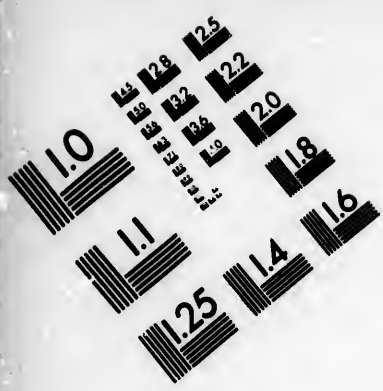

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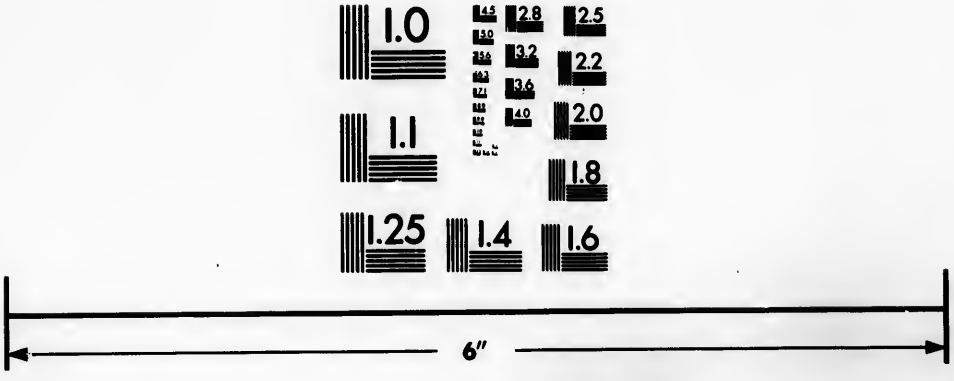

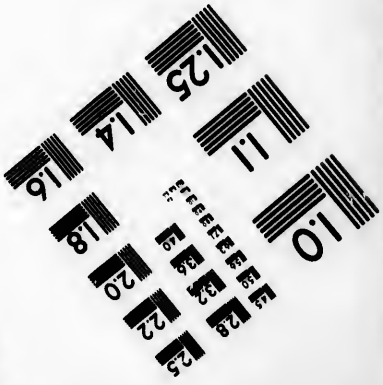

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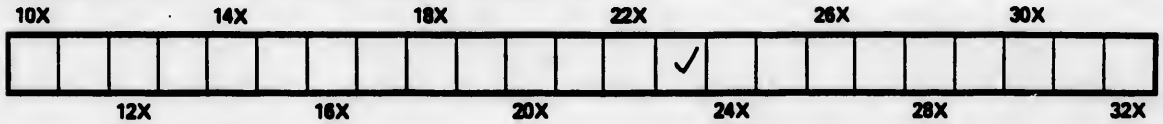

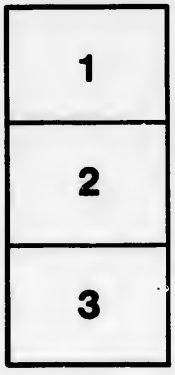

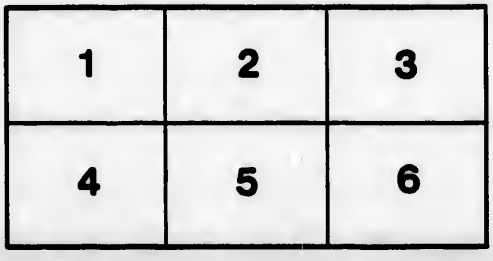

ON THE MEDICO-LEGAL APPLICATION OF ENTOMOLOGY.

BY

WYATT JOHNSTON, M.D., AND GEO. VILLENEUVE, M.D.

(*Reprinted from the Montreal Medical Journal, August*, 1897.)

ON THE MEDICO-LEGAL APPLICATION OF ENTOMOLOGY.[1]

BY

WYATT JOHNSTON, M.D., and GEO. VILLENEUVE, M.D., Montreal.

The remarkable results of Mégnin's[2] studies on cadaveric fauna have made medico-legal entomology part of the regular stock-in-trade of the medical expert. One may now judge from the animal fauna met with in a dead body how long it has been exposed. The creation of this special department of legal evidence is an honour which belongs to Mégnin alone, although prior to him, Bergeret[3] had already made some practical applications based on the erroneous views current at the time.

Through the publishing of his Faune des Cadavres, the popularisation of the subject has been greatly furthered, though the subdivision of the stages in the process of destruction into 8 successive stages is perhaps less easy to comprehend than the simpler classification previously adopted with 4 stages.

The result of over 15 years experience at the Paris morgue, during which period M. Mégnin had been entrusted with all the expertises requiring a knowledge of entomology, has been, according to Professor Brouardel[4], entirely satisfactory. Often the conclusions which he had arrived at from the examination of a few debris and insects were borne out in the most striking manner by the subsequent course of the case. Sometimes the mystery was never cleared up. But in no single instance did the results of the inquiry go to show that M. Mégnin's deductions were erroneous. There is something almost uncanny in the way which M. Mégnin could state for instance after examining a few bones and some dust that a murder had been committed during the latter part of February of the year before last —and then be absolutely justified by the dying confession of the suspected party. The chief danger to be feared from Mégnin's imitators

[1] Read before the Canadian Medical Association, Montreal, August, 1896.

[2] P. Mégnin Faune des Cadavres, Paris, 1894, Gazette Hebdom. de Méd. et de Chirurg., July 20, 1883; La Faune des Tombeaux, 1887.

Annales d'Hygiene, 1855, Tome IV., p. 404.

[4] La Mort Subite, 1894, p. 99; L'Infanticide, 1896, p. 141.

is that they might tend to indulge in guesses having no very solid basis and to apply rules to countries and climates where they were inapplicable. We considered that before any safe deductions can be made in the case of Canada a number of comparative observations must be made to show how far the data obtained from French fauna hold good here.

It is very much to be regretted that in addition to giving the generalisations and medico-legal applications made by him, M. Mégnin has not also given us the assistance of his numerous observations which underlie these deductions, that we may know accurately the degree of variation of dates actually met with under definite conditions of experiment.

For convenience we have arranged in tabular form the dates which Mégnin assigns for different fauna to attack the body, as far as these can be determined from the literature above mentioned, though, of course, considerable latitude must continually be allowed for variations, and for this tabulation M. Mégnin is not personably responsible.

The principle is that the products formed at different epochs in the progress of decomposition attract certain forms and repel others.

The typical course of events shown by the table may be summarised as follows: While the body is still fresh it attracts the diptera *Musca*, *Curtonevra* and *Calliphora*. After decomposition has set in, the flesh flies *Lucilia* and *Sarcophaga* are attracted. Later, when fatty acids are formed, the body is invaded by the beetle *Dermestes* and by the moth *Aglossa* (this latter we have never met with in our Canadian observations, but it is apparently very common in France). Later *Pyophila* of the diptera and *Necrobia* of the coleoptra appear, as the condition becomes caseous. After this comes a period of ammoniacal decomposition marked by liquefaction of the tissues into a blackish pulp, during which stage a group of coleoptera, *Necrophorus*, *Silpha*, *Hister* and *Saprinus* are met with, as well as the diptera *Ophyra*, *Thyreophora*, *Phora* and *Lonchea*. In the next stage the tissues dry up and are invaded by acari, the debris and excrement of which form a powdery deposit. Subsequently, with the progressive drying of the tissues, *Aglossa* (2nd generation) reappears, together with the moth *Tinea* and the coleoptera *Attagenus* and *Anthrenus*. Finally, when nothing but the dried ligments remain on the bones, two forms of coleoptera, *Tenebrio* and *Ptinus*, appear and devour these.

In the case of buried bodies, the fauna are said to be much less varied and to consist mainly of *Phora* and *Ophyra* in the diptera, and *Philonthus* and *Rhizophagus* of the coleoptera, together with any diptera which have gained access to the body before burial.

FAUNA OF DEAD BODIES EXPOSED TO THE AIR[1]—(COMPILED FROM MÉGNIN).

	Physical Condition.	Minimum time.	Forms met with.
First Period.....	Bodies fresh.....	First three	(D) *Musca.** *Cyrtoneura.** *Calliphora.**
Second Period...	Decomposition commenced.....	months.	(D) *Lucilia.** *Sarcophaga.**
Third Period.....	Fatty acids.....	3 months	(L) *Dermestes.** *Aglossa.*
Fourth Period...	Caseous products.....	to 6 months.	(D) *Pyophila.** *Anthomyia.* (C) *Necrobia* (*Cornytes*).
Fifth Period.....	Ammoniacal fermentations, black liquefaction.....	4 months to 8 months.	(D) *Thyreophora.* *Ophira.** *Lonchea, Phora.* (C) *Necrophorus.* *Silpha.** *Hister.** *Saprinus.**
Sixth Period.....	Dessication.....	6 months to 12 months.	(A) *Uropoda.* *Trachynotus.* *Tyroglyphus.** *Glyciphagus.* *Serator.*
Seventh Period..	" extreme...	1 year to 3 years.	(L) *Aglossa.* *Tineola.* (C) *Attagenus* *Anthrenus.*
Eighth Period...	Debris.....	Over 3 years.	(C) *Tenebrio.* *Ptinus.*

FAUNA OF BURIED BODIES.

Before Burial.....	(D) *Calliphora**, *Cyrtoneura.*
After Burial.....	(D) *Ophira**, *Phora.*
	(C) *Philontes**, *Rhizophagus.*
	(T) *Achorutes*, *Templetonia.*

(The genera marked * in the table are those met with by ourselves.)

[1] (D) Diptera, (C) Coleoptera, (L) Lepidoptera, (A) Acari, (T) Thysanura.

The following list of all the species mentioned by Mégnin has been furnished us by Mr. F. A. Chittendale, of the Washington Bureau of Entomology, and contains corrections of the list as first published in the MONTREAL MEDICAL JOURNAL. Those found by us and not mentioned by Mégnin are placed in square brackets. Those marked A are NorthAmerican; marked E European, and those marked C Cosmopolitan, and common in North America.

DIPTERA.—C *Musca domestica*, *Musca carnaria* = E *Sarcophaga carnaria*, C *Cyrtoneura stabulans*, C *Calliphora vomitoria*, C [*C. erythrocephala*,] C *Lucilia cæsar*, E *Sarcophaga carnaria*, E *S. arvensis*, E *S. laticrus*, C *Piophila casei*, C *P. petasionis*, E *Anthomyia vicina* (*species unknown*), E *Thyreophora cynophila*, E *T. furcata*, E *T. anthropophaga*, C *Ophyra leucostoma*, E *O. cadaverina*, = *Pyrellia cadaverina*, E *Lonchea nigrimana*, C *Phora aterrima*.

COLEOPTERA.—C *Dermestes lardarius*, C *D. frischii*, C *D. undulatus*, C *Necrobia* = *Ernatus ruficollis*, C *N. cæruleus*,= *violaceus*. C *Necrophora* (*fossor*), *interruptus*, C *N. humator*, C (*Silpha littoralis*) = *Asbolus littoralis*, C *S. obscura*, A [*S. noviboracensis*], C *Hister cadaverinus*, A *H. fœdatus*, C *Saprinus rotundatus*, A [*S. assimilis*], C *Attagenus pellio*, C *Anthrenus museorum*, C *Tenebrio molitor*, C *T. obscurus*, C *Ptinus brunneus*, C *Philonthus ebeninus*, C [*P. politus*], C *Rhizophagus parallelocollis*, C [*Omosita colon*, A *Trox unistriatus*].

LEPIDOPTERA—E *Aglossa pinguinalis*, C *A. cuprealis*, C *Tineola bisellirla*, C *T. pellionella*.

ACARI—E *Uropoda nummularia*, E *Trachynotus cadaverinus*, C *Tyroglyphus spinipes*, *T. siro*, C *T. longior*, E *Glyciphagus spinipes*, E *G. cursor*, E *Serrator amphibius*, E *S. necrophagus*.

THYSANURA.—E *Achorutes armatus*, E *Templetonia nitida*.

Looking at the table, one is at once struck by the small number of genera represented out of the total diptera, coleoptera, acari and lepidoptera occurring in France, so that in practice their recognition becomes a relatively easy matter.

It must be kept in mind that Mégnin's observations apply to human bodies. One is also struck by the absence of several forms well known to attack the flesh of dead animals, birds or reptiles; either they do not appear in the above list, or only appear at a much later date. The burying beetles, for instance, which attack game left exposed for a few days, does not attack human bodies under several months. Hence observations conflicting with Mégnin's work which rest upon observations on other animals, horseflesh for example, have, to our mind, very little practical value, what is wanted being rather multiplication of observations upon human remains, when all the conditions as to dates and meteorological conditions are accurately known. In this direction we have made some studies, which will be mentioned later, and others are still in progress. The possibility that some of the fauna may be attracted by the clothes and not by the bodies we have not found to be a serious obstacle.

Our observations were begun over two years. As far as we are aware, no American or Canadian observations on this subject have been published, so that we had no direct information as to how far the dates and successions, laid down by Mégnin, might hold true of the climate of Canada. As to the comparative frequency of occurrence of various European, American and cosmopolitan genera and species there is considerably more information, though this is for the most part recorded in transactions and books not generally accessible.

To compare the different climates we have tabulated the mean monthly temperatures of the air and soil for Montreal, Greenwich and Paris (the depth of soil in the case of Paris being slightly different).

The differences in summer temperature are very much less than one might expect, and this may explain the general correspondence of our results with those of Mégnin. The climate of Canada is peculiar in having a long, cold winter, during which the ground is deeply covered with snow, which prevents the frost from penetrating deeply followed by a hot summer. The interval between winter and summer is short. Everything is in full leaf within about a month after the disappearance of the snow, and during the warm weather temperatures from 80° to 95° Fahr. (27° to 32° C.) are not uncommon. Thus the temperature of the surface soil in summer is rather higher at Montreal than at Greenwich, and apparently very near that of Paris, The percentage of bright sunshine between April 1st and September

Fig. 1. M
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N.B.—

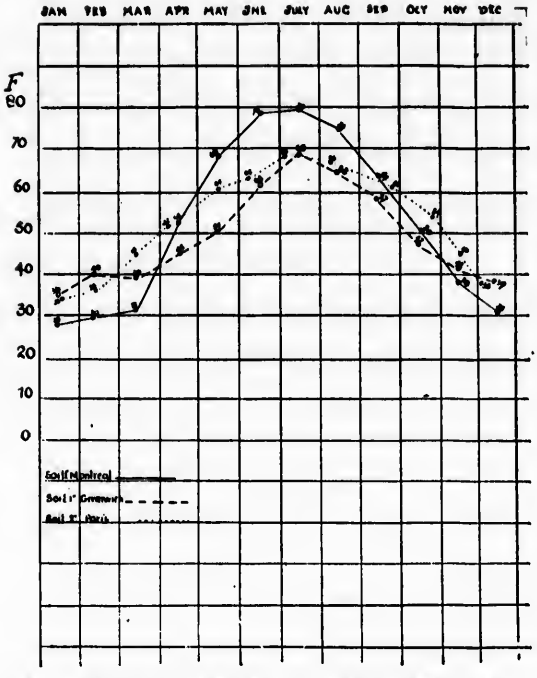


Fig. 3. Monthly means of soil temperature at Montreal 1 In.
—— Paris 2 In.— — — — — and Greenwich 1 In.....

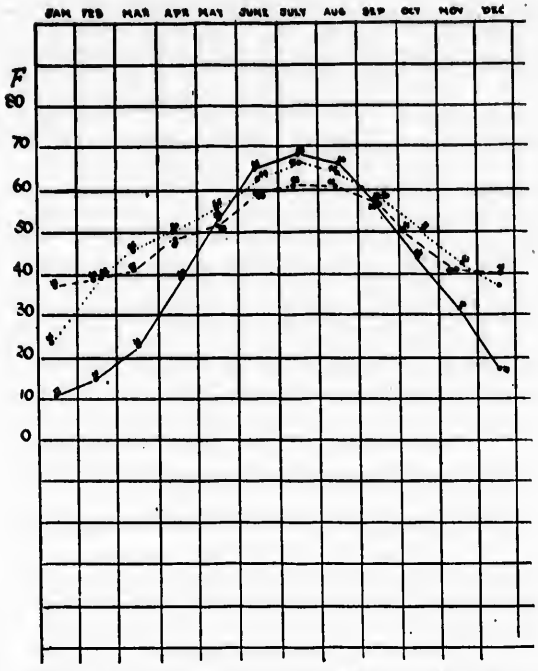
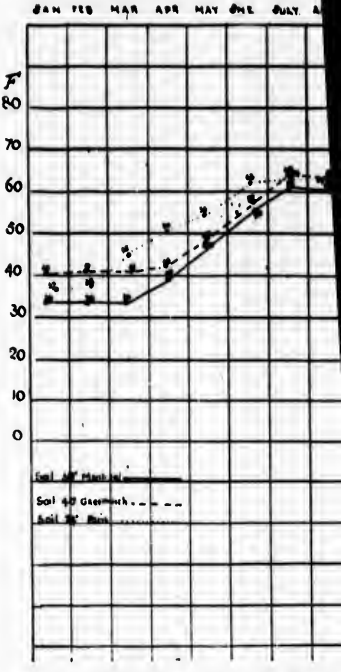


Fig. 1. Monthly means of air temperature at Montreal——· Paris— — — — and Greenwich.....

N.B.—The charts are not drawn quite accurately as to scale.



Fig, 2. Monthly means of soil tempe
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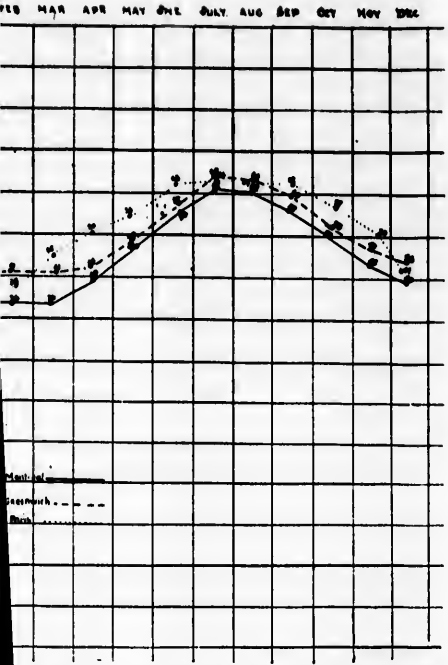

Monthly means of soil temperature at Montreal 40
aris 24 in.— — — — — and Greenwich 38 in..... ..

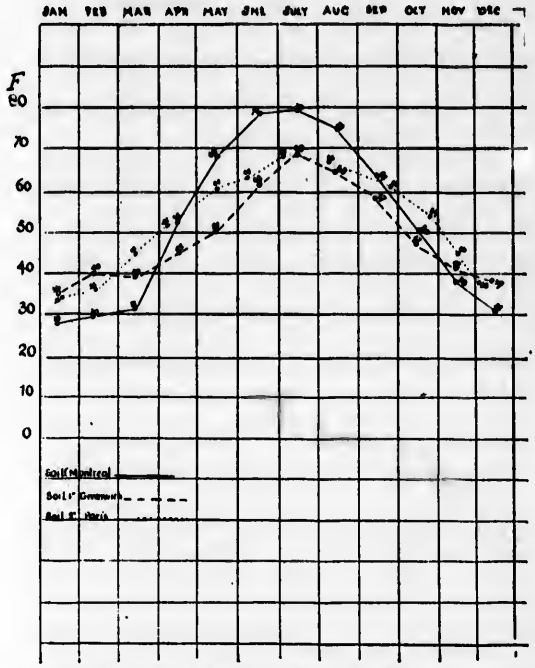

Fig. 3. Monthly means of soil temperature at Montreal 1 in.
—— Paris 2 in.— — — — — and Greenwich 1 in.....

30th, a good index of soil heat, is 65 at Montreal and less than 53 at Paris. From the tracings it will be seen that the mean air temperature at Montreal is slightly higher than that at Paris during the summer. The relative humidity in summer is 72 at Montreal and 71 at Paris.

Our fauna were all obtained from the vicinity of Montreal.

	Air Temperature °Fahr., Monthly Means.			* Soil Temperature °Fahr. Monthly Means.					
	Montreal.	Paris.	Greenwich.	Montreal at 40 in.	Paris at 24 in.	Greenwich. at 38 in.	Montreal at 1 in.	Paris at 2 in.	Greenwich at 1 in.
January ...	12	26	38	36	37	40	28	35	36
February ..	15	40	39	36	38	41	30	36	40
March	24	45	42	36	45	41	32	46	39
April	40	50	47	40	50	44	54	52	45
May	54	55	53	48	55	49	68	61	51
June	64	63	60	56	63	57	78	64	63
July	67	67	63	62	64	65	79	68	68
August	66	65	62	62	64	64	74	66	65
September.	58	50	58	57	62	60	64	61	57
October....	46	51	51	52	57	53	50	54	47
November .	33	43	43	45	50	47	38	46	42
December .	18	38	41	40	41	46	31	38	39
Annual Mean...	41·8	52·0	50·0	47·6	52·0	50·3	51·8	51·8	49·5

It was suggested to us that the relatively rapid growth and development of the Canadian flora might be associated with a corresponding rapid evolution of the fauna as compared with those of Europe. This we did not find to be the case with the individual insect forms studied. We did find, however, that the successions of insect forms occurred in a shorter time on exposed bodies than we had expected from Mégnin's statements.

On the other hand we found that the order of the successions followed the rules laid down by Mégnin.

In our comparatively small number of observations, out of the 23

* The soil temperatures for Montreal are from observations by H. L. Callender and C. H. McLeod, Pro. Roy. Soc. Canada, 1895 and 1696. The soil temperatures for Paris are from observation by E. and H. Bequerel, Comptes Rendues, 1883, Tome 96, p. 1109. All temperatures were taken beneath turf. For simplicity they are expressed by the nearest whole number of degrees Fahr. The variations from the monthly means average 1° to 4° Fahr.

genera indicated by him, as characteristic of exposures up to one year, we have met with 11, and 5 of the 12 remaining are rare on this continent. We have only encountered two which he does not mention. These were *Trox* and *Omosita*, both rare in France, although necrophagous.

The diptera characteristic of the first and second periods were found by us regularly on bodies exposed during the warm months, and were not found during the cold weather, unless the body had been previously kept for some time indoors. An exception worth noting was met with in the case of a patient who escaped from an asylum on February 22, 1896, while the fields were covered with snow. The body was found on April 20, 1896, in a snowy spot in a field, and showed about the eyes and nostrils numerous small white larvæ, which on hatching out, proved to be those of *Calliphora Erythrocephala*. It is true that the development and hatching of the pupæ had not taken place. A knowledge of the period of the year at which breeding of the different insect forms takes place is of the utmost importance in determining the dates.

A deduction not mentioned by Mégnin, which we have repeatedly found of practical use, is that if empty dipterous puparia are present, the date of exposure may be reckoned as not less than one month, while the absence of empty puparia indicates an exposure of not over one month in warm weather.

Our observations conform with Mégnin's as to the order of the successions. Thus whenever acari were found, it was evident that *Silpha* and *Hister* had preceded them. *Pyophila* was only seen when saponification of the fat was well marked. *Dermestes* was seen earlier in the saponification period, but never in the preliminary decomposition. *Calliphora* and *Lucilia* were the forms met with up to the end of the first month in cases where the dates were accurately established. Where the exposure lasted a few days only, *Lucilia* was absent.

Our failure to find such forms as *Attegenus*, *Anthrenus*, *Tenebrio* and *Ptinus*, taken in connection with the fact that none of the observations reached the time limit at which they were found by Mégnin, is also confirmatory of his statements. In one case where the date of exposure was definitely fixed at five weeks, these forms were absent, although the bones of the skull were laid bare and the cervical vertebrae were stripped of their flesh and disarticulated. The inequality of the destruction in different parts of the body was striking in this case. for the state of the abdominal organs was so entirely free from decomposition that an analysis for arsenic was made, with negative results.

Whenever possible we bred the larvæ in order to determine the time necessary for the complete cycle. This was not found in any case to be lower than that given by Mégnin. It was found to be extremely difficult to obtain more than two generations. Unfortunately the pamphlet of instructions for practical entomological work, published by the Washington Bureau of Entomology was not obtained in time to adopt its valuable suggestions in our earlier observations.

In a case in which one of us (V.) was summoned as an expert, the nature of the fauna present afforded much valuable information. Early in May, 1895, the body of an unknown man was found dead in a lonely spot, with a bullet hole in the skull. There existed an advanced state of adipocere transformation, and in places the bones were partly bare. The body and clothes were swarming with small white larvæ which, from their characteristic skipping action, were thought to be those of *Pyophila casei*, and which on being hatched out subsequently proved to be so. In addition, the body and the clothing were literary covered with large dipterous larvæ and empty pupa cases. These we were not able to identify satisfactorily. No acari or coleoptera were found. The assumption of the police that the man had been murdered *during the winter* in a house near by was disproved by the evidence of abundant diptera, placing the date of exposure back to some time during the warm weather of the preceding summer or autumn. Following this clue, information was obtained which resulted in the body being identified as that of an individual who had been seen in the vicinity during the harvest season of the previous year and who was known to have a revolver in his possession. The subsequent finding of a revolver near where the body lay strengthened the original opinion of the medical examiner that the case was one of suicide.

In another case the body of a new-born male infant, found under some loose planks in the floor of a bath-room and directly over the kitchen ceiling in April, 1895, was sent to one of us (J) for examination with the statement that if the testimony of the witnesses was correct it must have been placed there on a certain night, 5 weeks previous. The supposed mother, a servant in the family had been noticed by strangers to have a suspicious degree of abdominal enlargement, though her mistress stated that she had not noticed this. After the night in question this enlargement suddenly vanished and the girl was noticed to be out of sorts for a few days. Her fellow servant who occupied the same room said that the accused had gone to the bath-room in the night "to change her socks" and had come back covered with blood. Marks of a copious bloody discharge were found

on her bedding and on her under-garments when seized by the police a month later. Unfortunately a proper vaginal examination was not consented to at the time of the inquest, though we learned subsequently that she allowed herself at the request of Coroner McMahon to be examined by a midwife, who claimed to have found a condition indicating recent parturition. There appeared to be no moral doubt that she had been pregnant and confined in reality at the time alleged, the only question being as to the identity of the child.

The body when received for examination was in an advanced state of decomposition and was swarming with *Dermestes lardarius* in both adult and larval stages, as well as large numbers of *Calliphora erythrocephala* larvæ and puparia of which a number were empty and some of the adult flies were found inside the coffin on opening it after it had contained the body for a few hours. The body was found on examination to be in an advanced state of decomposition. It exhaled a strong odour like that of old cheese, and the surface showed extensive pitting from the attacks of the insects. No microscopic or other evidence of acari could be found. The advanced state of decomposition made any decided opinion as to the cause of death impossible. The decomposition of the lungs was relatively far advanced, pointing to the probability of live-birth, but too far to let the question be decided positively. No marks of violence of the severer forms, alone recognisable under the circumstances, existed. The infant was between the 8th month and full term. There were no signs of its having been cared for.

Here we had the anomaly of very positive evidence of witnesses pointing to less than 5 weeks as the time elapsed since death, while on the other hand the state of the body, which according to Mégnin, the only authority on the subject, would require at least 3 months under favourable conditions for its production. The abundance of *Calliphora* did not correspond either with what is met with in early spring and in no other cases of one month's exposure have we ever personally met with the conditions found in this case. On the other hand the position of the body between the floors and over the kitchen was one likely to favour the drying which is so favourable to the *Dermestes*. Some experiments we made with the bodies of new-born infants showed that for the first month the *Dermestes* could not be induced to attack a body, but at the end of the second month they would do so. This latter period was the minimum and was only obtained in a dry atmosphere. The presence of the fatty acids in the vernix caseosa was thought of as a possible factor tending to hasten matters, but under experimental conditions it did not appear to make much difference.

The contradiction between the medical evidence and the theory of the prosecution was pointed out at the preliminary examination, but the case came to trial with the result that the prisoner was acquitted. In this case the circumstances were apparently contradictory of Mégnin's views but the material facts were not established so as to exclude doubt.

In another case where the body of an old woman was found lying in a field in August, 1895, there was extensive decomposition and the fatty tissues showed the adipocere change. The integument, where exposed, was parchmented and the bones of the upper extremity were exposed in places. As far as could be ascertained the body had been exposed since the middle of April making an interval of a little over four months. The insects present in this case were the diptera *Calliphora erythrocephala, Lucilia cæsar* and *Pyophila casei;* with the coleoptera *Silpha noviboracensis, Omosita colon, Hister fœdatus, Trox unistriatus* and *Saprinus assimilis.* In addition there were in parts of the body large numbers of acari not fully determined by the experts to whom they were referred but which belonged to the genus *Tyroglyphus.*

The finding in this case is decidedly what one might expect according to Mégnin as regards the forms present, though they appeared as already stated at an earlier date than he would assign. The presence of two forms not mentioned by him, Trox and Omosita is not evidence against the correctness of his statements as these forms are said to be rare in Europe.

Mégnin's method of computing the time interval by the *number of individuals* found and the proportion of males and females, though one of the earliest means employed by him appears to have a less solid foundation, as the number of individuals first having access cannot be positively known.

In the case of buried bodies our examinations have been confined to a few examinations for medico-legal purposes and are not numerous enough to be of any statistical value. We found that in these cases *Philonthus politus* was invariably present. *Rhizophagus* was not met with. Other forms were extremely scanty except in the cases where the bodies had been kept for a few days in the warm weather before burial and as might be expected showed abundance of diptera, mostly *Calliphora.*

Some very interesting observations made by Dr. Murray Motter on buried bodies in Washington, D.C., which will be published shortly, have been in part privately communicated to us. They show the fauna of buried bodies at Washington to be much more varied and numer-

ous than would be anticipated from Mégnin's statements as to France. The importance of comparing the results in different localities is of course very great, and we venture to think that the soil temperature may prove a better index of what may be anticipated than can be had from the atmospheric conditions of climate and temperature, both as to exposed and buried bodies.

Conclusions.—It appears certain that observations and experiments upon exposed human bodies should be made in the particular locality before the present entomological data can be directly applied to legal medicine, In the vicinity of Montreal it seems probable that the deviations will be in degree rather than in kind, and concern species rather than genera. As a whole, the statements as to the fact of successions occurring and as to the general order of these successions are likely to be strengthened by further observations. Experiments with animal bodies, other than human, are apt to misleading, and adverse results under such circumstances have not very much significance. The time limits, however, apparently require modifications for the particular locality. We know very little at present as to the difference in habit of different species of the same genera.

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