Identification of forensically important beetles on exposed human corpse in Jeddah, Kingdom of Saudi Arabia

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Abstract: This study described beetle species attracted to an exposed human corpse in the decomposition stage between advanced decay and skeletal. The corpse was found during summer season in Jeddah city, the west region of the Kingdom of Saudi Arabia. Two families of Coleoptera were detected to colonize the corpse, they were Dermestidae represented by *Dermestes frischii* and Cleridae including *Necrobia rufipes.* The collected stages of beetles were described and photographed. The present work is the first documentation of these two species of beetles on human corpse for Jeddah city, kingdom of Saudi Arabia.
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Key words: forensic entomology, Jeddah, beetles, *Dermestes frischii, Necrobia rufipes.*

Introduction:

Among the arthropods visiting corpses or carrions, class Insecta is clearly prevalent with Diptera and Coleoptera being the most abundant orders **(1)**. They attract by the odors and gases released from a corpse, and then start to use it as a resource for feeding, reproduction and larval development **(2)**. Beetles which belong to order Coleoptera are associated with corpses according to different trophic roles of adults or their immature stages, which can feed on dead tissues (necrophagous) or on other insects on the dead body, such as larvae of Diptera or other Coleoptera species (necrophilous) **(3)**. Beetles attract to the corpse in the later stages of decomposition, and they are important to provide information after several weeks or months and to estimate the time elapsed since death or post mortem interval (PMI) within long period after death **(4; 5; 6)**. Among many beetles attract to corpses, families Dermestidae and Cleridaeare commonly found on human and animal cadavers. Family Dermestidae includes 1400 species and sub species belong to about 50 genera worldwide **(7; 8)**. Dermestes is one of these genera, and belongs to subfamily Dermestinae. The *Dermestes* spp. well known as the hide, larder and leather beetles. They feed directly upon decomposition corpse or carcasses in advanced stage of decomposition with preference for dried tissues such as hair, feathers and skin **(9; 10; 11; 12)**. They can be used to aid in establishing a time of colonization or PMI **(13)**. The species *Dermestes frischii* has been frequently mentioned in forensic studies all over the world; in Hawaii **(14)**, Portugal **(15)**, Turkey **(16; 17)**, Spain **(18)** and Iran **(19)**.

However, Family Cleridae has been recognized as multiple taxa. Most species are brightly colored. The subfamilies are rather varied in appearance compared to other families of Coleoptera **(20)**. The Clerid, *Necrobia rufipes* belong to subfamily Korynetinae, and known as the red-legged ham beetle in the United State, copra beetle in tropical countries, copra bug in the Pacific Island **(20)**. It associates with rotting meat, fish, cheese, curd ham and bacon, mammal tissues, coconut and grains. Although, it does not feed on any of these materials; it instead feeds on other insects that infest products or decaying animal matter **(21; 22)**. This species is predator of cheese skipper blowfly and Dermestid larvae **(23)**. *Necrobia rufipes* is also recorded as a serious pest of cashew nuts in India **(24)**. It was frequently present on dry carrion in North America **(25)**. In Brazil, it was identified on pig carrion and human corpses by Carvalho *et al*. **(26)**, and on pet food bags by Gredilha &Lima **(27)**. Shalaby *et al.* **(14)** collected *Necrobia rufipes* from carcasses in contact with soil in Hawaii. It was also recorded in Turkey **(16)**, and in Taiwan for the first time by Hsu *et al.* **(28)**.

The present study aimed to document the presence of these two species of Coleoptera; *Dermestes frischii* and *Necrobia rufipes* on an exposed human corpse for the first time for Jeddah city, Kingdom of Saudi Arabia. In addition to describe morphological characters of the stages found on a corpse which were adults and mature larvae.

2. Materials and Methods:

The specimens examined in this research were obtained from a corpse for 81-year-old woman who

found exposed inthe decomposition stage between advanced decay and skeletal in a goat yard at area located eastern of Jeddah city. Jeddah is presented on the west coast of the Kingdom of Saudi Arabia (latitude 29.21 north & longitude 39.7 east), in the middle of the eastern shore of the Red Sea south of the Tropic of Cancer. The average temperature at the time of discovering the corpse was varied from 33.43°C to 39.13°C.The beetles were collected from the corpse using fine forceps in the death scene. Immediately adult beetles were killed with ethyl acetate in glass jar and then were preserved with collected larvae in 70% ethanol. Specimens were taken to the entomological research laboratory, University of king Abdulaziz in Jeddah, where they were identified. The specimens were examined using dissecting stereomicroscope from Leica Company (Leica M205 C stereomicroscope). Digital photographs of the specimens were taken with Leica IC80 HD camera adapted to a Leica M205 C stereomicroscope, and measurement given in millimeters. The stages of beetles which found on a corpse were identified based on morphological characterization, according to the keys given by Bousquet **(29);** Leavengood **(20)** and Peacock **(30)**. Adults and larvae were described by helping with previous literatures and terminology follows Hava **(31)**.

3. Results:

In this study two families of Coleoptera were detected to colonize an exposed human corpse in the decomposition stage between advanced decay and skeletal stages at summer season in Jeddah which is coastal city, at the western side of the Kingdom of Saudi Arabia. The two families were Dermestidae represented by *Dermestes frischii* Kugelann, 1792 and Cleridae including *Necrobia rufipes* De Geer, 1775. The two species were found in both stages adult and mature larva.

Adult of *Dermestes frischii* is elongate-oval in shape. The size is 11.360 mm in length and 4.133 mm in width. The dorsal face is dark brown, elytra covered with thick white sparse hairs, hind wings are present (fig.1).Head without median ocelli. Antenna is light brown color, short and consist of 11 segments, the last 3 are wider and form a club, without anntenual cavity (fig. 2).

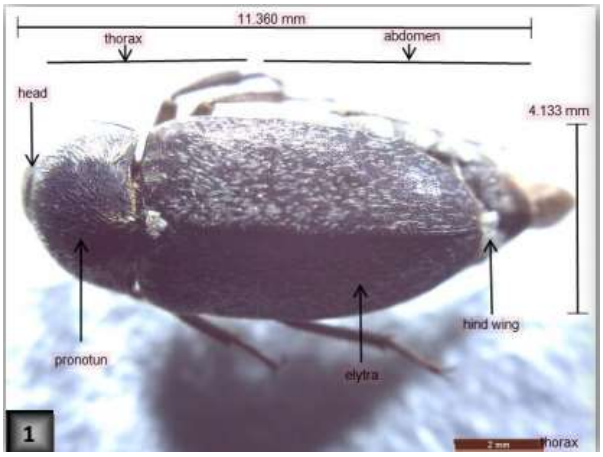
The pronotum (fig.3) is transverse, evenly convex, narrowest at the front and with the posterior angles acute. The pronotum is about 1/3 of the elytra in length, and there are golden setae at its posterior margin. The pronotum is clothed with dense pubescence with white and golden color interspersed forming a broad, longitudinal band on each side and on front part of pronotum (fig.3).The same kind of pubescence is also found on the top of the head (fig.4).

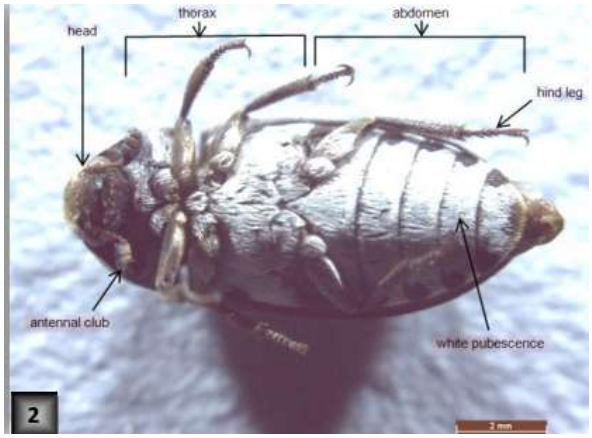
The elytra is long (fig.3), entirely cover abdominal tergites. Elytra pubescence consisting of black and white thick setae interspersed, not in groups with a few golden setae anteriorly. There are suture at the internal angle of each elytra anteriorly, so that they meet in a smooth curve. Margin of elytra smooth apically, apex rounded (fig.5).

The abdomen has 5 visible abdominal sternites (fig.6).Abdominal sternites with white pubescence, and there are 2 spots of black hairs on the sides of each sternite, in addition the last sternite has a median blackish spots on its rear border, which does not extend to the front border of the sternite. In the female there is ovipositor apparatus extend from end of the abdomen.

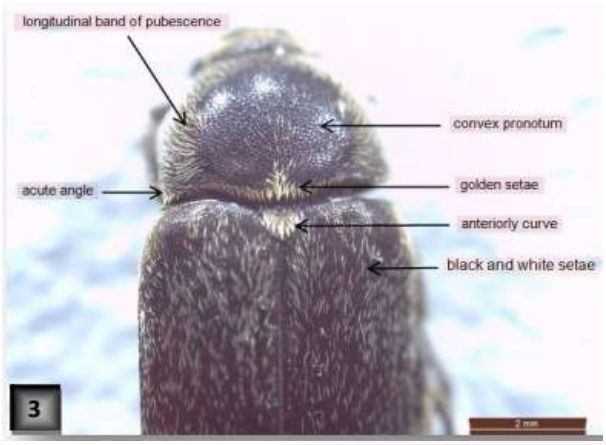
The hypomeron is usually concave, the elytra epipleura are generally distinct (fig.7). The legs are usually retractable and the femur is grooved to receive the tibia when retracted. The ventral part of the body have cavities to receive the legs. The fore coxae are large, conical often contiguous. The hind coxae transverse, slightly separated, and grooved to receive femur, each is dilated to form a plate which extending laterally at least as far as outer edge of metasternum. The tarsus has 5 segments.

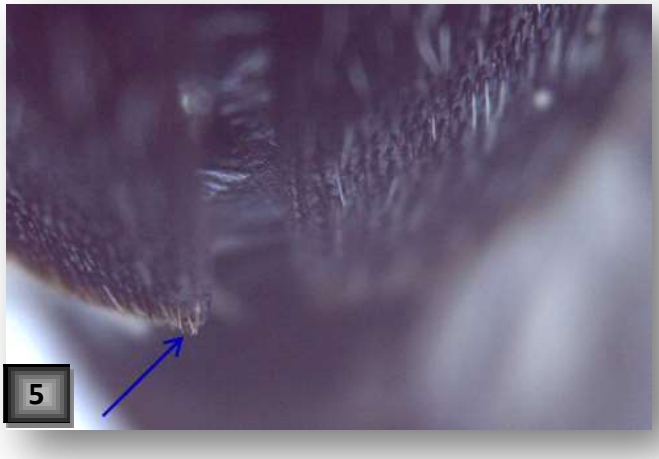
The mature larva are 13 mm in length (fig.8).The body is elongate, subcylindrical, hard cuticle, densely covered with long and short reddish-brown spinulate setae. The posterior end narrower than anterior end (fig9).Head hypognathous and subglobular, visible from above (fig.8).There are 6 ocelli present on each side of the head (fig.10).Antennae consist of 3segments, segment 2 with accessory appendage (a usually small and conical shape) (fig.11).The thorax has three pairs of legs, the leg has 5 segments, with tarsus and claw fused into a single claw-shaped, terminal segment (fig.12).Abdomen has 8 to 10-segmented.On the 9^{th} abdominal segment (the last one), there are two rigid sharp spikes called urogomphi, which are faintly bulbous at their base, get thinner and end up sharp pointed, seen in profile, these sharp ends are distinctly curved toward the insect's backs (fig. 13).The whole body is dark brown to black color, the thorax and the abdomen have a longitudinal dorsal stripe made of light-colored spots, the stripe is roughly the same width from thorax to end of the body, and it is clearly distinguishable from the rest of the body (fig.8 &9).



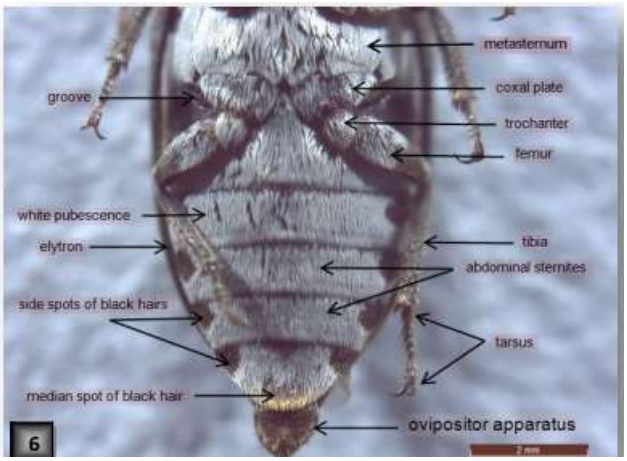


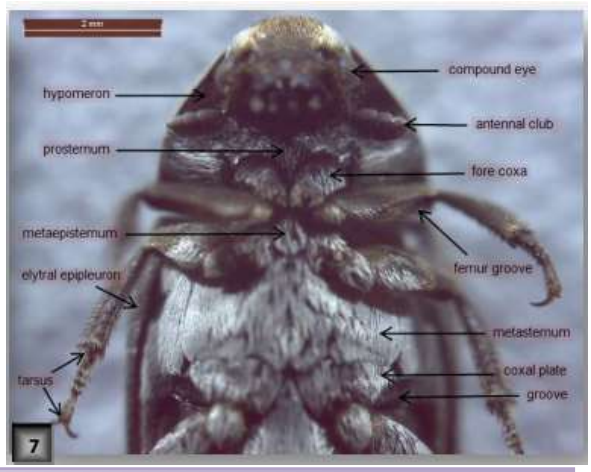
Figs. 1-2: Adult of *Dermestes frischii* beetle . 1. Dorsal view. 2. Ventral view.



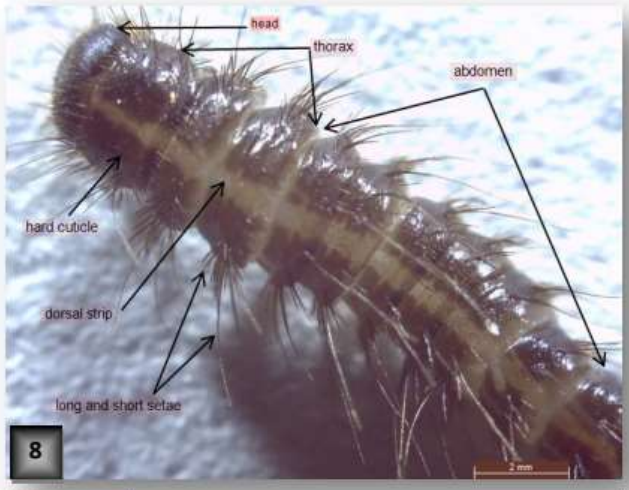


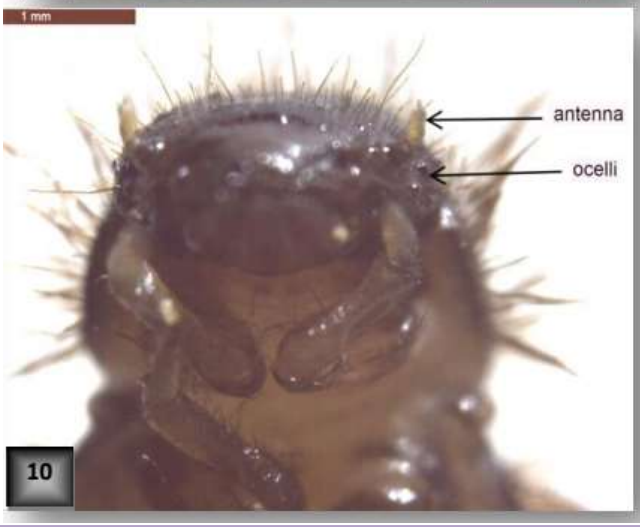
Figs. 3-5: Adult of *Dermestes frischii* beetle . 3. Anterior end. 4. Magnified view for the anterior end. 5. Margin of the elytra (the arrow point to smooth apex)





Figs. 6-7: Ventral view for adult *Dermestes frischii* beetle. 6. Thorax and abdomen regions. 7. Head and thorax regions.



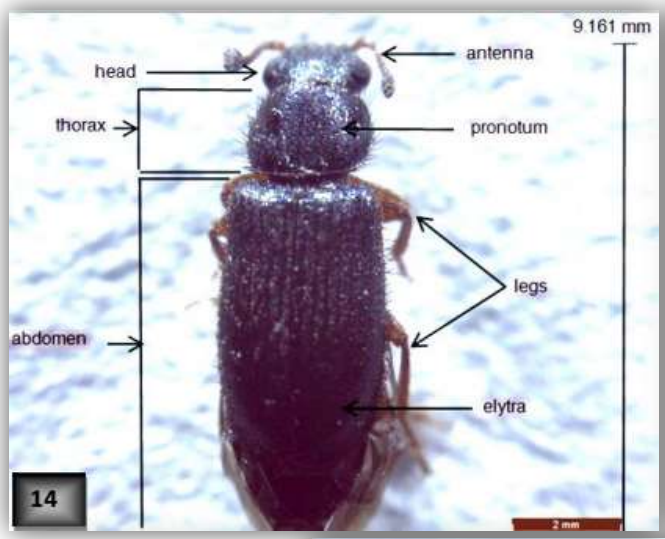


Figs. 8-11: Mature larva of *Dermestes frischii* beetle. 8. Dorsal view. 9. Dorsal view for the posterior end. 10. Ventral view for anterior end illustrates structure of the head. 11. Structure of the antenna (arrow points to the conical accessory appendage)

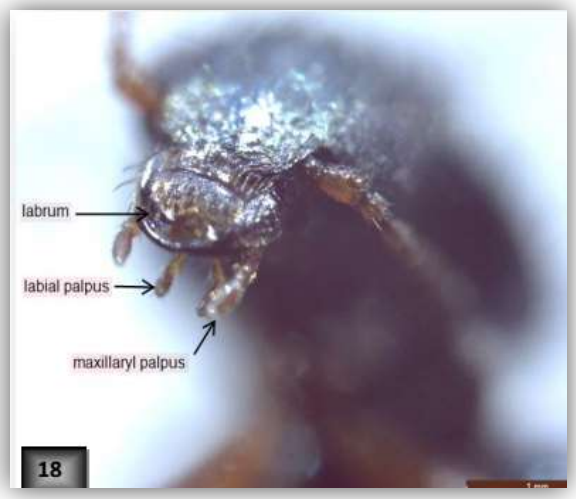
Figs. 12-13: Mature larva of *Dermestes frischii* beetle. 12. Ventral view of head and thorax region. 13. Magnified view for posterior end (the arrow points to the urogomphi)

Adult of *Necrobia rufipes* (fig. 14) is oval-body, brightly colored, with the size of body about 9.161 mm in length, the elytra is metallic blue. The head is wider than pronotum, which is in turn rather cylindrical and narrower than the elytra. The sides of the pronotum have bristle-like hairs pointing outwards (fig. 15). There is no median ocellus on the head, and compound eyes are coarsely granulate, deeply emarginated (fig. 16).The antennae have eleven-segments, with three-segmented club, the ninth and tenth segments distinctly narrowly transverse (fig. 17). There is apical maxillary palps which is oval and apically truncate (fig. 18).The body is mostly metallic bluish-black, the legs and basal segments of antenna are orange, but remaining antenna, eyes and venter are blackish brown, (fig.14&19).Tarsal segment IV much narrower than I-III, tarsal pulvilli present, and on each leg there are flat appendages with light color on the first three segments of tarsus at ventral side which point toward the claws (fig.20).

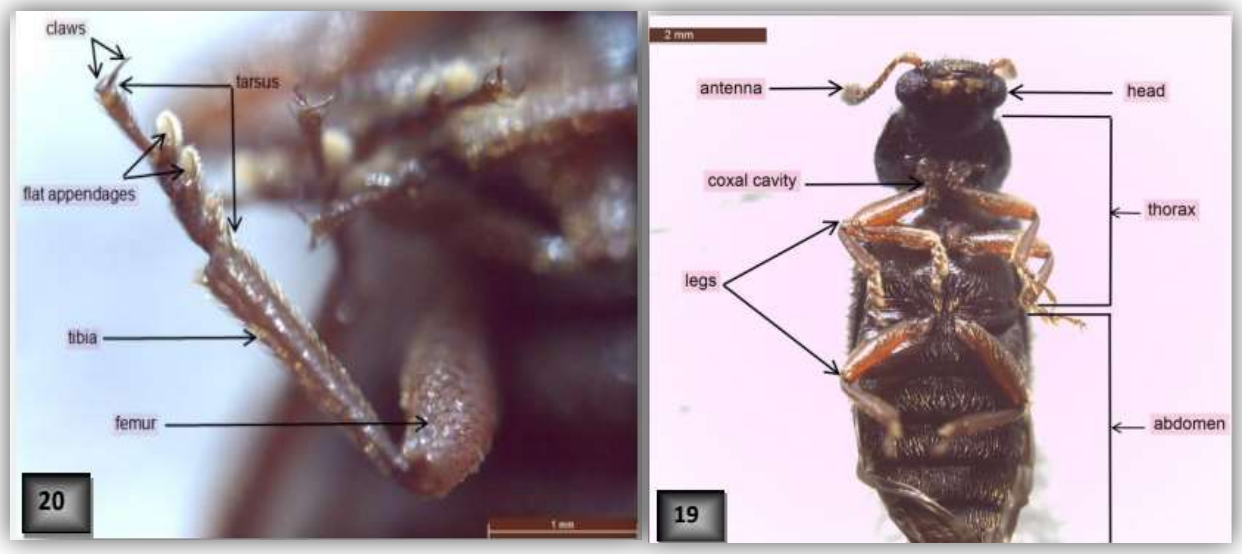
The mature larvae for *Necrobia rufipes* are 11-13 mm in length. The body is elongate, cylindrical; moderately hairy, and the head is rectangle (fig.21).Abdomen has 9 segments (fig. 22).Mouth parts which clear externally are labrum, mandibles, maxillary palps and labial palps (fig.23).There are 2 ocelli present on each side of the head (fig. 24).Antennae consist of 4 segments (fig.25).There are three pairs of legs join with the thorax (fig. 21).The leg has 5 segments end with claw (fig. 26).The whole body is creamish-grey with mottled violet-grey markings on the upper surface (fig.22).The head and upper surfaces of the 1st thoracic segment and the last large abdominal segment with brown hardened plates; 2nd and 3rd thoracic segments also with tiny brownish plates (fig. 21&26).Plate on last abdominal segment with two horn-like protuberances which curve strongly upwards (fig. 26).



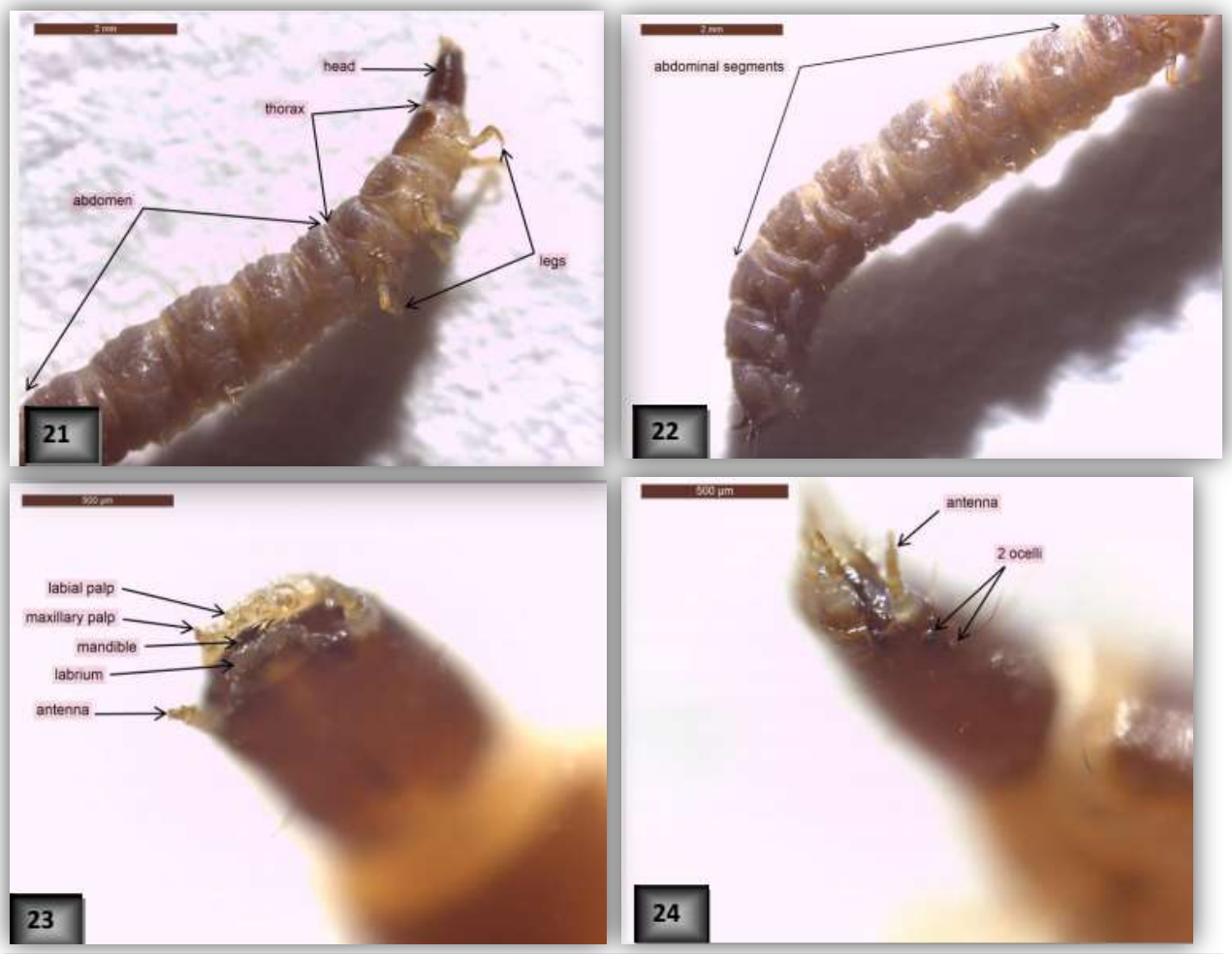
Figs. 14-16: Adult of *Necrobia rufipes* beetle. 14. Dorsal view. 15. Magnified view for thorax (arrow points to the bristles on thorax). 16. Magnified view for the head (arrow points to coarsely granulate compound eye).



Figs. 17-18: Adult of *Necrobia rufipes*beetle. 17. The structure of antenna. 18. Anterior view for the head illustrates mouth parts.



Figs. 19-20: Adult of *Necrobia rufipes* beetle. 19. Ventral view for the body. 20. Structure of the leg.



Figs. 21-24: Mature larva of *Necrobia rufipes* beetle. 21. Lateral view for the body. 22. Lateral view for abdomen region. 23. Anterior-ventral view for the head illustrates mouth parts. 24. Lateral view for the head.

Figs. 25-27: Mature larva of *Necrobia rufipes* beetle. 25. Structure of the antenna. 26. Structure of the leg. 27. Dorsal lateral view for posterior end.

4. Discussion:

The dead body represented food source and habitat for a variety of organisms that extend from bacteria and fungi to vertebrates. Insects were the most important decomposition agents for the animal carcasses and human corpses, being present during all stages of decomposition. In the recent study, two Families of Coleptera were collected from an exposed human corpse at summer season in Jeddah city of the Kingdom of Saudi Arabia. These two families were Dermestidae represented by *Dermestes frischii* and Celeridae including *Necrobia rufipes.* In the kingdom of Saudi Arabia, the two species of beetles were recorded previously on rabbit carcass in Jeddah city by

Al-Shareef & Al-Mazyad **(32)**,other studies proved the presence of beetles from family Dermistidae, (*Dermestes maculatus)* and family Cleridae *(Necrobia ruficollis*) is also on rabbit carcasses in Southwestern Mountains of the Kingdom of Saudi Arabia **(33)**.

In this study, adult and larvae of the hide beetle *Dermestes frischii* were collected from the corpse in the decomposition stage between advanced decay and skeletal, this result due to the beetle feeding habitat, where each of adult and larvae were known to feed on dry skin and hairs and other dry dead animal matter containing animal proteins which are necessary for their full development **(11; 34)** and even so, it had been associated with remains years after death **(3)**. This result is consistent with those recorded by Al-Shareef and Al-Mazyad **(32)** who collected *Dermestes frischii* from rabbit carcass in dry stage of decomposition. Whereas, some authors recorded this species in more earlier stages; Anderson & Van Laerhoven (35) detected larvae of *Dermestes frischii*on on a human corpse in the early stage of advanced decay. Grisales *et al.* **(36)** found *Dermestes frischii* on pig carcass in active decay stage, advanced decay stage and remains in Colombia. Yones *et al.* **(37)** collected *Dermestis frischii* from human left over parts, as adult in bloated stage, but larvae was first observed in decay stage of decomposition, with increasing in number later in the dry stage. Kökdener & Polat **(38)** detected this species on dog carcasses in the active decay stage, advanced decay stage and dry stage.

The present work proved that *Dermestis frischii*was found outdoor, previous studies recorded Dermestid beetles in an open environment, and they were absent or less represent indoors. Goff **(39)** conducted a study to compare the diversity in insects which collected from human decomposing remains; he found that the remains discovered outdoors had a greater variety of Coleoptera species than the remains indoor which had a greater variety of Diptera larvae associated with them. Grisales *et al.* **(36)** found *Dermestes frischii*on pig carcass in an open field. Martin-Vega & Baz **(18)** recorded active of *Dermestes frischii* in natural open habitats using crrion-baited, in central Spain.

From the recent study it was clear that *Dermestis frischii* was found in summer season, where the temperature varied between 33.43°C to 39.13°C, the high temperature produce a quick desiccation of carrion and this condition was suitable for feeding adult and larvae of *Dermestis frischii*. Earlier studies proved that, summer is the most favorable season for this species. *Dermestes frischii*was detected in Alexandaria city in Egypt during summer season by Hegazi *et al.* **(40)** using bait traps and by Tantawi *et al.* **(41)** using rabbit carrion. Grisales *et al.* **(36)** found *Dermestes frischii*on pig carcass when the temperature fluctuated from 22°C to 37°C in Colombia. Martin-Vega & Baz **(18)** recorded active of species *Dermestes frischii* through spring and summer months of the year with the most abundant in June to August. Kökdener & Polat **(38)** detected this species in summer season on dog carcasses. While, Al-Shareef & Al-Mazyad **(32)** collected *Dermestes frischii* in Jeddah city at autumn season where the temperature fluctuated from 23.6°C to 31.55°C.

In the recent study, *Necrobia rufipes* was collected from the corpse in the later stages of decomposition. This result has also been reported by other authors such as Knull **(42)** who recorded a live specimen of *Necrobia rufipes* in the skull of a mummy in Egypt. Also, Carvalho *et al.* **(26)** collected *Necrobia rufipes* from human corpses and pig carrion in Southern Brazil, and Hsu *et al.* **(28)** found *Necrobia rufipes* on a head of caw carcass in Taiwan.

Necrobia rufipes differs from *Dermestids frischii* by being predator not necrophagous **(35; 43)**. It has been reported as predator of the cheese skipper, *Piophila casei* (Diptera: Piophilidae), blowfly and Dermestid larvae by **(23)**. Live larvae of *Dermestes frischii* were recorded to be eaten by *Necrobia rufipes* as natural enemy by Peacock **(30)**.

Some authors recorded species, *Dermestes frischii* and *Necrobia rufipes* together on the corpse, such as Özdemir & Sert **(16)** who found them on pig carcasses in spring and summer season in Ankara, Turkey. Bana & Beyarslan **(17)** detected *Dermestes frischii*and beetles from Genus *Necrobia* in the advanced and dry stages of decomposition on pig carcasses in Turkey. Shalaby *et al.* **(14)** in Hawaii recorded *Dermestes frischii* in the bloated stage, decay stage, post decay stage and skeletal stage, and *Necrobia rufipes*in just decay and post decay stages of decomposition on pig carcasses.

According to study about the beetles associated with animal carcasses and data collected from earlier publication since 1995 in Portugal by Grosso-Silva & Soaress-Vieira **(15)**, *Dermestis frischii* was found on reptile and mammal species and *Necrobia rufipes* was recorded on cat carcasses in central and southern parts of Portugal **(44)**.

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