

Effect of Arthropods on the Decomposition of Rat Carrions in an Aerated Environment in Spring Season in Assiut, Egypt

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ABSTRACT

Arthropods represent one of the most important invertebrates to arrive and colonize carrion. **Objective:** The present investigation aimed to determine the arthropods fauna of forensic importance that colonizes carrion in an aerated environment during Spring season in Assiut, Egypt. **Methods:** Experimental models rats were killed and divided into Seven groups three rats in each group. Group 1;Control, Group 2 ; Drowning, Group 3;Electro cusion, Group 4 ;Stab of the heart, Group5; Heart-abdomen stab, Group 6;Cold and Group 7; Burn. Rats were used to determine succession in an aerated area during the spring of 2018 in Assiut governorate,Egypt. **Results:** The present results indicated that the arthropods of forensic importance, represented by the thirteen taxa belong to phylum Arthropoda and 10 families, Family: Calliphoridae represented by *Chrysomya albiceps* (5%), Family: Muscidae represented by *Musca domestica* (33%), Family: Sarcophagidae represented by *Sarcophaga* sp.(23%), *Wohlfahrtia magnifica* (22 %)and *Parasarcophaga orgyrostama*(2%), Family: Dermestidae represented by *Dermestes maculates*(1 %) and *Dermestes frischii*(1 %), Family: Histeridae represented by *Saprinus* sp. (4 %), Family: Pteromalidae represented by *Nasonia* sp. (2 %), Family: Lycosidae represented by spider (3%), Family: Pyroglyphidae represented by *Dermatophagoides* sp. (1 %), Family: Cimicidae represented by *Cimex lectularis* (2 %) and Family: Porcellionidae represented by *Porcellionides pruinosus* (1 %). **Conclusion:** The present investigation submitted a basis for further studies dealing with arthropods colonization of carrions.

INTRODUCTION

Arthropods species varies and the great part of all known animal species and occupied all known habitats; marine, freshwater, land and air (Yadav *et al.*,2017and Abd El-Aziz,2018), the number of arthropod species (1,170,000 - 10 million), which represented over 80 % of all known living animal species (Ødegaard, 2000). Arthropods are one of the most important invertebrates to arrive and colonize a cadaver human and animals (Valdes-Perezgasga *et al.*2010), which includes insects, arachnids, myriapods, and crustaceans (Smith,2014 and Ortega-

Hernández, 2016). Arthropods are found in decomposing carrion (Amendt *et al.*, 2004), so arthropods are playing a key role in medico-criminal recognition of human death (Gurafi and Mohamed, 2012). Some information can result from the study of arthropods at carrions after death (Nyasha *et al.*, 2014).

Phylum Arthropoda in the domain of Eukarya. Insects are invertebrates of class Insecta, insects are one of the most abundant animals on the earth (Triplehorn *et al.*, 2004), and occupied all habitats; earth, air and fresh water (Thompson, 1994). James (2004) mentioned that there are about 700,000 described species and there may be more than 10 million species of insects do not describe until now. Although the number of insect species at risk of extinction (Schultz *et al.*, 2019). Insects are the most abundant living creatures that exist on the dry lands of the earth. Insects are the most abundant living creatures that exist on the dry lands of the earth.

Forensic entomologists calculate approximately post mortem interval by analyzing the development or succession of arthropods on the carrions (Matuszewski *et al.*, 2008 and Byrd & Castner, 2009). Forensic entomology is one of the emerging fields of forensic sciences which aids in the legal investigation and there is a need to cover of morphological identification of arthropods species especially if in the adult form of insect is not available (Zar and Huang, 2018). Identification and classification of infesting species should be done by experienced taxonomical scientists and by using different keys (Benecke 2004). Nyasha *et al.*, (2014) and Padonou *et al.* (2017) conclude that there is a lack of information about forensic arthropology or entomology in South Africa, Egypt, Nigeria, Cameroon, Ghana and Zimbabwe. So, the present work is an attempt to fulfill this lack and the present results of this study could be very useful for further forensic work.

MATERIALS AND METHODS

. The present investigation was carried out in Assiut University, Faculty of Medicine, Assiut Governorate, Egypt (Lying between 27° 14' N and 31° 11' E), during the Spring of 2018. The site was devoid of vegetation, the climate is dry, with a mean temperature (29°C shade and 36°C in sun). Experimental models were killed and divided into Seven groups three rats in each group. Group 1; Control (271 g), Group 2; Drowning (286 g), Group 3; Electro cusion (338 g), Group 4; Stab of the heart (339g), Group 5; Heart-abdomen stab (352g), Group 6; Cold (300 g) and Group 7; Burn (340 g) to be used as experimental models to simulate human cadaver decomposition. Each rat was placed in a plate and surrounded by a perforated plastic box to prevent the entry of birds and animal consumers: *Passer passer domesticus*, *Corvus corone*, *Upupa epops*, *Egretta ibis*, cats and reptiles: *Mabya quinquetaeniata*. The substrate of this site is formed mainly of sand and dust.

During the first two weeks after death, the carcasses were visited daily. During each visit, arthropod specimens were collected from the groups and transported to the Laboratory of the Zoology Department, Faculty of Science, Assiut University. For identification of the collecting arthropods, arthropods were placed in 72% ethanol or 10% neutral formalin for permanent storage. Half the larvae collected were preserved and the other half were reared to the adult stage using row liver in the laboratory condition for identification.

RESULTS

1. Identification of the Collecting Arthropods:

In the present study, thirteen taxa were recorded. These taxa belong to phylum Arthropoda and 10 families (Table 1) and (Figs.1- 3).

1.1. Family: Calliphoridae. The adults are commonly shiny with metallic colouring, between 10 and 14 mm in length, often with blue, green with black thoraces and abdomens; *Chrysomya albiceps* (Figs.2,A&4,A) (blow fly) represented by (5%),.

1.2. Family: Muscidae. The adults are grey or black, with darker stripes and other patterns, medium-sized 6–9 mm long, the whole body is covered with hair ; *Musca domestica* (house fly) (Figs.2,B&4,B) represented by (33%).

1.3. Family: Sarcophagidae. The adults are small to large flies (4–23mm). Black and gray longitudinal stripes on the thorax and checkering on the abdomen and is its 3-segmented antennae; *Sarcophaga* sp. (flesh fly) (Figs.2,C&4,C) represented by (23%), *Wohlfahrtia magnifica* (Figs.2,D&4D) represented by (22%) and *Parasarcophaga orgyrostama* (Figs.2,E&5,A) represented by (2%).

1.4. Family: Dermestidae. The adults are very small, the length is (2–12mm). Their bodies are oval and convex in shape, and sometimes elongated. These are covered in hair or scales; *Dermestes maculatus* (hide beetle) (Figs.2,F&5,B) represented by (1 %) and *Dermestes frischi* (Figs.2,G&5,C) represented by (1 %).

1.5. Family: Histeridae. The adults are shiny black or metallic green. Its shape is oval and flat. ; *Saprinus* sp.(clown beetles) (Figs.2,H&5D) represented by(4 %).

1.6. Family: Pteromalidae. The adults are very small, the length is(1–48mm).Its body slender to quite robust; *Nasonia* sp. (Figs.2,I&6,A) represented by(2 %).

1.7. Family: Lycosidae. The body length is(10–35mm)They have eight legs and eyes arranged in three rows. The adults are often dark colored, shades of tan or brown ; Spider(Figs.2,J&6,B) represented by(3%).

1.8. Family: Pyroglyphidae. The body length is 420µm and 320 µm in width; *Dermatophagoides* sp.(dust mites) (Figs.2,K&6,C) represented by(1 %).

1.9. Family: Cimicidae. The body is 5 to 7 mm long and 1.5–3 mm wide. ,reddish-brown, flat, oval, wingless and visible by the human eye and ; *Cimex lectularis* (Bed bugs) (Figs.2,L&6,D) represented by(2 %).

1.10. Family: Porcellionidae. The body length is 5-10 mm (without antennae), abdomen slender clearly divides from thorax, the abdomen is narrower than the thorax, ranges from blue-violet to light orange colored, with waxy grains that makes a soft of surface and flagellum is 2-segmented; *Porcellionides pruinosus* (woodlouse) (Figs.2,M&6,E) represented by(1 %).

2. Stages of Decomposition:

In the present investigation decomposition is divided into five stages (Fig.7).

2.1. Fresh stage (0-12 h)

This stage since the moment of death and continued until bloating. In all the seven groups no putrid odors. Families: Calliphoridae, Muscidae and Sarcophagidae were found flying around carcasses except group 7(burn).

2.2. Bloat stage (12h-3 days)

In the present study, all groups the carrions were completely bloated, a strong putrid odor with decomposition fluids oozing beneath the corpse. The initial colonizers were *Chrysomya albiceps* , *Musca domestica*, *Sarcophaga* sp., *Wohlfahrtia magnifica* and *Parasarcophaga orgyrostama*. Under the carcasses, there were numerous isopods, spiders, and beetles.

2.3. Active decay stage (4-6 days)

In group 1(Control) the skin fur separation, all body surface intact and larval infestation, group 2 (Drowning) purification, open abdomen and mild larval infestation, group 3 (Electro cusion) dry body liquefied tissues in dryness form arborization, group 4 (Stab of the heart) sever putrefaction ,severely liquefied tissues, intestine out abdomen and ruptured intestine pelvis, group5 (Heart-abdomen stab) liquefied tissues and intact intestine , group 6(Cold) sever infestation ,heavy larval infestation and tissue severely putrefied and group 7(Burn) just mild bloating, no ova, no larval and small ruptured left iliac fossa.

2.4. Advanced decay stage(7-29 days)

In all groups odors were less. Carrions were completely dehydrated with loss of weight. Dry skin was starting to separate from the bodies. Numerous insects, isopods, beetles were found. Except group 7(Burn)

2.5.Dry (remains) stage (30-70 days)

In all groups the fleshy tissue disappeared and odor of carrion started to fade.The rats consisted of dry skin and bone. Fewer specimens were collected from Calliphoridae , Muscidae and Sarcophagidae.

Table 1: Most abundant arthropods of forensic importance collected from on rat Carrion in a desert aerated Environment.

Family	Species	Days postmortem	roups (adult arthropods no.)						
			1	2	3	4	5	6	7
Calliphoridae	<i>Chrysomya albiceps</i> (blow fly)	(0-1), (2-4), (5-7) Days	10	10	15	14	14	10	0
Muscidae	<i>Musca domestica</i> (house fly)	(0-1), (2-4), (5-7) Days	30	33	34	103	98	88	0
Sarcophagidae	<i>Sarcophaga sp.</i> (flesh fly)	(0-1), (2-4), (5-7) Days	25	30	16	67	73	75	0
	<i>Wohlfahrtia magnifica</i>	(0-1), (2-4), (5-7) Days	13	18	31	63	63	63	0
	<i>Parasarcophaga orgyrostama</i>	(0-1), (2-4), (5-7) Days	1	1	1	7	6	3	0
Dermestidae	<i>Dermestes maculates</i> (hide beetle)	(2-4), (5-7) Days	2	2	0	5	2	1	0
	<i>Dermestes frischi</i>	(2-4), (5-7) Days	2	5	3	4	1	2	0
Histeridae	<i>Saprinus sp.</i> (clown beetles)	(2-4), (5-7) Days	7	9	3	9	11	9	0
Pteromalidae	<i>Nasonia sp.</i>	(2-4), (5-7) Days	3	4	7	4	4	4	0
Lycosidae	Spider	(2-4), (5-7) Days	5	4	10	6	5	8	0
Pyroglyphidae	<i>Dermatophagoides sp.</i> (dust mites)	(2-4), (5-7) Days	2	2	2	2	5	2	0
Cimicidae	<i>Cimex lectularis</i> (Bed bugs)	(2-4), (5-7) Days	4	5	3	1	2	6	0
Porcellionidae	<i>Porcellionides pruinosus</i> (woodlouse)	(2-4), (5-7) Days	1	2	1	1	1	1	0



Fig. (1) :(A) Group 1; Control,(B) Group 2 ; Drowning,(C) Group 3;Electro-cution,(D) Group 4 ;Stab of the heart,(E) Group5; Heart-abdomen stab, (F) Group 6;Cold,(G) Group 7; Burn, (H) rat carrions in active decay stage and (I) Abundance of arthropods larval stages were present all over the rat carrion.

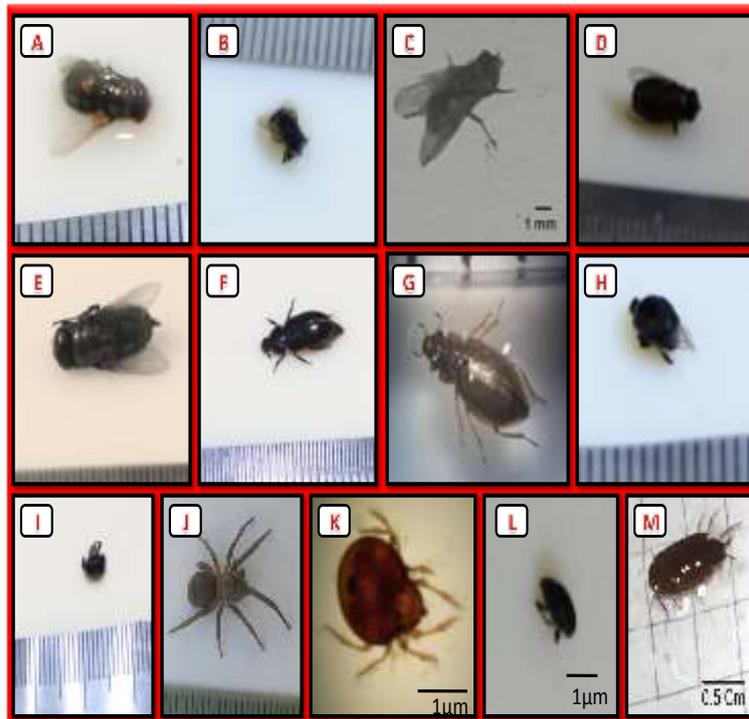


Fig. (2): (A) *Chrysomya albiceps*, (B) *Musca domestica*, (C) *Sarcophaga* sp.,(D) *Wohlfahrtia magnifica* ,(E) *Parasarcophaga orgyrostama*,(F) *Dermestes maculatus*,(G) *Dermestes frischii*, (H) *Saprinus* sp., (I) *Nasonia* sp., (J) spider,(K) *Dermatophagoides* sp., (L) *Cimex lectularis* and (M) *Porcellionides pruinosus*.

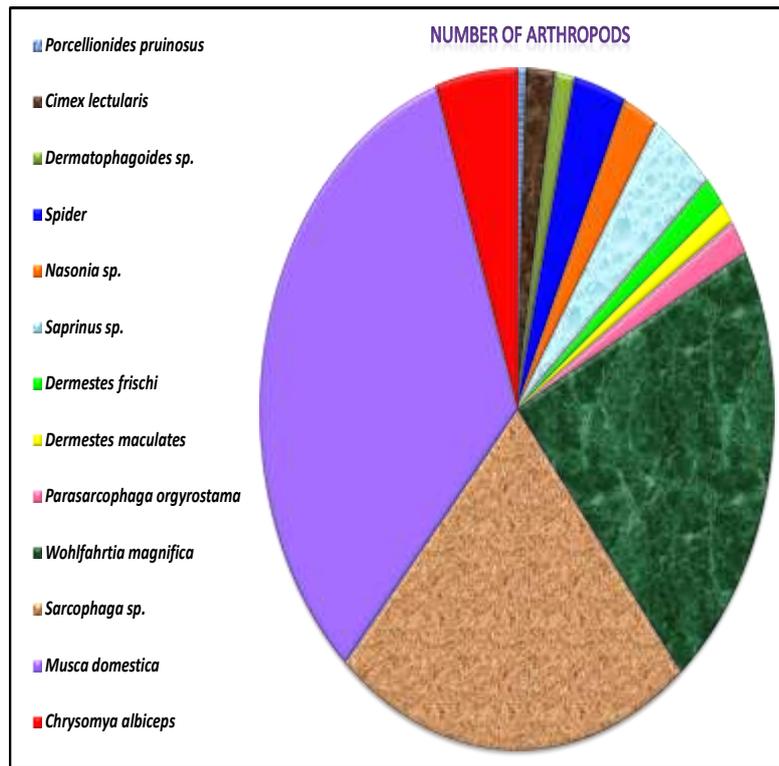


Fig. (3) : Number of arthropods from rat carrions in all seven groups.

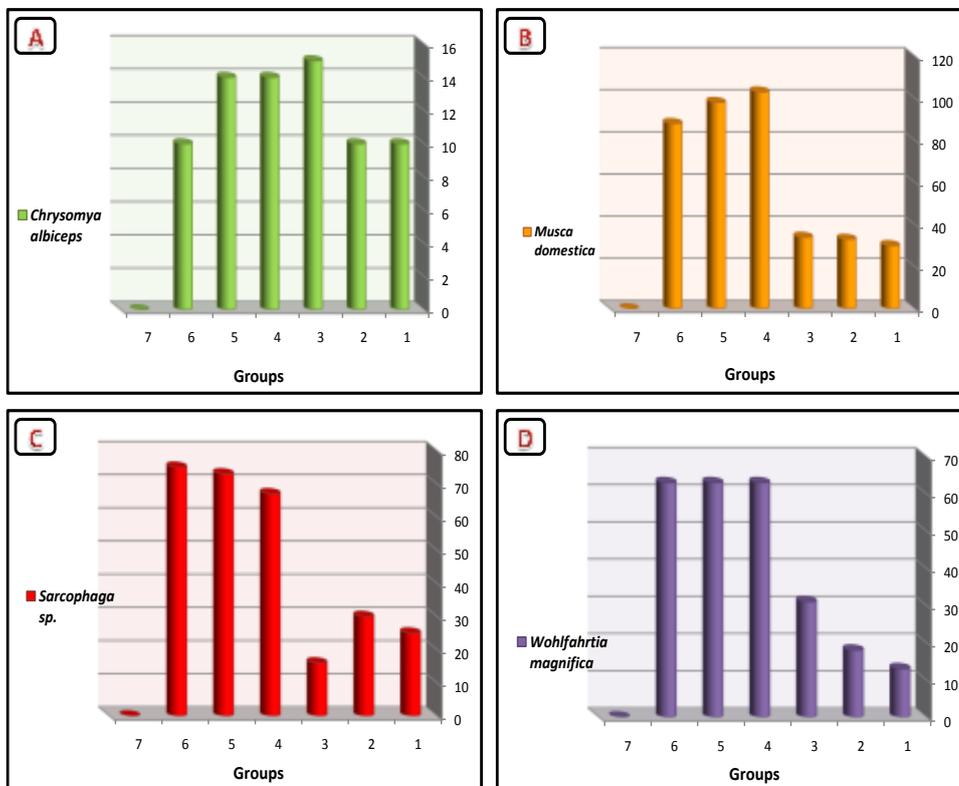


Fig. (4) : Number of arthropods from rat carrions in all seven groups, (A) *Chrysomya albiceps*, (B) *Musca domestica*, (C) *Sarcophaga sp.* and (D) *Wohlfahrtia magnifica*.

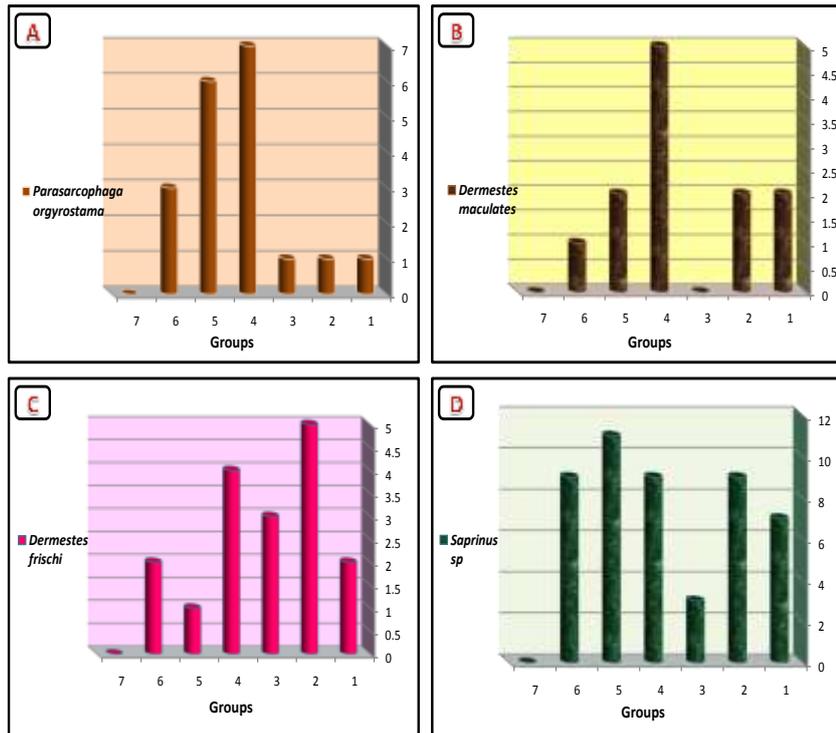


Fig. (5) : Number of arthropods from rat carrions in all seven groups, (A) *Parasarcophaga argyrostama*, (B) *Dermestes maculatus*, (C) *Dermestes frischii* and (D) *Saprinus sp.*

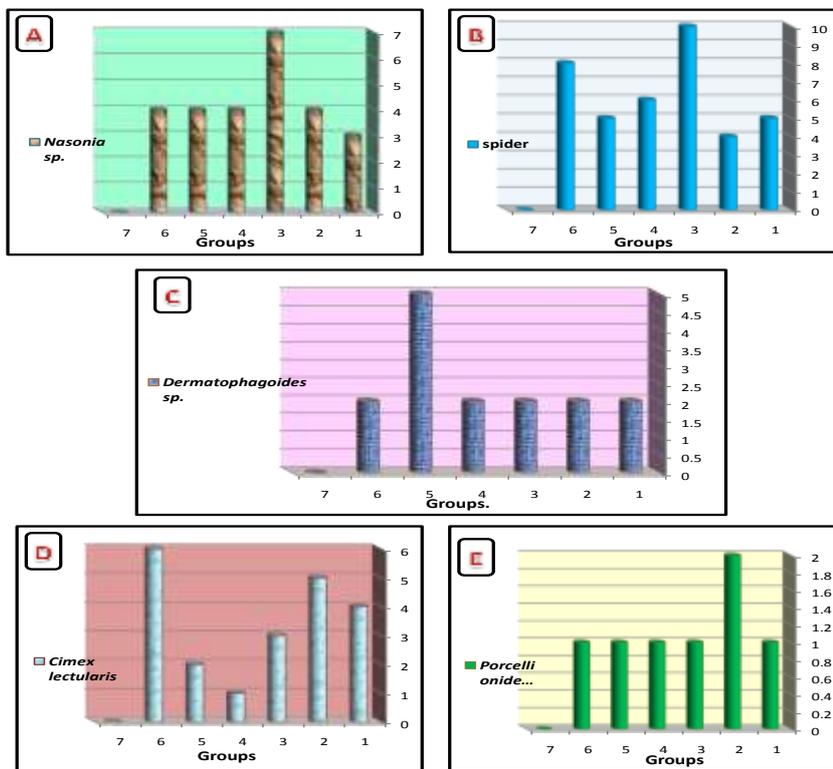


Fig.(6) : Number of arthropods from rat carrions in all seven groups, (A) *Nasonia sp.*, (B) spider, (C) *Dermatophagoides sp.*, (D) *Cimex lectularis* and (E) *Porcellionides pruinosus*.

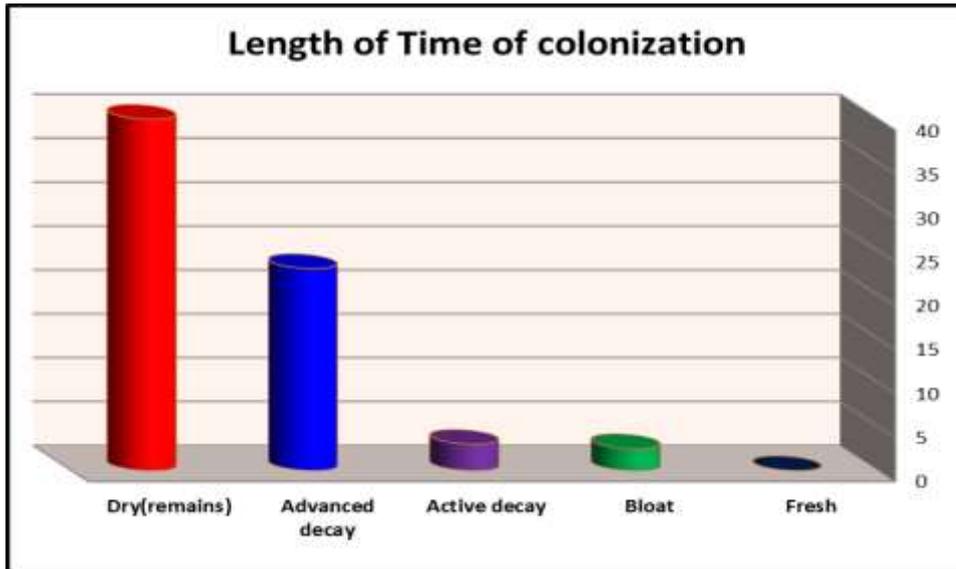


Fig. (7) : Length of time of colonization estimate by stages of decomposition.

DISCUSSION

The present results indicated that the arthropods species of forensic importance and represented by the thirteen taxa belong to phylum Arthropoda and 10 families, Family: Calliphoridae represented by *Chrysomya albiceps* (5%), Family: Muscidae represented by *Musca domestica* (33%), Family: Sarcophagidae represented by *Sarcophaga* sp. (23%), *Wohlfahrtia magnifica* (22 %) and *Parasarcophaga orgyrostama* (2%), Family: Dermestidae represented by *Dermestes maculatus* (1 %) and *Dermestes frischii* (1 %), Family: Histeridae represented by *Saprinus* sp. (4 %), Family: Pteromalidae represented by *Nasonia* sp. (2 %), Family: Lycosidae represented by spider (3%), Family: Pyroglyphidae represented by *Dermatophagoides* sp. (1 %), Family: Cimicidae represented by *Cimex lectularis* (2 %) and Family: Porcellionidae represented by *Porcellionides pruinosus* (1 %), while Aly *et al* (2017) indicated that the maximum number of forensic species was represented by the dipterous insects 18 species on rabbits, Aly *et al.* (2013) also observed 7 families and 10 arthropod species from rabbits and rats, Yassa *et al.* (2014) listed six species of insect and Valdes-Perezgasga *et al.* (2010) mentioned the nineteen species of Arthropods on Pig in Mexico.

In the present investigation decomposition is divided into five stages. Similar observations were also reported by Valdes-Perezgasga *et al.* (2010) and Aly *et al.* (2013) with slight modifications.

No doubt that good environmental conditions of Egypt suitable for increasing the richness of arthropods. likewise, (Goddard & De Shazo, 2009 and Steen *et al.*, 2004) who revealed *Cimex lectularius* is more prevalent in temperate climates. Aerated environment and exposure to sun reduce the time of development insects this agree with (Greenberg *et al.*, 2002). Temperature and access for arthropods to the body is most important affecting the decomposition of the body (Mann *et al.* 1990).

Mites were collected from the early stages of decomposition and the remains of corpses, this result is in accordance with the previous succession studies (Battan, *et al.*, 2005, Camacho, 2005 and Magaa, 2001), which feed on the skin flakes (Frost *et al.* 2010). González *et al.* (2013) concluded that the mites feed on corpses in the early stages of decomposition and feed on dry skin in the later stages of decomposition.

Spiders, *Cimex lectularis* and *Porcellionides pruinosus* which use the corpse as an extension of their environment this agree with the investigated by (Joseph *et al*,2011).

In the present study families: Calliphoridae, Muscidae and Sarcophagidae were found flying around carrions, on the other hand Whitworth (2006) showed the family Sarcophagidae generally arrived at a corpse next to Calliphoridae. Several studies in other regions where Calliphoridae (Watson & Carlton,2003 and Sharanowski *et al.*, 2008) and Sarcophagidae (Watson & Carlton,2003 and De Barros *et al.*,2008) have been mentioned as most important colonizers of carrion.

In the present result beetles found on the carrions from bloat stage until dry or remains stage, this result is supported by the point of view of Midgley *et al.*(2010) where they indicated that beetles are the largest of the insect orders and are extremely adaptive and can be found in almost all environments, beetles found on the corpse when it is more decomposed or advanced decay stage. Beetles they are one of the most diverse macroinvertebrate groups and occur on all continents except Antarctica (Bilton *et al*, 2019).

During the first 29 days after death, biomass loss noticeably. Tissue severely putrefied and water loss during the first four decomposition stages and arthropod colonization. This result is in accordance with the previous succession studies where disturbed and undisturbed rat (De Jong & Hoback , 2006) and rabbit carcasses (Adlam & Simmons ,2007).So, according to the type of carrion, habitat and region, arthropoda species and decomposition times were specific.

Conclusion: The present investigation revealed, the first arthropods arrival time as well as the species of arthropods and its relation to the stages of decomposition were determined. The presence of arthropods was checked at the regular intervals during the period of experiment. The arthropods of forensic importance, represented by the thirteen taxa belong to phylum arthropoda and 10 families.

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ARABIC SUMMERY

تأثير مفصليات الأرجل على تحلل جيف الجرذان في بيئة هوائية في فصل الربيع بأسبوط ، مصر

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تعتبر مفصليات الأرجل واحدة من أكثر الحيوانات اللاقارية انتشارا في الوصول إلى الجيف واستعمارها. **الهدف:** تعريف أهمية الحيوانات المفصلية في الطب الشرعي التي تستعمر الجيف في بيئة هوائية خلال موسم الربيع في أسيوط ، مصر.

الطرق: أجريت الدراسة علي عدد واحد وعشرون من الجرذان البالغين الأصحاء وتم تقسيمهم إلي سبعة مجموعات : كل مجموعة تحتوي علي ٣ جرذان. المجموعة ١ ؛ المجموعة الضابطة ، المجموعة ٢ ؛ تم قتلها بالغرق ، المجموعة ٣ ؛ تم قتلها بالكهرباء ، المجموعة ٤ ؛ تم قتلها بطعنها بالقلب ، المجموعة ٥ ؛ تم قتلها بطعنها في البطن ، المجموعة ٦ ؛ تم قتلها البرودة والمجموعة ٧ ؛ تم قتلها بالحرق. استخدمت الجرذان لتحديد تتابع المفصليات عليها في منطقة هوائية خلال ربيع عام ٢٠١٨ في أسيوط ، مصر.

النتائج: تم تحديد وقت وصول المفصليات إلي الجثة ، وكذلك تحديد أنواع المفصليات المتتابعة علي الجثة وعلاقتها بمراحل التحلل. كما تم التحقق من وجود المفصليات علي فترات منتظمة خلال فترة التجربة والمفصليات التي لها أهمية في الطب الشرعي تمثلت في ثلاث عشرة تصنيفاً تنتمي إلى مفصليات الأرجل ، ١٠ عائلات. عائلة: الذباب المعدني ممثلة في *Chrysomya albiceps* (٥%) ، عائلة: الذباب الحقيقي ممثلة في *Musca domestica* (٣٣%) ، عائلة: ذباب اللحم ممثلة في *Sarcophaga sp.* (٢٣%) ، *Wohlfahrtia magnifica* (٢٢%) ، *Parasarcophaga orgyrostama* (٢%) ، عائلة: خنافس الجلود ممثلة في *Dermestes maculatus* (١%) ، *Dermestes frischii* (١%) ، عائلة: خنافس الجنث الجافة ممثلة في *Saprinus sp.* (٤%) ، عائلة: بروكتوتروبويدا ممثلة في *Nasonia sp.* (٢%) ، عائلة: العنكبوت الذنب ممثلة في العنكبوت (٣%) ، عائلة: القراديات (حلم الغبار) ممثلة في *Dermatophagoides sp.* (١%) ، عائلة: البقيات ممثلة في *Cimex lectularis* (٢%) ، عائلة: بورسيلونيدي ممثلة في *Porcellionides pruinosus* (١%).

الخلاصة: قدمت هذه الدراسة الحالية الأساس لمزيد من الدراسات التي تتعامل مع استعمار المفصليات للجيف في موسم الربيع في وموقعها أسيوط ، مصر.