more especially around the natural openings, nose, mouth,
etc.

One can observe, if the season be favourable to flies, sufferers either men or animals being persistently attacked by flies, and many practitioners regard this as a sign of the extreme gravity of the patient's condition.

An imperative instinct seems to lure these flies for the purpose of ovipositing on animal matter which will soon enter into a state of decomposition. These flies belong exclusively to the two Genii: Curtonevra and Calliphora. The information to be drawn from perfect insects or cocoons of nymphs of these Genii, even if found in a leaden coffin, is that the interment took place during the hot season, and not during the winter months. If the larvae and flies are still living one can conclude that the death took place at the most three months previously, and if the metamorphosis is complete and only dead insects are discovered, one is justified in concluding that death took place more than six months previously, but at an epoch which one cannot determine without other evidences.

If the corpse has been interred in a wooden coffin, especially if these are constructed as they are for most pauper funerals, the weight of the
earth soon causes the planks to warp and large cracks appear through, which it is easy for insects to penetrate in their search for the dead. The odour from the body is appreciated by the delicate olfactory apparatus of the Ophira cadaverina, Phora Atterima, a Copeoptera of the Rhizophagus parallelocolis. The larvae and perfect insects of these orders have been found in corpses exhumed after having been buried for twelve months.

In corpses of two years standing are found quantities of the Phora Atterima both as nymphs and as perfect insects, which often escape as a veritable cloud of flies when these coffins are opened, to the astonishment of the onlookers, who do not understand how to account for this phenomenon. It is only on very fat corpses of two years standing that one is able to demonstrate the larvae and perfect insect of this Rhizophagus parallelocolis, they having been attracted by the rancid smell thrown off by a certain degree of fermentation.

In exhumed bodies of three years standing the skeleton is usually without flesh, the hollows being filled with a blackish powdery matter mixed with the remains of insects, and especially of their nymphs.
None of these are living, and they have consumed everything which could be devoured.

In conclusion. One will easily recognise that we have a certain basis upon which we are enabled to determine the age of an exhumed corpse up to the third year. The presence or absence of the remains of the first workers enables us to determine the season at which interment took place.

If one is provided with the cycle showing the periods of invasion of the various insects and their classification, it is an easy matter to submit the remains of insects, cocoons, nymphs, chrysalis etc., to an entomologist, who will at once be able to recognise it by its various characteristics.

We can then give it its proper place and estimate the period of death accordingly. It is not in any way necessary for the Medical Jurist to be an Entomologist, but a knowledge of the destruction wrought by insects in a corpse will perhaps assist in the unravelling of the "tangled skein" presented by the discovery of the body.

We must take into account the various factors in the metamorphosis of the insects such as climate and season, but with even an elementary knowledge of these points it is possible to arrive at a fairly
exact conclusion.
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