Jurnal Biosains Pascasarjana Vol. 25 (2023) pp

Systematic Review

EFFECT OF PESTICIDE POISON ON POST-MORTEM INTERVAL DETERMINATION BASED ON ENTOMOLOGICAL STUDY

Barizah Lu'ay Widyana*[1], Budi Utomo [2], Ahmad Yudianto[3]
[1]Magister Ilmu Forensik Sekolah Pascasarjana, Universitas Airlangga
[2]Fakultas Kedokteran Hewan, Universitas Airlangga
[3]Fakultas Kedokteran, Universitas Airlangga
*[1]e-mail : barizahldyana@gmail.com
[2]e-mail : author@gmail.com

Abstrak

Penentuan post-mortem interval (PMI) merupakan kunci utama dalam kepentingan forensik. Pada penemuan mayat yang telah membusuk, pemeriksaan post mortem sulit dilakukan. Penentuan PMI dapat dilakukan dengan pengamatan terhadap serangga yang muncul disekitar mayat, yang disebut entomologi forensik. Entomologi forensik dilakukan dengan menganalisis jenis larva dan menghitung usia serangga sehingga dapat diperkirakan rentang waktu kematiannya. Entomologi forensik telah dikembangkan dalam pemeriksaan toksikologi sehingga serangga yang ditemukan dapat dijadikan sampel toksikologi. Penyebab kematian dapat dikarenakan keracunan, Salah satu racun yang sering digunakan dalam kasus keracunan atau bunuh diri adalah pestisida. Penelitian ini merupakan Systematic Review yakni penelitian yang mengambil dan mengumpulkan data dari berbagai studi terdahulu yang terkait dengan tema yang dipilih. Penelitian dilakukan sesuai protokol dan registrasi dengan merujuk pada PRISMA dan JBI. Pencarian literatur didapatkan dari database online. Hasilnya didapatkan 21 studi setelah dilakukan seleksi dan eliminasi sesuai dengan protokol. Penentuan PMI yang paling akurat bergantung pada perubahan pasca kematian dan proses dekomposisi. Beberapa jenis pestisida dapat menyebabkan proses dekomposisi berlangsung lebih cepat namun beberapa jenis pestisida lainnya dapat memperlambat proses dekomposisi. Kandungan racun pada jasad yang termakan oleh serangga nekrofagus memberikan efek terhadap perkembangan dan pertumbuhan serangga nekrofagus. Pertumbuhan lalat akan terhambat atau bahkan terhenti, adanya racun pada mayat dapat menjadi faktor perancu dalam penentuan post-mortem interval. Kematian yang diakibatkan racun masih perlu dilakukan penelitian lebih lanjut karena perbedaan jenis racun dapat menunjukkan efek samping yang berbeda pada tubuh.

***Kata Kunci**: forensik, post-mortem interval, serangga, entomologi, pestisida*

Abstract

Determination of post-mortem intervals (PMI) is a major key in forensic investigation. On the discovery of a decomposed corpse, a post mortem examination is difficult. PMI can be made by observation of insects that appear around the corpse, called forensic entomology. Forensic entomology carried out by analyzing the species of larvae and calculating the age of insects so that the time of death can be estimated. Forensic entomology has been developed in toxicological examinations so that insects found can be used as toxicological samples. The cause of death can be due to poisoning. Poisons often used in case of poisoning or suicide is pesticides. This research is a Systematic Review, a study that takes and collects data from various previous studies related to the chosen theme. The study was conducted according to protocol and registration with reference to PRISMA and JBI. Literature searches are obtained from online databases. The results were obtained by 21 studies after selection and elimination in accordance with protocol. The most accurate determination of the post mortem interval depends on post-death changes and the decomposition process. Some types of pesticides can cause the decomposition process to take place faster but some other types of pesticides can slow down the decomposition process. The content of toxins in the body ingested has an effect on the development and growth of necrophagous insects. The growth of flies will be stunted or even stopped, the presence of toxins in the corpse can be a contributing factor in the determination of the post-mortem interval. Deaths caused by toxins still need to be further researched because different types of toxins can show different side effects on the body.

***Keywords**: forensic, post-mortem interval, insect, entomology, pesticides*

1. INTRODUCTION

Determining the time of death is one of the main keys in forensic purposes. In determining the time of death, the examination that is often carried out is checking for sure signs of death in the form of bruising, corpse stiffness, decreased body temperature, and decomposition. However, when a corpse is found that has long been dead and has been decomposed, these signs become difficult to identify. Bodies found in the final phase of decomposition had lost most of the tissue needed for toxicological analysis. So that the presence of poisons or drugs that may be present in the body will be difficult to detect (Stojak, 2017). The PMI determination method currently being developed is forensic entomology. Determination of PMI by entomology is based on various insect activities, including the process of growth and development of insects present in the bodies found (Matuszewski, 2015).

Deaths due to poisoning and drug abuse are quite common throughout the world. One type of poison that is commonly found in cases of poisoning or suicide is pesticides. Determination of toxic substances in the body is often difficult because of metabolic processes. Toxicological samples can come from various body tissues. In recent studies, toxicological samples can also be found in insects that are found around bodies.

This research is in the form ofsystematic review which aims to identify the effect of toxic pesticides on the determinationpost-mortem interval based on entomological studies by gathering data from previous research.

2. HEADING

Determining the length of time of death is done by identifying the changes that occur in the corpse up to the decomposition process, both internal and external changes. The most accurate and precise PMI estimation is based on postmortem changes and decomposition processes, which are determined by pathologists or forensic specialists, depending on the country of origin (Maile et al., 2017). On the discovery of a corpse that has long been dead and has decomposed, examinationafter deathhard to do. One alternative that can be used in examining a decomposed corpse is forensic entomology.

Forensic entomology is based on a collection of insects found in remains, an insect colony takes time to grow and form a colony. This process involves the accumulation of data from the growth cycle and life cycle of insects. The presence of biotic and abiotic factors can affect the growth cycle (Harvey, 2016). Decaying bodies become a temporary habitat and food source for various insect species (Morris, 2005). Within a few hours after death, groups of insects such as flies (Diptera: Calliphoridae) will be attracted by smell to decaying bodies which are a source of protein that can be used as breeding grounds. Colony formation time, growth time, and departure time for each insect species are different, this is related to the decomposition process of the body (Matuszewski, 2010).

Flies (blowflies) are the most frequently encountered insect species in forensic investigations. The fly families that usually come first and colonize the carcass are from the Calliphoridae, Sarcophagidae, and Muscidae families. Species from this family eat corpses and

lay eggs and carry out a life cycle on corpses during the decomposition process (Badenhorst, 2018). The life cycle of flies in general is egg-larva-pupa-fly. The period between laying eggs and forming a certain developmental stage can be used to estimate the length of time of death. The type of fly also affects the period, because the type of fly affects the time of laying eggs or larvae on the corpse (Bardale, 2011).

Fly eggs are generally deposited soon after death during the day. If the corpse is not removed and only eggs are found on the corpse, it can be assumed that the time of death ranges from one to two days. This figure varies slightly, depending on temperature, humidity and fly species. After hatching, the larva grows larger until it finally reaches the pupal stage. This stage can take 6 to 10 days under normal tropical conditions. Adult flies emerge from the pupa after 12 to 18 days. It should be noted that many variables affect the development of insects, therefore the opinion of the authors is that an attempt to estimate the time of death using entomological methods should be assisted by a medical entomologist (DiMaio, 2001).

In cases of poisoning, the presence of poison in the body can change the rate of development and growth of the insects that land on the body. Toxins in the body can cause insects that land on them to also experience poisoning so that their developmental stage stops. The presence of poison can also reduce the number of insects that come to the body (Manik, 2019).

3. RESEARCH METHOD

This research is Systematic Review namely the type of research in the form of library research. Systematic review is one method that uses a summary, review, structured evaluation, classification, and categorization ofevidence-based experiments that have been carried out by previous researchers. Based on the selected topic,systematic review This is done to identify the effect of toxic pesticides found in cadaver or animal carcasses on insects as a determinantpot mortem interval.In writing systematic review This is done based on PRISMA andchecklist JBI.

Study search was performed usingonline database among themGoogle Scholar, PubMed, Science Direct, Spingerlink, ProQuest, Sage Journal, Academia, andResearch Gate. The inclusion criteria in the search for selected studies or journals must be in English and Indonesian and published within the last 10 years, namely between 2012 – 2022.Selected studies or articles must be in accordance with the research topic, namely studies related to the effect of pesticide poisoning on determinationpost-mortem interval based on entomological studies. Keywords that match with MeSH term,that is “forensic” AND “post-mortem interval” OR “PMI” AND “Entomology” OR “Insect” AND “Pestisides” OR “poisoning”.

Study selection was carried out based on study objectivity, this study focused on studies related to the effect of the presence of pesticides in cadaver or animal carcasses on insects as a determinantpot mortem interval.Based on the qualified abstract, the article is taken as a whole. Articles that have been obtained are fully selected by researchers to see their suitability in answering the objectives of the research study.

Data mapping from studies included in the review is made in the form of tables containing general and specific information including researchers, year of publication, samples, variables that influence research and results of research.

4. RESULT AND DISCUSSION

A total of 642 study titles were taken from eightdatabase electronic following keywords that matchMeSH term. Of the 642 studies, 171 were obtained after duplication selection was carried out on the keywords title and abstract. Then re-selection was carried out taking into account access to these studies and 58 studies were obtained whose titles led according to the theme. After that, elimination was carried out based on inclusion and exclusion characteristics in the abstract and obtained 21 studies that met the criteria. The literature search process in this systematic review is in accordance with the PRISMA diagram and protocol.

The selected study is an experimental study regarding the effect of organophosphates on the post-mortem interval based on forensic entomology. The majority of selected studies included in this systematic review will be conducted in 2021, namely seven studies. Furthermore, in 2018 and 2020 there will be four studies. In 2012, 2017 and 2022 respectively - two studies each, and only one study in 2012.

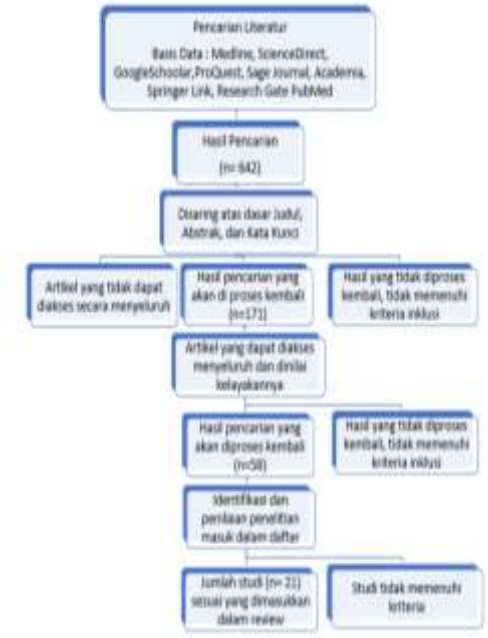

Figure 1. Study Research Results

All of these selected studies were then analyzed based on the sample, method, observed variables, statistical analysis, and research results. From the results of the analysis, it was found that the study was compatible with the topic, namely an entomological study on determining the post-mortem interval in cases of organophosphate poisoning.

Tabel 1. Rangkuman Hasil Studi

No	Penulis, Tahun, dan Judul Studi	Design, Sampel, Variable	Hasil
1	Mahat, N.A. (2012) *MALATHION EXTRACTION FROM LARVAE OF CHRYSOMYA MEGACEPHALA (FABRICIUS) (DIPTERA:CALLIPHORIDAE) FOR DETERMINING DEATH DUE TO MALATHION.*	Sample: Larvae of *Chrysomya megacephala* Visceral organs (stomach contents, liver tissue, blood) Variable independent: Dosage of Malathion in rabbits T1, T2, T3 Sun exposed area and shaded area.	Malathion can be detected in all visceral organs and at all stages of development *Chrysomya megacephala*, the highest concentrations were found in larvae up to 3rd instar larva. There is a correlation between contentmalathion on all treatments between visceral organs and on *C. megacephala*. The highest was in the T3 treatment with dosingmalathion the tallest.
2	Bakr, R.F.A. (2012) *ULTRASTRUCTURE OF THE MIDGUT OF THE THIRD LARVAL INSTAR OF CHRYSOMYA MEGACEPHALA (DIPTERA: CALLIPHORIDAE) FED ON MALATHION TREATED DIET.*	Samples: 3rd Instar Larva *C. megacephala* Independent variables: Dosingmalathion in rabbits R1 and R2	Control: Normal histopathological picture in the third larvae. The photo image of the larva showsdark columnar cell (dense compressed cells) in the middle areamid-well there is a nucleus. The nucleus is surrounded by many cells of the rough endoplasmic reticulum, and there are patches of chromatin from lysosomes of varying densities. R1:Dark columnar cell in the middlemid-well showed disorganized and shrunken nuclei, some fragmented, visible fat vacuoles between mitochondria, and no agglomerated chromatin. R2: middle sectionmid-well showing very few cells. Nucleus barely distinguishable, all cells damaged, many fat vacuoles. The cells shorten, shrink or stop growing.

3	Ekrakene, T. dan Odo, P.E (2017) *COMPARATIVE DEVELOPMENTAL EFFECTS OF TRAMADOL HYDROCHLORIDE AND CYPERMETHRIN ON CHRYSOMYA ALBICEPS (DIPTERA:CALLIPHORIDAE) REARED ON RABBIT CARRIONS.*	Samples: larva *Chrysomya albiceps* Independent variables: Givingtramadol hydrochloride and Cypermethrin	There were significant differences in larval colonies in the control, tramadol and cypermethrin treatments. Larval colonies that received tramadol treatment experienced faster development and had the highest body length and the greatest weight compared to the controls. Colonies with Cypermethrin treatment experienced a decrease in growth until the larval length was the shortest among the three treatments and the weight was the smallest.
4	Fouda, M.A. (2017) *ENTOMOTOXICOLOGICAL STUDY ON THE FORENSIC BLOW FLIES CHRYSOMYA ALBICEPS ASSOCIATED WITH DOG CARCASS*	Sample: *Flieschrysomya albiceps* independent variables: Givingmalathion in dogs as the treatment group	The statistical analysis showed no significant results for the incubation period of the larvaechrysomya albiceps which came from the control and treatment groupsmalathion. However, the growth of larvae to pupae showed significant results. The larvae in the treatment developed slower than in the control group.
5	Abajue, M. C. dan Ewuim, S.C. (2018) *CHEMICAL COMPOSITION AND GROWTH RATE OF BLOWFLY MAGGOT FROM POISONED CADAVERS IN AWKA, NIGERIA*	Sample: fly larvae (blowflies) Independent variable: Givingzinc-posphorus in the treatment group pigs Indoor and outdoor treatment	There was no significant difference between the poisoned pigs and the control group. However, in testing using AAS on the larvae of the treatment group it showed zinc posphorus in larvae found in poisoned pigs.
6	Bakr, R.F.A (2018) *DETECTION OF MALATHION IN DIFFERENT STAGES OF CHRYSOMAYA MEGACEPHALA AND ITS IMPLICATIONS FOR FORENSIC ENTOMOLOGY*	Sample: flies *Chrysomya megacephala* Rabbit organ tissue Variables: Givingmalathion in the rabbit treatment group	Malathion can be detected in all rabbit tissues except in the control group. Malathion can also be found at 3rd larvae and pupaeC. megacephala in the treatment group (R1 and R2) This shows a strong correlation between concentrationsMalathion in rabbit tissue as well as larvae and pupae in the treatment group
7	Denis, C.I. (2018) *INFLUENCE OF CITRONELLA AND CHLORPYRIFOS ON CHRYSOMYA MEGACEPHALA (FABRICIUS) AND*	Sample: *C. megacephala* and *C. rufifacies* Variables: Giving citronella in rabbits treated with T1 and Chlorpyrifos T2	Compared with the control group, arrivalC. megacephala in the treatment group slower 4-6 hours. Total growth duration in one life cycleC. megacephala and C.rufifacies between the control group and the groupcitronella T1 did not show any significant difference.

	CHRYSOMYA RUFIFACIES (MACQUART) (DIPTERA: CALLIPHORIDAE) INFESTING RABBIT CARCASSES		In groups chlorpyrifos there is delay in oviposition and difficulty in differentiating between *C.megacephala* and *C.rufifacies*.
8	Magni, P.A. (2018) *DEVELOPMENT AND VALIDATION OF A METHOD FOR THE DETECTION OF α-ENDOSULFAN AND β-ENDOSULFAN (ORGANOCHLORINE INSECTICIDE) IN CALLIPHORA VOMITORIA (DIPTERA: CALLIPHORIDAE)*	Sample: all stages *Calliphora vomitoria* Variables: Administration of endosulfan in the treatment of 10 mg T1, 25 mg T2 and 50 mg T3	GC-MS readings that did not detect the presence of endosulfan only at T1. At T2 and T3 endosulfan can be detected at all stages of fly development. But at T3 it only reaches the larva, because it doesn't develop into a pupa and the next stage. The presence of endosulfan only affects T3, the growth of larvae is shorter and does not develop into pupae. For T1 and T2 there was no significant difference with the control group.
9	El-Gawad, A.A. et al. (2019) *SUCCESSIVE WAVES OF DIPTERAN FLIES ATTRACTED TO WARFARIN-INTOXICATED RABBIT CARCASSES IN CAIRO, EGYPT*	Sample: all flies of the order Dipteran Variables: Giving warfarin to rabbits as a treatment group	The process of decomposition of rabbit carcasses occurred very quickly, 11-19 days in the control group and 9-16 days in the warfarin treatment. In the control and treatment, about 13 species of diptera could be found, with the largest number coming from the family calliphoridae, sarcophagidae, and muscidae. This research shows that warfarin poisoning can accelerate the decomposition process.
10	Abajue, M. C. dan Ewuim, S.C. (2020) *EVALUATION OF ACTIVITIES OF DIPTERAN MAGGOTS ON A POISONED PIG CADAVER AT NNAMDI AZIKIWE UNIVERSITY AWKA, NIGERIA*	.Sample: Larvae of three families of diptera Calliphoridae, Ulidiidae,and Stratiomyid Variables: Givingzinc phosphorus in the treatment group	Based on the findings in this study, the time required during the decomposition process between the control and treatment was the same. There is zinc phosphide does not delay or accelerate the decomposition of corpses nor does it alter the development of maggots or the emergence of adult flies.

11	Al Galil, F.M.A. *et al.* (2020) *EFFECT OF DIMETHOATE ON THE DEVELOPMENTAL RATE OF FORENSIC IMPORTANCE CALLIPHORIDAE FLIES*	Sample: *Chrysomya megacephala*, *Chrysomya saffranea*, *Chrysomya rufifacies* and *Chrysomya Indiana* Variables: Gift dimethoate in the treatment group (1ppm, 2ppm, 3ppm, and 4ppm)	Dimethoate greatly affect the development of flies. The duration of the life cycle of all the species used in the study increased with increasing dimethoate concentrations. Dimethoate prolong feeding time, post-feeding stage, and pupal stage development of flies.
12	Al Galil, F.M.A. *et al*. (2020) *EFFECTS OF INSECTICIDE DIMETHOATE ON THE DEVELOPMENTAL RATE OF FORENSIC IMPORTANCE SARCOPHAGID FLIES*	Sample: *Sarcophaga peregrine*, *Sarcophaga dux*, and *Sarcophaga ruficornis* Variables: Gift dimethoate in the treatment group (1ppm, 2ppm, 3ppm, and 4ppm)	Gift dimethoate in the treatment group (1ppm, 2ppm, 3ppm, and 4ppm) Dimethoate very influential on the development and morphology of sarcophagus flies. Dimethoate is a cholinestere inhibitor compound so that the development of the life cycle of flies is hampered, namely at the larval, pupa and prepupa stages. Including also affect the length of the larvae. The increase in dimethoate concentration was proportional to the duration taken at all developmental stages investigated.
13	Jales, J. T. et al. (2020) *CARRION DECOMPOSITION AND ASSEMBLAGE OF NECROPHAGOUS DIPTERANS ASSOCIATED WITH TERBUFOS (ORGANOPHOSPHATE) INTOXICATED RAT CARCASSES*	Sample: Family from *Calliphoridae*, *fanniidae*, Muscidae and Sarcophagidae, Variables: Administration of Terbufos in the treatment group T1 5mg/Kg, T2 10mg/Kg.	Terbufos accelerated the decomposition process of carcasses, altered the arrival pattern of incoming flies and resulted in 8% mortality in incoming flies. In the control group and T1 the fresh stage lasts 24 hours, whereas on the first day T2 it has entered the bloated stage. T2 entered the dry stage on the fifth day, while the control and T1 dry stages occurred on the sixth day. In high doses, terbufos also reduces the abundance of incoming flies.
14	Akpa, H.O et al. (2021) *POSTMORTEM EVALUATION OF RABBIT CARCASSES USING INSECT POPULATIONS IN KEFFI NASARAWA STATE, NIGERIA*	Sample: Diptera order flies include *Musca domestica*, *Lucilia sericata*, *Chrysomya albiceps*, *Dermestes maculatus*, and *Armadillidium vulgare*. independent variables: One rabbit was poisoned with 5g organophosphate One rabbit was sacrificed by being stabbed	In poisoned rabbits there is no insect activityfresh stage, the flies started coming onbloated stage and start dropping ondecay stage, post-decay, and dry stage. The type of fly that comes first calliphoridae.. In skewered rabbits, insect activity occursfresh stage, with the first type of fly present in the familymuscidae. The decomposition process is much faster in stabbed rabbits than in poisoned ones. The number and types of insects that came were also far more in the stabbed rabbit.

15	El-Samad, L.M. et al. (2021) *VARIATION OF INSECT SUCCESSION IN SUMMER ON DECOMPOSING RABBIT CARRIONS TREATED WITH ALUMINUM PHOSPHIDE IN BEHEIRA GOVERNORATE, EGYPT.*	Sample: Insects with the order Diptera and callioptera, with the most fly families calliphoridae. Variables: Giving alumunium phosphide with ½ LD50, LD50, and 2LD50.	Administration of AlP slowed down the decomposition process compared to the control. Insects that come from the order Diptera,coleoptera, hymenoptera, arneidae, andisopods. Calliphoridae andsarcopagidae come and form colonies on carcasses, so that these insects can be found from the beginning to the end. For other types of insects only around the carcass without forming colonies.
16	Musyaffa, M.F. et al. (2021) *THE DYNAMIC OF INSECT POPULATION SUCCESSION IN BIRD POISONED BY PYRETHROID INSECTICIDES*	Sample: All kinds of insects that visit the dead birds Variabe: Givingpyrethroid in the treatment group birds	The decomposition process in bird carcasses treated with pyrethroids took longer than the control. (138 hours control, 324 hours pyrethroid). The incoming insect population consisted of diptera (calliphoridae, muscidae, sacophagidae),coleoptera,hymenoptera, dermaptera, dictyopteran. Dangan *C. megacephal*a is the most dominant.
17	Handoko, A.C.D (2021) MENENTUKAN *POST MORTEM INTERVAL* (PMI) DENGAN PEMERIKSAAN PERTUMBUHAN LARVA SERANGGA BERDASARKAN FAKTOR PENYEBAB KEMATIAN	Sample: flies Chrysomya and Sarcophaga Variables: 1. Rats were given 30% body burns 2. Mice were poisoned with profenofos 3. Mice were submerged for 10 minutes. 4. Mice were killed by neck dislocation	There are differences in the growth of fly larvae based on the cause of death. Group three causes of death due to poisoning are values lowest average. Giving poison causes flies that come to also experience poisoning and the development of larvae is stopped. The growth of fly larvae is faster on land than the growth of fly larvae in the areawaters because the fly population is more on land
18	Putra, I.L.I dan Astuti, N.D (2021) *SPECIES OF FLIES LARVAE IN MICE (MUS MUSCULUS L.) WITH DISLOCATION, POISONED, AND BEHEADED TREATMENT IN* BEDOYO, PONJONG, GUNUNGKIDUL	Sample: *Chrysomya megacephala*, *Chrysomya rufifacies*, and *Sarcophaga haemorrhoidalis* Variables: A. Mice in dislocations B. Mice poisoned with insecticides C. Mice were decapitated on the head and tail	*Chrysomya megacephala*, and Sarcophaga haemorrhoidalis found in all three types of treatment. *Chrysomya rufifacies* found in B and C but not in A because these flies are attracted to carrion which gives off the smell of carrion.
19	Putra, I.L.I dan Marthadella T.L (2021) *IDENTIFICATION OF FLY LARVAS IN SYRIA HAMSTER CARDS*	Sample: *Chrysomya megacephala Fabricus* and *Sarcophaga haemorrhoidalis* Variables:	*S.haemorrhoidalis* can be found in all three treatments on hamsters. C. megacephala found only in dislocated hamsters. Fly larvae are most abundant in burnt carcasses.

	(Mesocricetus auratus Waterhause) WITH DISLOCATION, POISONED AND BURNED EUTHANASIA	A. Hamster on dislocation B. Hamster dislocated and burned C. Hamsters poisoned with insecticides	Correlation test with The ltrast factor showed a significance of >0.05 or there was a correlation between the measured ltrast factor and the abundance of fly larvae on the carcasses.
20	El-Ashram, S. et al. (2022) *REDUCED BODY LENGTH AND MORPHOLOGICAL DISORDERS IN CHRYSOMYA ALBICEPS (DIPTERA: CALLIPHORIDAE) LARVAE REARED ON ALUMINUM PHOSPHIDE-TREATED RABBITS*	Sample: larvae *Chrysomya albiceps* Variables: Giving Aluminum phosphide dose of 27.4 mg AlP/kg for a week in treated rabbits	The highest concentration of AlP is found in blood, liver and kidney. At 3rd instars can be found AlP at much lower concentrations. The length of the larvae with AlP was shorter than the control. Examination of the larvae with AlP showed that the shape of the larvae was curved, denser and compressed. There is deformation anteriorly with a smaller mouth and smaller respiratory spiracles
21	Ghiasvand, K. et al (2022) *THE EFFECTS OF CHEMICALS USED FOR SUICIDE ON INSECT SUCCESSION, DIVERSITY AND DEVELOPMENT: AN ANIMAL MODEL*	Sample: Diptera (*Chrysomya albiceps* Coleoptera (*Dermestes friscii)* Variables: Control in the form of a rabbit by being hit Treatment with diazinon Treatment with AlP Treatment with nortryptiline	Efek pemberian bahan kimia yang berbeda pada bangkai menunjukkan The effect of applying different chemicals to the carcass showed that the number of insects collected in the control group had a significant difference from the group that was givendiazinon andnortryptiline. However, AlP did not show a significant difference. The difference in the number and type of insects in each treatment proves that the presence of chemicals has an effect on insect diversity which can be useful in forensic entomology.

Insects are attracted to chemical compounds released during the decomposition process or compounds released by other organisms during succession patterns (El-Bar et al., 2016). In general, during the observation period, the decomposition process begins when the diptera insects begin the oviposition process, especially in the body openings, such as the mouth, nose, eyes and ears and ends until the rest of the body is completely dry and there is no insect activity at all which is in accordance with various other studies. conducted by El-Bar (2016) and Hore et al. (2017).

The fly families that usually come first and colonize the carcass are the Muscidae, Sarcophagidae, and Calliphoridae families. Species from this family will eat the carcass directly and lay eggs and carry out the life cycle on the carcass during the decomposition process (Badenhorst, 2018; Grzywacz et al., 2017; Szpila et al., 2015).

The decomposition process can be accelerated or slowed down due to the presence of chemicals including drugs that cause overdoses or in cases of

suicide depending on the substance and concentration (El-Shamad et al., 2020). In addition, the content of poisons or drugs contained in the bodies which are then ingested by necrophagus insects has an effect on the development and growth of necrophagus insects (Stojak, 2017).

Toxicological analysis to identify poisons and drugs in cadaver or animal carcass can be done on insects around the corpse. In a toxicological examination using insects, an examination is carried out to determine the effect of toxic substances or drugs contained in the bodies on the development of insects that eat them. In addition, it is also to determine the effect of toxic substances and drugs on the estimated time of death (Stojak 2017).
The effect of chemicals in corpses reduces the interest of insects that come to lay their eggs, the presence of toxic chemicals has a toxic effect on the development of flies that land on corpses which causes a small population of flies (Manik, 2019). The presence of toxic substances or drugs in decomposing corpses affects the process of insect development through food intake or food chains distributed by necrophagus insects so that it can damage the accuracy of post mortem interval (PMI) estimates (Al-Galil et al., 2020).

5. CONCLUSIONS AND SUGGESTIONS

This systematic review uses 21 studies related to entomological studies in determining the post mortem interval in cases of organophosphate poisoning. Each study used different types of pesticides with the aim of knowing the effect of pesticides on the decomposition process and the development of necrophagus insects which can be used as a determinant of the post mortem interval. The presence of toxic pesticides can affect the determinationpost-mortem interval.

Forensic entomology still needs to be developed for further research, especially in relation to various kinds of toxic substances and drugs because different types of poisons and drugs have different side effects on the body.

ACKNOWLEDGEMNET

Thanks to the Graduate School of Airlangga University, the research team for providing accessible data sources related to this research.

BIBLIOGRAPHY

Abajue, M.C., and Ewuim, S.C., 2018. "Chemical composition and Growth Rate of Blowfly Maggot from Poisoned Cadavers in Awka, Nigeria." *Nigeria Journal of Entomology*. NJE Vol. 34: 123-132.

Abajue, M.C., and Ewuim, S.C., 2020. "Evaluation of activities of dipteran maggots on a poisoned pig cadaver at Nnamdi Azikiwe University Awka, Nigeria." *Egyptian Journal of Forensic Sciences.* 10:33

Akpa, H.O., Tongjura, J.D.C., Amuga, G.A., and Ombugadu, R.J., 2021. "Postmortem Evaluation of Rabbit Carcasses Using Insect Popilation in Keffi Nasarawa State, Nigeria." *European Journal of Biology and Biotechnology Vol.2*. 6: 247.

Al-Galil, F.M.A., Zambare, S.P., Al-Mekhlafi, F.A., and Al-Kiridis, L.A., 2020. "Effect of Insecticide Dimethoate on The Developmental Rate of Forensic Importance Calliphorid Flies." *Journal of King Saud University – Science* 28: 1267-1271.

Al-Galil, F.M.A., Zambare, S.P. Al-Mekhlafi, F.A., Wadaan, M.A., and Al-Khalifah, M.S., 2020. "Effect of Insecticide Dimethoate on The Developmental Rate of Forensic Importance Sarcophagid Flies." *Journal of King Saud University – Science* 33: 101349

Badenhorst, R. and Villet, M.H., 2018. "The Uses of Chrysomya megacephala (Fabricius, 1794) (Diptera: Calliphoridae) in Forensic Entomology." *Forensic Sciences Research 3* (1): 2–15.

Bakr, R.F.A., Ramadan, R.H., El-Sawy, S., and Hussein, S.M.A., 2012. "Ultrastructure of the Midgut of the Third Larval Instar of Chrysomya megacephala (Diptera:Calliphoridae) fed on Malathion treated diet." Egypt. *Acad. J. Biolog. Sci*., 3 (1): 13-26.

Bakr, R.F.A., Ramadan, R.H., and Hussein, S.M.A., 2018. "Detection of Malathion in Different Stages of Chrysomaya megacephala and Its Implications for Forensic Entomology." *Egypt. Acad. J. Biolog. Sci.*, 10 (2): 103 – 111.

Bardale, R. 2011. *Principles of Forensic Medicine and Toxicology.* New Delhi: Jaypee Brother Medical Pub.

Denis, C.I., Nourdin, N.H., Azman, A.R., Wahab, R.A., Ismail, D., Omar, B., and Mahat, N.A.. 2018. "Influence of citronella and chlorpyrifos on Chrysomya megacephala (Fabricius) and Chrysomya rufifacies (Macquart) (Diptera: Calliphoridae) infesting rabbit carcasses." *Tropical Biomedicine Journal*, 35(3): 755–768.

Di Maio, V.J., Di Maio, D., and Kimberley, M., 2001. *Forensic Pathology*, 2nd ed., CRC Press. LLC. New York.

Ekrakene, T., Odo, P.E., 2017. "Comparative Developmental Effects of Tramadol Hydrochloride and Cypermethrin on Chrysomya Albiceps (Weid.) (Diptera: Calliphoridae) Reared on Rabbit Carrions." *Science World Journal Vol 12*.

El-Ashram, S., Toto, N.A., El-Wakil, A., Augustyniak, M., and El-Samad, L.M., 2022. "Reduced body length and morphological disorders in Chrysomya albiceps (Diptera: Calliphoridae) larvae reared on aluminum phosphide-treated rabbits." *Nature Scientific Reports*, 12:8358.

El-Bar, M. M., and Sawaby, R. F., 2011. "A Preliminary Investigation of Insect Colonisation and Succession on Remains of Rabbit Treated with Organophosphate Insecticide in El-Qalqayubiyah Governorate in Egypt." *Forensic Sci Int.* 208: 26-e30.

EL-Bar, M. M., Sawaby, R. F., El-Hamouly, H., and Hamdy, R., 2016. "A Preliminary Identification of Insect Successive Wave in Egypt on Control and Zinc Phosphide-Intoxicated Animals in Different Seasons." *Egyptian Journal of Forensic Sciences.* 6: 223–234.

El-Gawad, A., Badawy, R., Abd El-Bar, M., and Kenawy, M.A., 2019. "Successive Waves of Dipteran Flies Attracted to Warfarin-Intoxicated Rabbit Carcasses in Cairo, Egypt." *The Journal of Basic and Applied Zoology* 80 (56): 1-10

El-Samad, L.M., Tantawi, T. I., El-Ghaffar, H.A., and Beltagy, B.I., 2020. "The Effect of Morphine on the Development Rate of Flies (Diptera: Calliphoridae, Sarcophagidae) Reared on Rabbit Carcasses Containing this drug and its implications to post-mortem interval estimates." *Swed J BioSci Res.*1(1): 28 - 38.

El-Samad, L.M., Hussein, H.K., Toto, N.A., Mahmoud, D.M., and Radwan, E.H., 2021. "Variation of insect succession in summer on decomposing rabbit carrions treated with aluminum phosphide in Beheira governorate." *Egypt. Swed J BioSci Res* 2021; 2(1): 91 – 102.

Fouda, M.A., Al-Galil, A.G., Hammad, K.M., Abdrabou, M.M., and Kabadaia, M.M., 2017. "Entomotoxicological Study on the Forensic Blow Flies Chrysomya albiceps Associated with Dog Carcass." *Egypt. Acad. J. Biolog.* Sci., 10(6): 107–121.

Ghiasvand, K., Soltanian, N., Naghshzan, M., Pouladian, S., Hoseinpour, A., and Soltani, A., 2022. "The Effects of Chemicals Used for Suicide on Insect Succession, Diversity and Development: An Animal Model." *Indian Journal of Forensic Medicine & Toxicology,* Vol. 16, No. 1.

Grzywacz, A., Hall, M. J., Pape, R. T., Szpila, K., 2017. "Muscidae (Diptera) of Forensic Importance—an Identification Key to Third Instar Larvae of The Western Palaearctic Region and A Catalogue of The Muscid Carrion Community." *Int Journal Legal Med.* [doi:10.1007/s00414-016-1495-0]

Handoko, A.C.D. 2021. *Menentukan Post Mortem Interval (PMI) dengan Pemeriksaan Pertumbuhan Larva Serangga Berdasarkan Faktor Penyebab Kematian.* Syntax Literate: Jurnal Ilmiah Indonesia. 6(2).

Harvey, M. L., Gasz, N. E., and Voss, S.C., 2016. "Entomology-Based Methods for Estimation of Postmortem Interval. In: Research and Reports in Forensic" *Medical Science Vol. 6.* pp. 1-9. [DOI: 10.2147/RRFMS.S68867]

Hore, G., Parui, P., Saha, G. K., and Banerjee, D., 2017. "Variations in Colonization and Succession Pattern of Dipteran Flies of Forensic Importance on Indian Molerat Carcasses in Urban and Suburban Localities of Kolkata, West Bengal: Implications in Corpse Relocation Studies." *Malaysian Journal of Medical Research*, 1(3): 52–62.

Jales, J.T., Barbosa, T.D., dos Santos, L.C., Rachetti, V.P.S., and Gama, R.A., 2020. "Carrion Decomposition and Assemblage of Necrophagous Dipterans Associated with Terbufos (Organophosphate) Intoxicated Rat Carcasses." *Acta Tropica J.* 212 : 105652.

Magni, P.A., Pazzi, M., Vincenti, M., Converso, V., and Dadour, I.R., 2018. "Development and Validation of a Method for the Detection of α- and β-Endosulfan (Organochlorine Insecticide) in Calliphora vomitoria (Diptera: calliphoridae)." *J Med Entomol.* 55(1):51–58.

Mahat, N.A., Jayaprakash, P.T., and Zafarina, Z., 2012. "Malathion Extraction from Larvae of Chrysomya megacephala (Fabricus) (Diptera: Calliphoridae) for Determining Death due to Malathion." *Tropical Biomedicine* 29 (1): 9–17.

Maile, A.E., Inoue, C.G., Barksdale, L. E., and Carter, D. O., 2017. "Toward A Universal Equation to Estimate Post-Mortem Interval." *Forensic Science Int. Academic Press.* pp. 272: 150–153.

Manik, M. F. 2019. *Pengaruh Morfin Dan Arsen Dosis Letal Terhadap Pertumbuhan Larva Chrysomya Sp. Pada Bangkai Tikus Whistar di Kota Medan*, Tesis, Fakultas Kedokteran. Universitas Sumatra Utara. http://repositori.usu.ac.id/handle/123456789/22458

Matuszewski, S., Bajerlein, D., Konwerski, S., and Szpila, K., 2010. "Insect Succession and Carrion Decomposition in Selected Forests of Central Europe. Part 3: Succession of Carrion Fauna." *Forensic Sci. Int.*, 207:150-163.

Matuszewski, S., Frątczak, K., and Konwerski, S., 2015. "Effect of Body Mass and Clothing on Carrion Entomofauna." *International Journal of Legal Medicine*. Pp. 1–12.

Morris, B., and Dadour I., 2005. *Forensic Entomology: The Use of Insects in Legal Cases. In: Expert Evidence.* Sydney: Law Book Company.

Musyaffa, M.F., Soviana, S., Retnani, E.B, 2021. "The Dynamic of Insect Population Succession in Bird Poisoned by Pyrethroid Insecticides." *Acta Veterinaria Indonesiana. Special Issues*: 102-108.

Putra, I.L.I., and Astuti, N.D., 2021. "Jenis-Jenis Larva Lalat Pada Bangkai Mencit (Mus Musculus L.) Di Desa Bedoyo, Ponjong, Gunung Kidul." *Jurnal Biosains Vol.* 7 No. 2.

Putra, I.L.I., and Marthadella, T.L., 2021. "Identification of Fly Larvas In Syria Hamster Cards (Mesocricetus Auratus

Waterhause) With Dislocation, Poisoned And Burned Euthanasia." *Jambura Edu Biosfer Journal* 3 (1): 11-19.

Stojak, J. 2017. "Use of entomotoxicology in estimating post'mortem interval and determining cause of death." Mammal Research Institute of the Polish Academy of Sciences in Bialowieza. *Issue of Forensic sci.* 295(1)

Szpila, K., Madra, A., Jarmusz, M., and Matuszewski, S., 2015. "Flesh Flies (Diptera: Sarcophagidae) Colonising Large Carcass in Central Europe." *Parasitologi Research.* 114 (6): 2341 – 2348.