

# Role of Acari in Forensic Medicine: Review

## Adli Tıpta Akarların Rolü

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**ABSTRACT** The role of insects in determination of time of death in forensic medicine is undeniably important when conventional forensic medicine methods are inconclusive. Information about biology and ecology of insects and activity of not only insects but also acari is of vital importance in forensic entomology providing answers to questions such as time, place and manner of death. The aim of this study is to report role of acari too small to be detected by unfamiliar eyes on corpses in such important issues as determination of time and place of death. These small organisms belonging to Acarina class in Arthropoda root of animal world can be found antemortem and postmortem on the corpse. The most conspicuous acari groups on corpses belong to the suborders of Astigmata and Mesostigmata. Acari are transported to corpses via species belonging to Coleoptera and Diptera orders. Acari transported by insects are called "phoretic acari". Acari leaving their hosts feed with eggs and larvae belonging to insect species on corpses. Predator activities of phoretic acari on corpses give important hints in estimation of time of death. During collection of samples on corpses, it is difficult to identify acari by an unfamiliar eye. For this reason, in crime scene or in autopsy, acari on corpses and insects which carry them should be collected by a specialist and a forensic entomology specialist should be certainly invited to the scene where presence of entomological evidence is determined.

**Key Words:** Acari; diptera; forensic medicine

**ÖZET** Adli bilimlerde ölüm zamanı tayininde böceklerin yeri, klasik adli tıp yöntemleri ile sonuç alınmadığı durumlarda yadsınamaz derecede önemlidir. Böceklerin biyolojileri ve ekolojilerine ait bilgileri birarada kullanarak, bulunan ceset ile ilgili ölüm zamanı, nerede öldüğü, nasıl öldüğü gibi sorulara cevap vermemizi sağlayan adli entomoloji bilim dalında sadece böceklerin değil, aynı zamanda akarların da faaliyeti önem taşır. Bu çalışmadaki amacımız ceset üzerinde gözle görülme-yecek kadar küçük canlılar olan akarların ölüm zamanı ve ölüm yerinin tespiti gibi önemli konularda adli entomolojiye faydalarının belirtilmesidir. Hayvanlar aleminin Arthropoda kökünde Acarina sınıf altına ait bu küçük canlılar, ceset üzerinde ölüm öncesi ve ölüm sonrası bulunabilirler. Ceset üzerinde en fazla dikkat çeken akar grupları Astigmata ve Mesostigmata takımlarına aittir. Akarlar cesede Coleoptera ve Diptera takımına ait türlerle taşınırlar. Akarlar, uygun ortama gelince konaklarından ayrılıp ceset üzerindeki böceklerin yumurta ve larvaları ile beslenir. Böceklerle taşınan akarlar "Foretik akarlar" olarak adlandırılır. Foretik akarların ceset üzerindeki predator aktiviteleri ölüm zamanı tahmininde önemli ipuçları verir. Ceset üzerinden örneklerin toplanması sırasında akarların alışkın olmayan bir göz tarafından fark edilmesi güçtür. Bu nedenle olay yerinde ya da otopsi sırasında, ceset üzerindeki akarlarla onları taşıyan böcekler bir uzman tarafından toplanmalı ve entomolojik kanıtların varlığının tespit edildiği olay yerine mutlaka bir adli entomoloji uzmanı davet edilmelidir.

**Anahtar Kelimeler:** Akar; diptera; adli tıp

Forensic entomology is a science which uses biological, behavioural and ecological features of insects in forensic investigations and in determination of time elapsing from death until finding corpses.<sup>1</sup> Acari transported to corpses by insects are found intensively in all phases from the start of decomposition to dry stage where corpses are completely skeletonised.<sup>2</sup> Acari are seen even in mummified corpses or in low temperature environments or even in hidden corpses.<sup>3</sup> Mites are found almost everywhere from our carpets to pores in our faces.<sup>4-7</sup>

The first acarologist to use acari in estimation of time of death was Mégnin. He emphasized that organisms first reaching to corpses are not only insects, but also acari.<sup>2,8</sup> Mites either reach corpses by walking or are transported to corpses by other insects.<sup>9,10</sup>

The aim of this study is to report role of acari too small to be detected by untrained eyes in important issues such as determination of time and place of death in forensic entomology.

Acari supposed to be important in forensic entomology are found in human body antemortem and postmortem.

### ■ ANTEMORTEM: PERMANENT ACARI

Acari living in human skin in antemortem period are generally called permanent acari. These mites remain alive at wide temperature ranges.<sup>11</sup> It has been reported in the literature that living acari can be found on corpses at 0-53 C°.<sup>9</sup>

Several studies have shown that *Demodex folliculorum* and *Demodex brevis* species are found in follicles in the face and hair roots of all people regardless of race and age apart from newborn infants.<sup>5,12-16</sup>

### ■ POSTMORTEM: PHORETIC ACARI

Acari transported to corpses by arthropods are called phoretic acari.<sup>3,9</sup> This transportation is termed as phoresis. It is frequently observed in places where there are faecal, carcass and rotting plant materials.<sup>3,17,18</sup> It is a kind of parasitism and means that one organism is transported to another

organism temporarily.<sup>3,19-23</sup> Generally this transportation emerges in order to avoid inappropriate environmental conditions such as food shortages and crowded environments in which acari live.<sup>24</sup> They neither have a harmful effect on each other nor benefit from each other. Phoretic acari are transported to corpses by species belonging to Coleoptera and Diptera orders in particular.<sup>3,19-21</sup>

Phoretic acari select the species which live in the same ecology as themselves as carriers and also they are capable of selecting the habitat in which they want to leave their carriers.<sup>25-27</sup> Acari leaving their hosts feed with eggs and larvae belonging to insect species on corpses.<sup>3,25,28</sup> Mites are found in both buried and unburied corpses. Presence of acari which control the population of other insects fed from both environments explains the absence or limited numbers of some insects supposed to exist in the environment.<sup>29</sup>

In what ways we benefit from acari on corpses are as in the following:

1. They are used to determine the time of death and to identify insects by which they have been transported to corpses and to determine when they have reached corpses.<sup>3</sup>

2. They control larva populations on corpses, which may explain absence of the species supposed to be found on corpses.<sup>2</sup>

3. Since they are active in certain seasons, they give seasonal and regional information, which is used to determine whether corpses have been moved from the place of death to somewhere else.

4. House dust mites cause asthma and sometimes they cause anaphylactic shocks in allergic people.<sup>30</sup>

5. It gives information about antemortem life. Permanent acari are important for obtaining information about life-style and personal hygiene.<sup>5</sup>

6. Like other insects, acari can be used in analyses of narcotics and toxins on corpses. For this reason, they may be helpful in obtaining information about causes of deaths.

The most conspicuous acari groups on corpses belong to the suborders of Astigmata and Mesostigmata.<sup>24</sup>

Table 1 shows the distribution of acari and insects by the order of their arrival to corpses during decomposition.

Determination of time of death has social importance in terms of family, society and work relations. In forensic cases, estimation of postmortem interval is as important as determination of the cause of death.<sup>32</sup> Acari transported by insects reaching corpses at different stages of decomposition are of forensic importance. Acari together with insects are encountered in every environment where corpses are found (on land, in aqua...).<sup>3,4,33,34</sup> However these small organisms difficult to be identified by untrained eyes are mostly ignored and as they are not collected, they are not reported.

In winter of 1878 in Paris it was reported that the mummified corpse of a newborn was examined by Mégnin to determine the time of its death and that 2.4 millions of *Tyroglyphus longior* Gervais species were found in the skull of the newborn.<sup>1,4,35</sup> It was the first case where acari were used in estimation of time of death. Perotti stated that *Tyroglyphus* acari were not phoretic after re-examining the article by Mégnin and the data presented. According to Perotti, *Tyroglyphus* acari settled in the skull of the newborn immediately after death and they survived there.<sup>8</sup>

The case reported by Edston and van Hage-Hamsten was quite different from other forensic cases. He was a 47-year-old farmer. In the radioallergosorbent test (RAST) and skin prick tests conducted, rhinoconjunctivitis and asthma-like symptoms were determined in 1988. Mite allergens were measured by Allergen-specific IgE antibodies and in 1995 sensitivity to *Dermatophagoides pteronyssinus* and *Dermatophagoides farinae* were determined. In this period, he complained about headache, nasal obstruction, respiratory distress, nausea, shivering, hot flush, diarrhea and severe thirst while he was staying in his bed. These attacks continued for about 30-45 minutes and ended up with shivering and severe fatigue. They appeared either every week or every six months. During autopsy, he was found to die of anaphylactic shock due to an allergy against all acari allergens and especially *D. pteronyssinus* and *D. farinae* species based on the results of total IgE in immunological tests in blood from the heart and femoral vessels.<sup>36</sup>

In the case presented by Merrit et al., the corpse of a woman shot on her head in 1977 was exhumed and reviewed when new evidence was found in 2005. During autopsy, many acari species belonging to Glycyphagidae family were detected on the corpse.<sup>29</sup>

**TABLE 1:** Arrival stages of insects and acari to corpses depending on decomposition stages.<sup>2,31</sup>

Decomposition Stages	Carriers	Phoretic Acari
Fresh Stage (0-1 day)	Sarcophagidae Muscidae, Hymenoptera	Mesostigmata, Astigmata, Prostigmata, Oribatida
Bloated Stage (2-6 days)	Calliphoridae	Mesostigmata, Astigmata, Prostigmata,
Active Decay Stage (7-12 days)	Calliphoridae, Muscidae, Coleoptera	Mesostigmata, Astigmata, Oribatida, Prostigmata,
Advanced Decay Stage (13-51 days)	Coleoptera-weighted	Mesostigmata, Astigmata, Oribatida, Prostigmata)
Dry Decomposition Stage (52-207 days)	Hymenoptera, Dermestidae,	Mesostigmata, Astigmata
After 2-3 years	Lepidoptera, Phiophilidae	Astigmata

Acari as well as insects can be beneficial in determining the time of death. In a study on permanent acari, Özdemir et al. examined 100 corpses were examined at autopsy. Biopsy samples were taken from body surfaces such as the forehead, nose, chin and eyelashes and *Demodex* was detected in 10% of the cases. It was reported that *Demodex* type mites remain alive for 55 hours in the body postmortem.<sup>37</sup> This information is very valuable in that it provides supporting evidence for estimation of time of death.

Phoretic mites leave living organisms on which they live when they come to an appropriate environment. They feed by eating eggs and larvae of flies and Coleoptera which arrive at corpses earlier than themselves. In the meantime they control the population and development of species which are expected to exist on corpses. It should be remembered

that removing the species arriving at corpses previously may lead to estimations of postmortem interval longer than it is. While examinations are being carried out on the scene and during autopsy, predator activities of acari should be taken into consideration.

In Turkey, a study about phoretic acari and their activities on corpses has not been conducted yet. Researches to be conducted in this regard will help researchers working in forensic entomology field to estimate time of death accurately.

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## REFERENCES

- Açıkğöz H. [Forensic entomology]. *Türkiye Parazitol Derg* 2010;34(3):216-21.
- Braig HR, Perotti MA. Carcasses and mites. *Exp Appl Acarol* 2009;49(1-2):45-84.
- Perotti MA, Braig HR. Phoretic mites associated with animal and human decomposition. *Exp Appl Acarol* 2009;49(1-2):85-124.
- Alejandra Perotti M, Lee Goff M, Baker AS, Turner BD, Braig HR. Forensic acarology: an introduction. *Exp Appl Acarol* 2009;49(1-2):3-13.
- Desch CE. Human hair follicle mites and forensic acarology. *Exp Appl Acarol* 2009;49(1-2):143-6.
- Türk M, Öztürk İ, Şener A, Küçükbaş S, Afşar İ, Maden A. Comparison of incidence of *Demodex folliculorum* on the eyelash follicle in normal people and blepharitis patients. *Türkiye Parazitol Derg* 2007;31(4):296-7.
- Bavbek S. [Aeroallergens and Bronchial Asthma]. *Türkiye Klinikleri J Med Sci* 1997; 17(4):255-9.
- Perotti MA. Mégnin re-analysed: the case of the newborn baby girl, Paris, 1878. *Exp Appl Acarol* 2009;49(1-2):37-44.
- Perotti M, Braig H. Acarology in crimino-legal investigations: The human acarofauna during life and death. In: Byrd J, Castner J, ed. *Forensic Entomology: The Utility of Arthropods in Legal Investigations*. 2<sup>nd</sup> ed. New York: Taylor & Francis; 2009, p.637-45.
- Oconnor BM. Astigmatid mites (Acari: Sarcopitiformes) of forensic interest. *Exp Appl Acarol* 2009;49(1-2):125-33.
- Özçelik S, Sümer Z, Değerli S, Özyazıcı G, Berksoy Hayta S, Akyol M, et al. [The incidence of *Demodex folliculorum* in patients with chronic kidney deficiency]. *Türkiye Parazitol Derg* 2007;31(1):66-8.
- Zhao YE, Guo N, Wu LP. Influence of temperature and medium on viability of *Demodex folliculorum* and *Demodex brevis* (Acari: Demodicidae). *Exp Appl Acarol* 2011;54(4): 421-5.
- Emre S, Aycan O, Atambay M, Bilak S, Daldal N, Karıncaoğlu Y. What is the importance of *Demodex folliculorum* in Behçet's disease? *Türkiye Parazitol Derg* 2009;33(2):158-61.
- İnceboz T, Yaman A, Över L, Öztürk A, Akisu Ç. Diagnosis and treatment of Demodectic blepharitis. *Türkiye Parazitol Derg* 2009;33(1):32-6.
- Yazar S, Özcan H, Çetinkaya Ü. [Investigation of *Demodex* sp. using cellophane tape method among university students]. *Türkiye Parazitol Derg* 2008;32(3):238-40.
- Emre S, Aycan Ö, Atambay M, Bilak Ş, Konuş İ, Doğanay S, et al. [Demodex folliculorum prevalence among chronic blepharitis patients]. *Turkiye Klinikleri J Ophthalmol* 2008; 17(3):178-81.
- Atakan E, Çobanoğlu S, Yüksel O, Bal D. [Phoretic uropodid mites (Acarina: Uropodidae) on the red palm weevil [*Rhynchophorus ferrugineus* (Oliver, 1790) (Coleoptera: Curculionidae)]. *Turkish Journal Entomology* 2009; 33(2):93-105.
- Macchioni F. Importance of phoresy in the transmission of Acarina. *Parassitologia* 2007; 49(1-2):17-22.
- Evans G. Phoresy. *Principles of Acarology*. 1<sup>st</sup> ed. Cambridge: CAB International; 1992. p.364-5.
- Bajerlein D. Uropoda orbicularis by beetles (Coleoptera) associated with cattle dung in Poland. *Eur J Entomol* 2004;101(1):185-8.
- Yano S. Does *Tetranychus urticae* (Acari: Tetranychidae) use flying insects as vectors for phoretic dispersal? *Exp Appl Acarol* 2004; 32(4):243-8.
- Krantz GW. Reflections on the biology, morphology and ecology of the Macrochelidae. *Exp Appl Acarol* 1998;22(3):125-37.
- Grossman J, Smith R. Phoretic mite discrimination among male burying beetle (*Nicrophorus investigator*) hosts. *Ann Entomol Soc Am* 2008;101(1):266-71.
- Salmene I, Telnov D. Mesostigmata mites (Acari: Parasitiformes) associated with beetles (Insecta: Coleoptera) in Latvia. *Latvijas Entomologs* 2009;47(1):58-70.
- Nehring V, Müller JK. Social environment affects the life history tactic of a phoretic mite. *J Evol Biol* 2009;22(8):1616-23.
- Bloszyk J, Klimczak J, Lesniewska M. Phoretic relationships between Uropodina (Acari: Mesostigmata) and centipedes (Chilopoda) as an example of evolutionary adaptation of mites to temporary microhabitats. *Eur J Entomol* 2006;103(3):699-707.
- Rodrigueiro T, do Prado A. *Macrocheles muscaedomesticae* (Acari, Macrochelidae) and a species of *Uroseius* (Acari, Polyaspididae) phoretic on *Musca domestica* (Diptera, Muscidae): effects on dispersal and colonization of poultry manure. *Iheringia Sér Zool* 2004;94(2): 181-5.
- Bölükbaş C, Soner D. [Alternative control approaches for helminth infections]. *Türkiye Parazitol Derg* 2007 ;31(4):322-6.
- Merritt RW, Snider R, de Jong JL, Benbow ME, Kimbrauskas RK, Kolar RE. *Collembola* of the grave: a cold case history involving arthropods 28 years after death. *J Forensic Sci* 2007;52(6):1359-61.
- Çiftçi F. [Treatment of allergic asthma]. *Türkiye Klinikleri J Fam Med-Special Topics* 2011; 2(1):50-3.
- Wolff M, Uribe A, Ortiz A, Duque P. A preliminary study of forensic entomology in Medellín, Colombia. *Forensic Sci Int* 2001;120(1-2):53-9.
- Açıkğöz H, Açıkğöz A, İşbaşı T. [Predator behavior of *Chrysomya albiceps* (Fabricius) (diptera:Calliphoridae) on human corpses]. *Türkiye Parazitol Derg* 2011;35(2):105-9.
- Solarz K. Indoor mites and forensic acarology. *Exp Appl Acarol* 2009;49(1-2):135-42.
- Proctor H. Can freshwater mites act as forensic tools? *Exp Appl Acarol* 2009;49(1-2):161-5.
- Benecke M. A brief history of forensic entomology. *Forensic Sci Int* 2001;120(1-2):2-14.
- Edston E, Hage-Hamsten M. Death in anaphylaxis in a man with house dust mite allergy. *Int J Leg Med* 2003;117(5):299-301.
- Ozdemir MH, Aksoy U, Akisu C, Sönmez E, Cakmak MA. Investigating demodex in forensic autopsy cases. *Forensic Sci Int* 2003; 135(3):226-31.