DESAFÍOS DE LA ESTIMACIÓN DEL INTERVALO POSTMORTEM EN ESTRUCTURAS ÓSEAS

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The postmortem interval

The postmortem interval

- Estimating the PMI of skeletal remains continues to be subject of current research.
- Estimating the PMI becomes more difficult the more advanced the decomposition.

- A key question concerns the „forensic relevance“:

  50 years[1]

  75 years[2]

  post 1950[3]

1 Verhoff MA., Kreutz K. (2005) Macroscopical Findings on Soil-Embedded Skeletal Remains Allowing the Exclusion of a Forensically Relevant Lay Time. In: Tsokos M. (eds) Forensic Pathology Reviews. Forensic Pathology Reviews, vol 3. Humana Press.

2 Swift B (2016) The timing of death. The essentials of autopsy practice: current methods and modern trends. Springer pp 189-214

3 Cappella et al(2018). The comparative performance of PMI estimation in skeletal remains by three methods (C-14, luminol test and OHI): analysis of 20 cases. Int J Legal Med, 132(4), 1215–1224.

The postmortem interval

- Accompanying finds / findings may already suffice

The postmortem interval

Bone Find with an unknown PMI

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Findings	Earliest PMI
No soft tissue coloring left	56 years
Macroscopically no traces of adipocere on outer surface, compact bone or bone marrow	> 50 years
Noticable incisions of humerus head and femur condyles	52 years
Compact bone opening in the direction of the incisions, partly polygonally arranged	155 years
Longitudinal and transversal incisions of compact bone	200 years
Fraying of outer lamellar system	155 years
Lifting of cortical bone	200 years
Enlarged defects of outer surface	> 50 years
Torsion of tissue	200 years
Dark brown, earthy colour	155 years
Intensive blackish-brownish discoloration due to microorganisms on outer surface	155 years
Brushite: White effflorescence on the compacta	155 years
Bone manually breakable	1200 years

Based on: Verhoff MA., Kreutz K. (2005) Macroscopical Findings on Soil-Embedded Skeletal Remains Allowing the Exclusion of a Forensically Relevant Lay Time. In: Tsokos M. (eds) Forensic Pathology Reviews. Forensic Pathology Reviews, vol 3. Humana Press.

Macromorphological criteria

Macromorphological criteria

- The decomposition of soft and boney tissue is highly determined by various external conditions, foremost the soil composition.
  - Additional factors influence the speed of decomposition e.g.
    - the burial depth and
    - weather conditions.
  - No sufficient Data on open-air storage.

- Estimating the PMI solely on macromorphological criteria remains to be challenging and risky.

^{14}C radiocarbon dating

- Based on the uptake of ^{14}C into living organisms through photosynthesis and the food chain.[1]
- Upon death, the ^{14}C quantity declines with a documented half-time of 5730 years.[2]
- Can be applied directly to samples of human bones and teeth.[2]

1 Taylor RE (2000) Fifty years of radiocarbondating. Am Sci 88(1):60-7
2 Ubelaker DH (2014) Radiocarbon Analysis of Human Remains: A Review of Forensic Applications. J Forensic Sci, 59(6), pp 1466-1472

^{14}C radiocarbon dating

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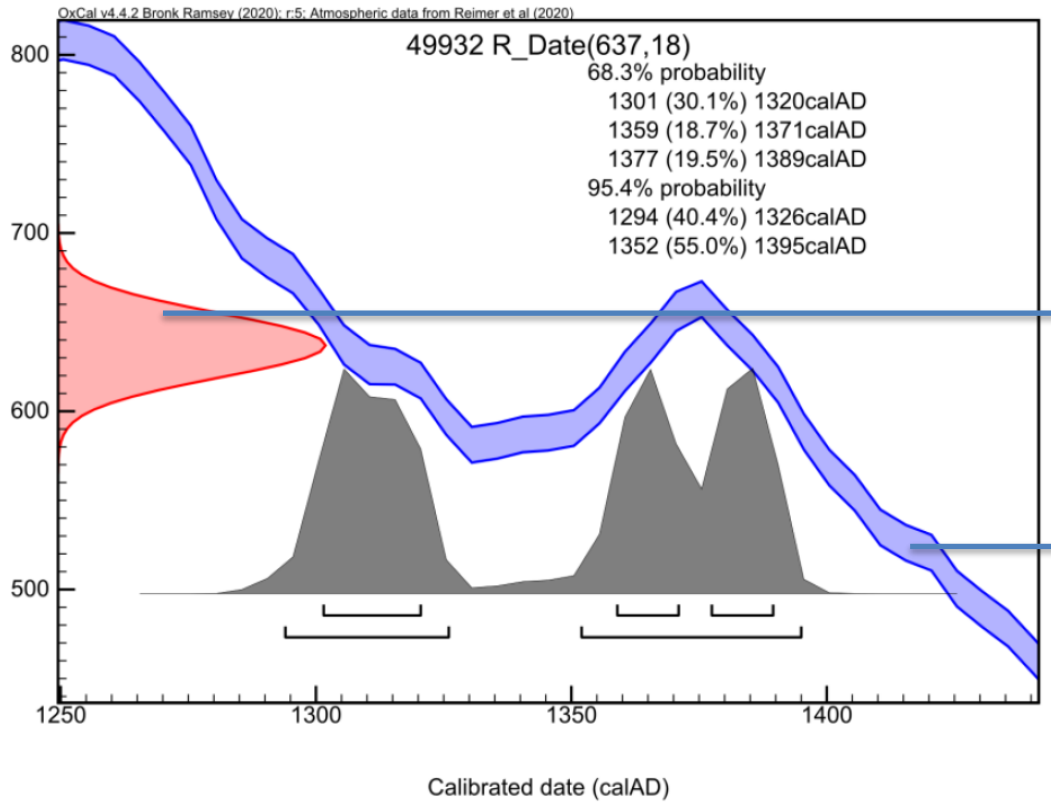
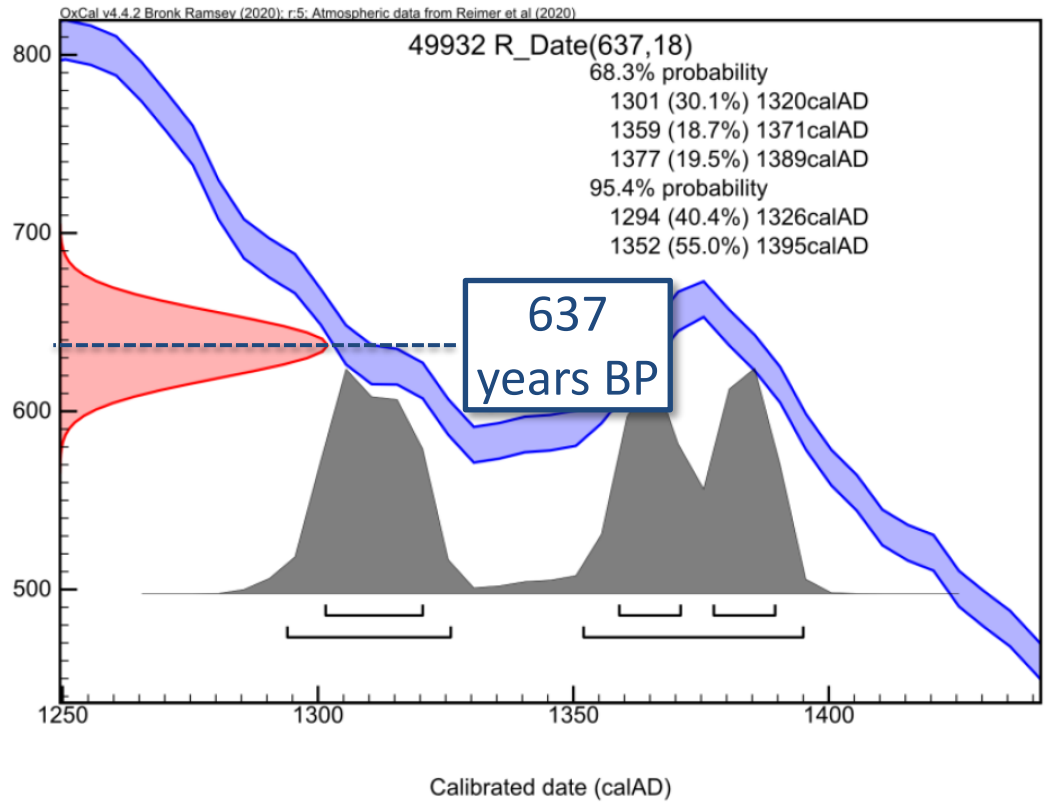


Measured ^{14}C age

Calibration curve

Results from the Curt-Engelhorn-Zentrum Archäometrie gGmbH in Mannheim Germany

^{14}C radiocarbon dating



Results from the Curt-Engelhorn-Zentrum Archäometrie gGmbH in Mannheim Germany

Independant of external influences

Sample was received on Jan. 27

Results came March 15

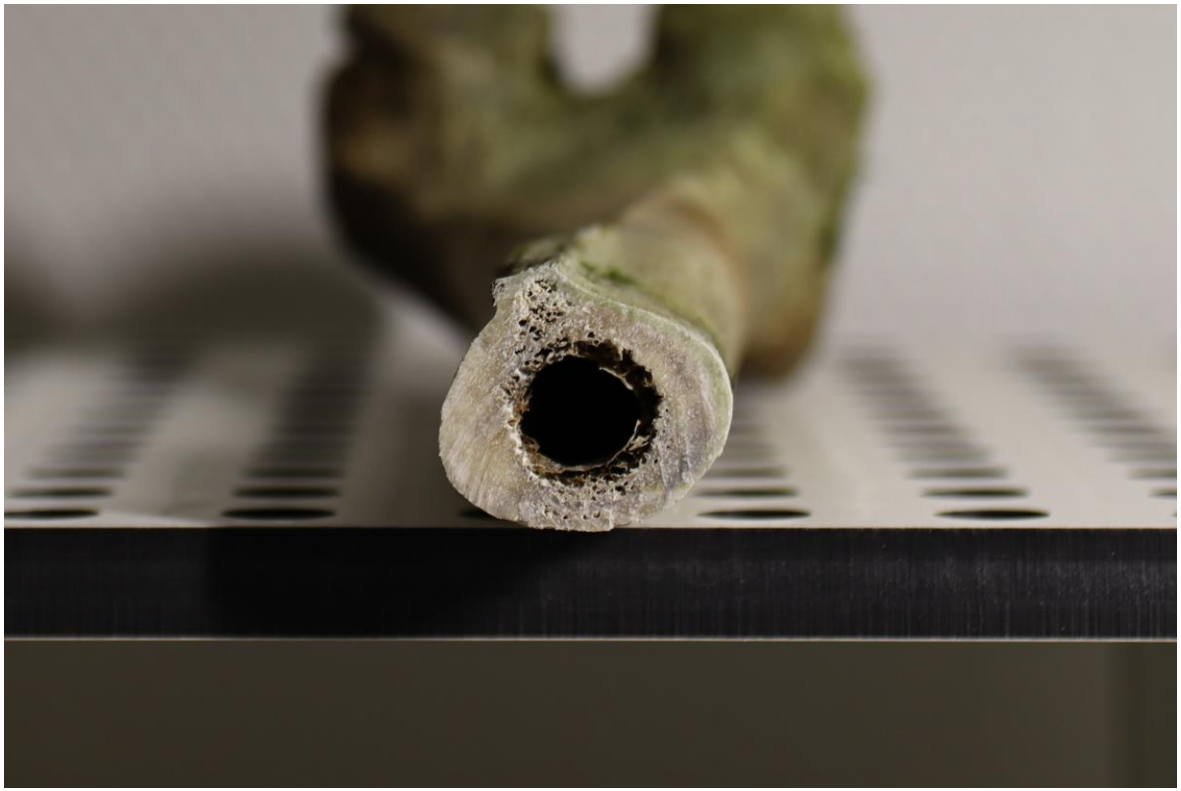
Cost ~ 525 US-Dollar

UV-Fluorescence

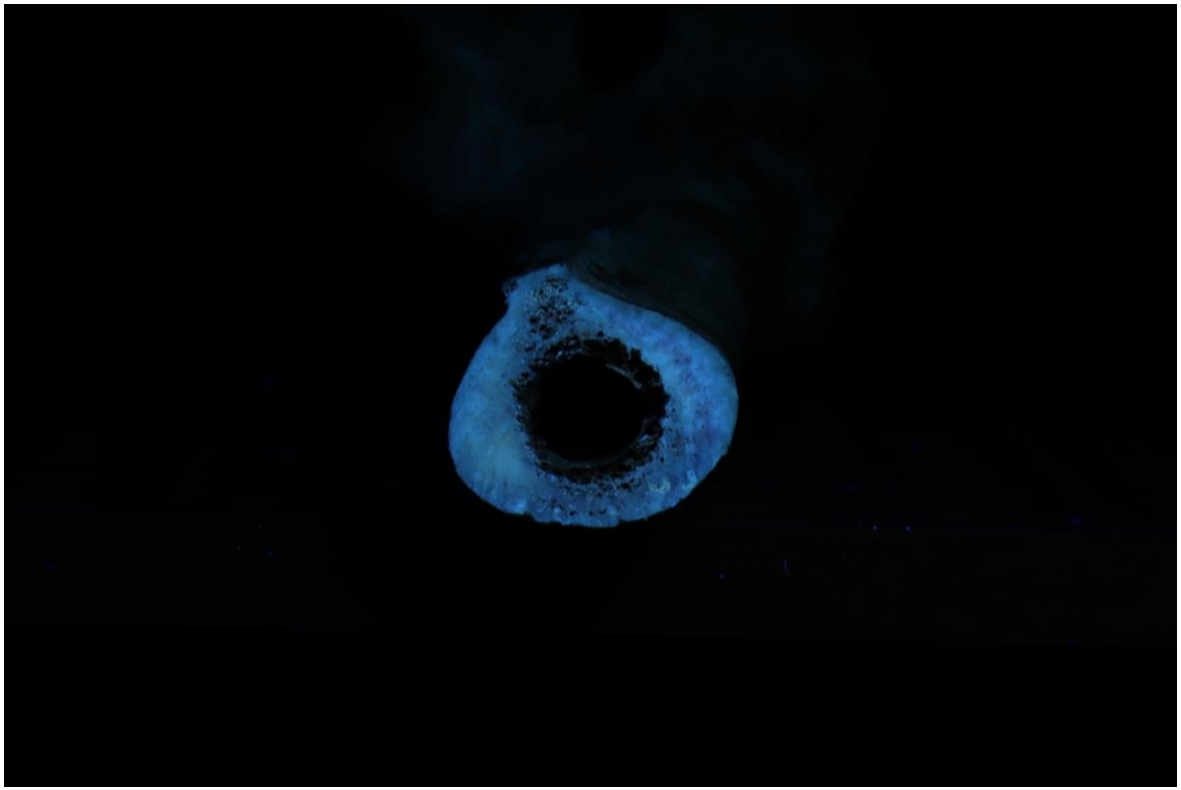
- First investigated by Knight and Lauder in 1969.[1]
- The phenomenon has yet to be understood, but it is thought to be based on degradation of the collagen fibers.[2]

1 Knight B, Lauder I (1969) Methods of dating skeletal remains. Hum Biol 41:322-41
2 Swaraldahab M, Christensen A (2016) The effect of time on bone fluorscence: implications for using alternate light sources to search for skeletal remains. J Forensic Sci 61:442-444

UV-Fluorescence



UV-Fluorescence



UV-Fluorescence

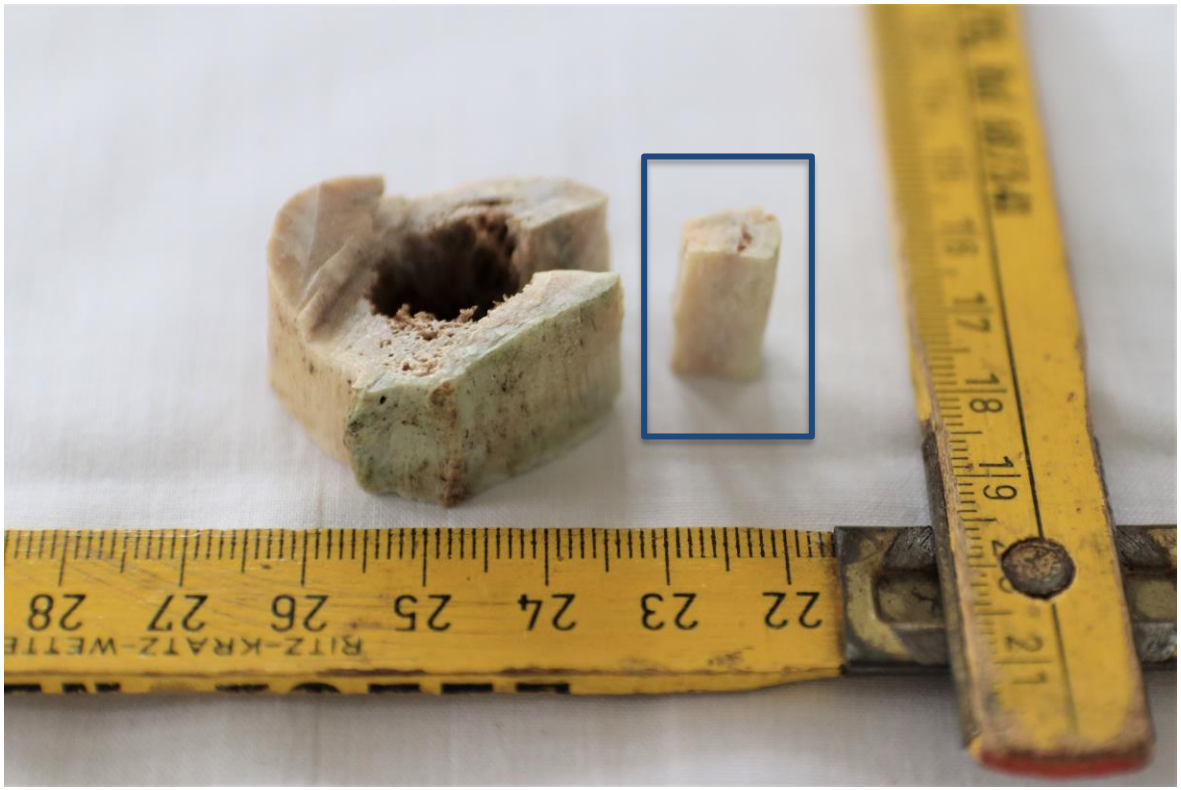
- First investigated by Knight and Lauder in 1969.[1]
- The phenomenon has yet to be understood, but it is thought to be based on degradation of the collagen fibers.[2]
- Hoke et. al. did not find sufficient correlation between the PMI and blue fluorescence being present, but only a overall yellow colour to indicate a PMI > 50 years.[3]
- Sterzik et. al. showed how combining 365 and a 490 nm UV-light can help to exclude a PMI > 50 years.[4]

1 Knight B, Lauder I (1969) Methods of dating skeletal remains. Hum Biol 41:322-41
2 Swaraldahab M, Christensen A (2016) The effect of time on bone fluorscence: implications for using alternate light sources to search for skeletal remains. J Forensic Sci 61:442-444
3 Hoke N et. al. (2013) Reconsideration of bone postmortem interval estimation by UV-induced autofluorescence. For Sci Int 228(176):e171-e176
4 Sterzik V, Holz F, Ohlwärther T, Thali M, Birngruber CG (2018) Estimating the postmortem interval of human skeletal remains by analyzing their fluorescence at 365 and 490 nm. Int J Legal Med 132:933-938

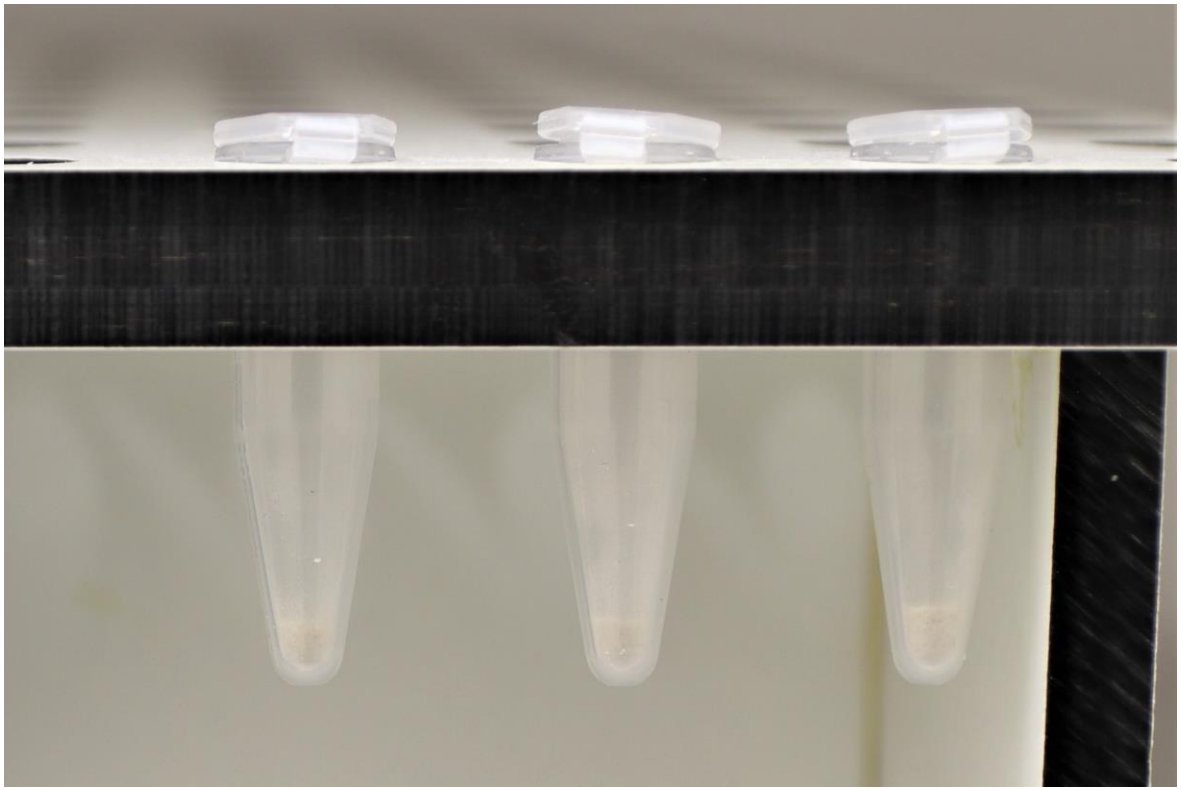
Luminol and chemiluminescence

- Based on the reaction between luminol and hydrogen peroxide which is catalyzed by ironmolecules and results in a chemiluminescence light.

Luminol and chemiluminescence



Luminol and chemiluminescence



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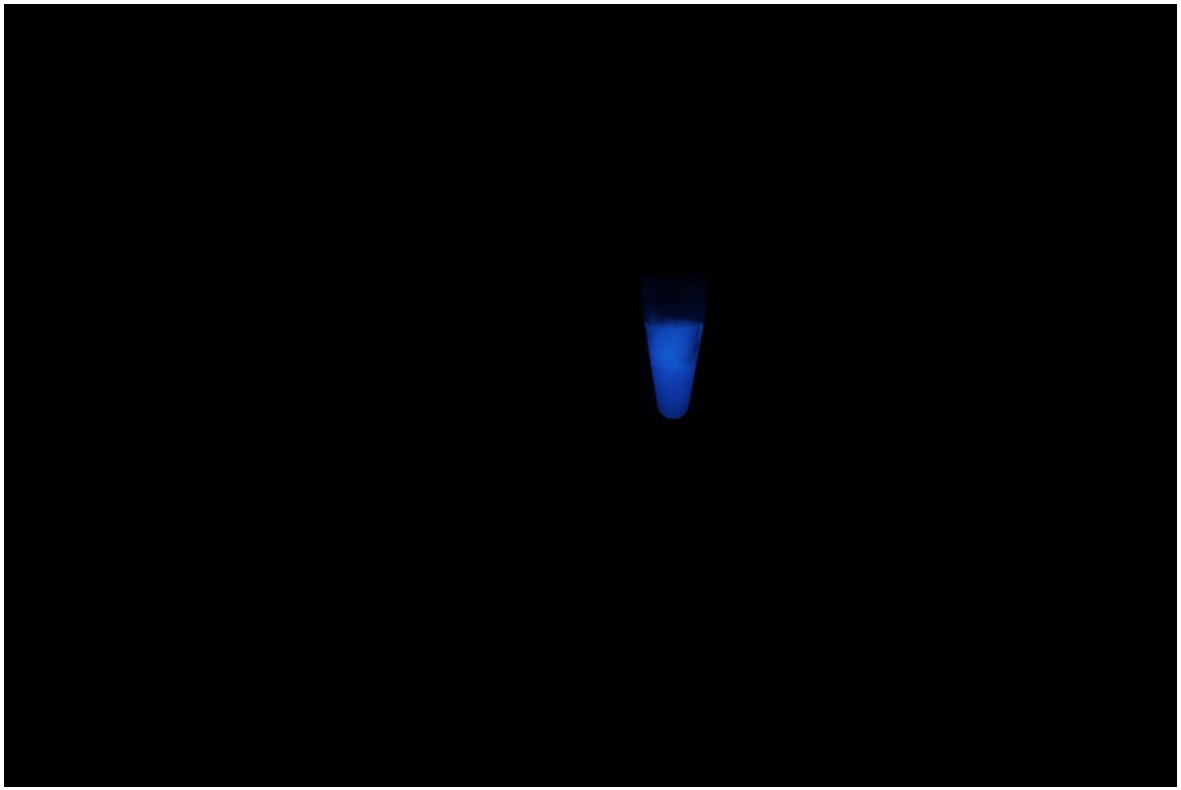

Luminol and chemiluminescence

- Based on the reaction between luminol and hydrogen peroxide which is catalyzed by ironmolecules and results in a chemiluminescence light.
- Ramsthaler et. al.: A negative Luminol-Test and reduced UV-fluorescence are proof for a PMI > 50 years.[1]
- Caudullo et. al.[2], Cappella et. al.[3] and Ermida et. al.[4] had inconsistent result deeming this method inadequate when used without additional tests.

1 Ramsthaler F, Ebach SC, Birngruber CG, Verhoff MA (2011) Postmortem interval of skeletal remains through the detection of intraosseal hemin traces. A comparison of UV-fluorescence, luminol, Hesagon-OBTI, and Combur tests. Forensic Sci Int 209:59-63
2 Caudullo G et. al. (2017) Luminol testing in detecting modern human skeletal remains: a test on different types of bone tissue and a caveat for PMI interpretation. Int J Legal Med 131:287-292
3 Cappella A et. al. (2018) The comparative performance of PMI estimation in skeletal remains by three methods (C16, luminol test and OHI): analysis of 20 cases. Int J Legal Med 132:1215-1224
4 Ermida C et. al. (2017) Luminol chemiluminescence: contribution to postmortem interval determination of skeletonized remains in Portugese forensic context. Int J Legal Med 131:1149-1153

Conclusion

When estimating the PMI of skeletal remains, it is important to

- combine morphological criteria with UV-fluorescence as well as Luminol-tests,
- work interdisciplinary, if possible,
- be aware that one might easily overestimate the PMI of bones, thereby inhibiting further forensic work and
- when in doubt, assume to deal with a forensically relevant find.

Challenges of Estimating the PMI

- No universal algorithm for estimating bones is yet established.
- The more definite Methods are material-, time- and cost-intensive.
- The common Methods are often highly influenced on internal and external factors.

Thank you for your attention

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