

The history of forensic entomology in German-speaking countries

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Abstract

Megnin's book "La fauna des cadaveres" published in 1894 in France is generally accepted as a mile-stone in forensic entomology. It is hardly known that at the same time this topic was likewise explored in the German-speaking countries. Even PMI estimation based on developmental data of blowflies was performed. After a more descriptive period in the first half of the 20th century the complexity and variability of insects' biological behavior were detected and formally investigated. Improved technical facilities, enhanced comprehension of scientific studies and multidisciplinary cooperation, enabled rapid progress in forensic entomology during the last decades. With the European Association for Forensic Entomology founded in 2002 the frame work for a high standard of competency at an international level was constituted.

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1. The beginning of formal investigations

In medieval Europe the awareness of the association between maggots' colonization of carcasses and oviposition of flies was impeded by the theory of spontaneous generation. According to this theory life was spontaneously generated from material. Illustrations of corpses colonized by maggots were recorded since the 16th century (Fig. 1). Comprehension of biological fundamentals referring to different steps of development of numerous insects up to adult stages (metamorphosis) (Fig. 2) started in the course of the 17th century.

It lasted a few more centuries until forensic entomology as a scientific discipline was established [2,9]. In France Megnin published his famous book "La faune des cadavres" in 1894 [24] and set up a mile-stone of formal records on different waves of insects' colonization of human corpses (succession). At the same time this topic was explored in Germany by von Hofmann [17,18] and Reinhard [30]. After mass exhumations in Franconia and Saxonia, Phorid flies

were discovered at human remains including *Conicera tibialis* Schmitz. These organisms are still denominated as "coffin flies" today [9]. In Switzerland the entomological fauna of graveyards in Basel was recorded by Hunziker [20] in 1919. During this period also the differentiation of post-mortem feeding defects caused by insects was of forensic relevance. In 1881, Maschka [23] described the case of a deceased child with skin defects located in the face and neck that had been caused by ants, but were initially misunderstood to be due to a corrosive substance. After this case had been published a father was exonerated after 8 years of imprisonment. His child had been found dead with similar lesions. The skin defects had foremost been misinterpreted by the forensic pathologists as acid-induced skin burns, although there were no injuries of the esophageal or gastric mucosa and ants had been discovered in the oral cavity. In 1898, a comparable case was reported by Klingelhöffer [21]: An infant, probably dying from enteritis, was found with drop shaped skin defects located at nose, lips and thorax. The lesions were initially interpreted as skin burns, but finally diagnosed as feeding defects caused by cockroaches post-mortem. The father of the infant, who had access to acidic agents was likewise exonerated. On the grounds of improved living conditions, pest control and enhanced knowledge regarding the phenomenon of postmortem

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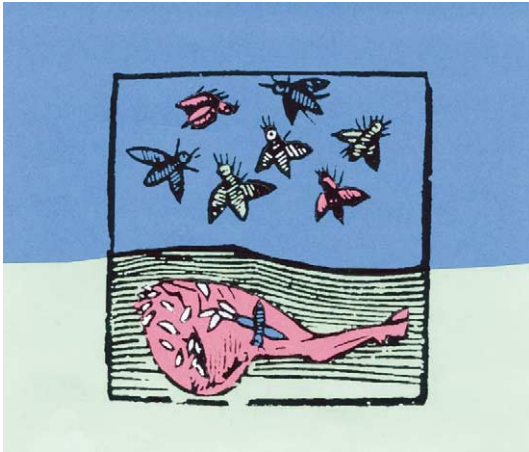


Fig. 1. Wood carving from 1521: flies swarming above carcass remnants colonized by maggots (Forschung Frankfurt).

feeding defects in legal medicine, such cases are merely of historic interest contemporary.

2. From descriptive case reports across “rough calculations” to scientific PMI-estimation

The determination of the time of death is one of the major topics in legal medicine and becomes more difficult with increasing postmortem interval (PMI). Hence considerations

if insects’ colonization of human corpses may lead to conclusions usable for PMI-calculations had been established in Germany during the 19th already. The bibliography of forensic medicine during the turn of the 19th to the 20th century is containing manifold graphic descriptions regarding the colonization and development of fly larvae on human corpses comprising several precise and detailed accounts which are still of current relevance [18,19]. Moreover PMI-calculations based on the developmental data of blowflies were published in 1898 by von Hofmann [19] including laboratory investigations.

The theory of time-dependent waves of insects’ succession on human corpses was objected by Strauch in 1912 [40]: “The biological behavior of the different insect species is not sufficiently estimated for conclusions regarding the time of death of the colonized organism”. This statement was also supported by Pietrusky and Leo [28] who were discussing that insect development was influenced by external components predominantly by climatic conditions.

Beginning with the 20th century insects in general became a focus of interest due to the necessity of improvement of hygienic conditions. Moreover, Baer [6] reported on maggot debridement as an effective treatment option for non-healing chronic wounds. In forensic pathology various case reports were published concerning the biological behavior of necrophagous insects on human corpses, including species composition [27], duration of development [25], oviposition [27] and feeding behavior [25,41]. Already in 1908 Puppe [29] observed a case of completed skeletonization of a human corpse within a couple of days due to the



Fig. 2. Different developmental stages of blowflies (clockwise): adult flies, eggs, three distinct larval stages, puparia from which the adult stages emerge after completing the metamorphosis (by M. Hall, Natural History Museum, London).

activity of blowfly maggots. On the occasion of a double homicide with the two victims in close vicinity over 3 weeks, Merkel in 1925 [26] accomplished a comparative study and described that the colonization pattern of necrophagous insects was also depending on the character of the previous wounds and the covering of the body by clothing. Weimann [43] referred to the temperature-dependent development of necrophagous insects in 1940 and discussed the question of nocturnal oviposition, which is still of current interest. In general the relation between death of the individual and the oviposition of flies which might be delayed by impeded accessibility was already emphasized by Schönberg in Switzerland in 1951 [34]. On part of the biologists in 1864 Weismann [44] published developmental data of forensically important species. Studies on the morphology of relevant blowflies including determination keys were issued by Schumann in 1954 [39] presumably without apprehension in the forensic world.

Altogether the first half of the 20th century can be summarized as a descriptive period in forensic entomology. The perception of the complexity and variability of the biological behavior of necrophagous insects apparently implied reluctance concerning interpretations usable for PMI-estimation. In the course of the following decades the scientists were challenged by the difficulties to detect and systematically investigate all influencing factors.

The growing behavior of forensically relevant fly species under laboratory conditions was systematically investigated by Schranz in 1935 [35] in Germany. However, the influence of the ambient temperature was not considered, a fact reproved by Mueller and Berg [11]. In his medical thesis, issued in 1951, André [5] investigated the correlation between larva development and PMI related to different ambient temperatures. The author discussed difficulties regarding the species determination of fly larvae and emphasized the necessity to acquire data of temperature and further environmental conditions of the crime scene. Referring to this, Berg [11] concluded that aberrations in PMI-estimation based on colonizing insects were of more importance than basically considered. However, the potential of a “rough calculation” should not be underestimated. As a forensic pathologist he also encouraged the application of expanded entomological knowledge in the field of PMI-estimation and presumed that different species may vary referring to their growing behavior. He indicated that the determination of young larva might be limited. Also Mueller (cited after [31]) emphasized the necessity of formal morphological investigations by entomologists. The influence of chemical substances on the developmental behavior of necrophagous insects ingested by the deceased



Fig. 3. Human remains infested with maggots.

prior to death was first described by Wagner in 1960 [42]. He investigated different biological behavior of maggots colonizing dead bodies of individuals who had recently been treated with tetracyclin and anticipated the subject of entomotoxicology which became foremost popular in the 1980s.

3. Aspects of modern forensic entomology

During the last decades the rapid progress in the field of forensic entomology was based on improved technical facilities, enhanced comprehension concerning the essential design of scientific studies and extension of a multidisciplinary cooperation between entomologists, specifically trained police officers and forensic pathologists.

In Vienna, Austria, Reiter et al. issued systematical studies on flies of forensic relevance including their morphology, taxonomy, ecology and growing behavior in the early 1980s [31–33]. Grassberger together with Reiter [13–16] published further work on biological behavior of necrophagous insects. In comparison with work from other authors his data indicated that the same species may differ in their developmental time due to the geographical region. During the 1990s further research teams were established in Switzerland and Germany. In addition with extending publicity the subject became more and more appreciated concerning forensic relevance. In 1997, a murder case with high interest for the public at large was solved on the grounds of entomological evidence [7]. Ants acting as crime scene stains had linked the suspect to the incident and a priest was sentenced as perpetrator to 8 years imprisonment. In Cologne the biologist Benecke reported on several examinations of human corpses colonized by necrophagous insects [8]. In a crime case Benecke and Lessig [10] concluded, on the grounds of entomological investigation, that a child had been neglected prior to death. Since the mid-1990s the police officer Wyss [12,45] is operating on

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unknown      : ACATTATTTTACATGATACATATTATGTAGTAGCTCATTTTCATTATGTTCTATCAAT
S. canaria  : .....
P. albiceps : .T.....C.....C.....A.....T..
    
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Fig. 4. Sequence-polymorphism of flesh fly larvae: Identical nucleotides are indicated by dots, differing nucleotides by their symbols. The unknown species has a different sequence compared to *P. albiceps* and an identical sequence with *S. canaria*.

entomological crime cases and performing studies on insects' succession on pig carcasses in co-operation with the entomologist Cherix and the department of Legal Medicine in Lausanne, Switzerland. In 1997, a research project on forensic entomology was founded by the entomologists Amendt and Krettek, the biologist Zehner and the forensic pathologists Bratzke and Constanze Niess in Frankfurt/Main and 3 years later for the first time in Germany an autonomous unit of forensic entomology was constituted in the department of Legal Medicine. Besides entomological education for police officers and pathologists, the scientific activities [1–4,46,47] of the research group are including studies on insects' succession on human corpses (Fig. 3) and genetic identification of barely distinguishable flies of forensic relevance, e.g. flesh flies (Diptera: Sarcophagidae) [46] (Fig. 4).

Following the model of Frankfurt in 2000 in Hamburg a research group on forensic entomology was constituted by the entomologist Hilke Schröder and the forensic pathologists Heike Klotzbach, Oesterhelweg and Püschel in cooperation with police forces. Research is mainly focused on species composition and succession on corpses found in domestic environment [22,36,38]; the differentiation of morphological similar calliphorid larvae with PCR-RFLPs was established [37]. In accordance with Grassberger [13–16] differences in the developmental time of the same species were observed indicating geographical variabilities.

4. The European Association for Forensic Entomology (EAFE)

The EAFE was founded in 2002 to promote the development of forensic entomology throughout Europe and achieve a high standard of competency. With Reiter, Vienna and Amendt, Frankfurt, there are two board members from the German-speaking countries. The 1st EAFE meeting was held in April 2003 in Frankfurt, Germany, with 29 presentations of highest international level and 75 participants from 18 countries including USA, Canada and Australia. Forensic entomology is on a promising track into forensic departments and courtrooms.

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