

Statement on public debate on Margaryan et al. (Nature, 2020)

Recently, the Danish weekly newspaper Weekendavisen published an article[§] featuring our 2020 publication in Nature on Viking Genomic history[§].

The newspaper article was based on statements by Sturla Ellingvåg, a co-author on our publication, who has been prominent on social media to question the findings of the study. The newspaper article correctly refers to why these public statements led us to withdraw from future collaborations with Sturla Ellingvåg.

In brief, Sturla Ellingvåg, holding a Master's degree in History, claimed that findings in the study of genetic admixture from southern Europe among Vikings were due to sampling biases and gross and deliberate misinterpretation of data. The criticism, which is incompatible with the data, was not raised during the scientific discussions among co-authors, while interpreting our results and writing the manuscript for Nature; rather, these discussions were falsely described by Ellingvåg in his statements to Weekendavisen.

Weekendavisen, considering a more scientifically oriented follow-up article, forwarded a number of detailed and technical questions that elaborated on the criticism by Ellingvåg. The questions by WEEKENDAVISEN as well as our answers, inserted below[#], document a near complete ignorance of the subject matter, be it sampling bias, population genetics, actually performed and analyses reported in the Nature publication.

Following our reply, Weekendavisen informed us that they did not intend to pursue this issue further.

[§] <https://www.weekendavisen.dk/2020-49/ideer/vikingestrid>

[§] <https://www.nature.com/articles/s41586-020-2688-8>

[#] Please see questions and answers from mail correspondence with WEEKENDAVISEN are inserted below.

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(English) Questions from the Danish newspaper, Weekendavisen, and below our point-to-point answers. The original Danish questions and point-to-point questions are included at the end of this document.

1. When you mention that the study documents migration from Southern Europe in the Viking age and the presence of South European genes in Vikings, is this DNA-overlap then due to the five skeletons in Foggia and the skeletons from Scandinavia?

- No, the Foggia individuals have not contributed to that conclusion and have nothing to do with the analyses of Southern European DNA. As stated in the article, the conclusion is based on a comparison between 1462 modern individuals and DNA from skeletons in Scandinavia (see Figure 4 and Table S6 in the article). The conclusions are supported by two different types of analyses based on the software 'Chromopainter' and on so-called f4 statistics, both standard population genetic statistical methodologies.

2. Did you examine whether the five skeletons from Foggia could have had a different background that was not local?

- Yes, of course we did; it is reported in Table S6. The five individuals from Foggia have a local, genetic profile without significant Scandinavian features.

3. Did you, during your study, know that the Normans ruled the city of Foggia in the 11th and 12th century?

- Yes, of course, we did; in fact, this was precisely the reason that we obtained skeleton samples from this particular area and examined their genetic profile.

4. Did you know that the Normans (who ruled Foggia in the period from which your skeletons originate), were emigrated Vikings from Denmark, among other places?

- Yes, this is completely common knowledge, and, as mentioned, the reason we obtained skeleton samples from this particular area and examined their genetic profile. It should be stressed that at the onset of the study it was not known whether the common population had Norman (genetic) origin, or whether that was only true for the ruling elite. This was also a motivation for the analyses.

5. In your opinion, is it possible that the skeletons from Foggia were of Norman origin and thus not local, South European DNA?

- No, as written in the article, we do not find significant genetic indications of Scandinavian origin of the five samples from Foggia. However, this observation is irrelevant for the conclusions re. Southern European DNA in Scandinavia.

6. When you, in various interviews, talk about a 'giant gene flow' from Southern Europe during the Viking age, is it then based on other data than the five skeletons from Foggia?

- The premise of the question is incorrect, as these conclusions are in no way based on the five skeletons from Foggia; this reflects the ignorance that has given rise to the questions. Our conclusions are based on comparisons between DNA from Viking skeletons found in several places in Denmark and Sweden and detailed knowledge of DNA-profiles in present day Europeans. It is precisely the same analysis that so-called

Direct-to-Consumer genetics companies (e.g. Veritas Genetics, Ancestry, 23andMe, MyHeritage) utilize when, based on a saliva sample, they are able to determine the place of origin of a person's ancestors.

- We are dealing with simple, standard analyses, also used in forensic genetics, that students are taught relatively early in their studies. The notion that we should have used the experimental samples from Italy as reference for analyses of Viking is absurd and reflects yet another fundamental element of ignorance of the very foundation of the study design.
- For your information, we have several Viking samples with a genetic profile being more than 50% Southern European (corresponding to having one Southern European parent), e.g. the samples VK365 og VK286 (from Denmark), VK442 and VK35 (from the Southern Sweden), og VK265 (from Kärda).
- The South-European genetic background found in Viking samples, is also found in samples from skeletons from the period right before the Viking age, as well as in the even earlier Iron age, although the degree of South-European genetics is somewhat lower in these older samples. Thus, our findings of South-European genetic profiles in the Viking age is not a solitary observation.

7. Is it based on a match between the Foggia skeletons and Vikings in Scandinavia that you deduce that Vikings were hardly blonde?

- No, not at all. As mentioned several times above, our conclusions do not in any way rest on analyses of the Foggia skeletons. Furthermore, we do not claim that Vikings were hardly blonde; that is a grossly distorted version of our conclusion. We conclude, that the examined Vikings were more genetically predisposed to dark hair and eyes than present day Danes. That conclusion is based on two complementary analyses that compare (a) DNA from Vikings in Denmark and Sweden, and (b) knowledge of DNA in present day Danes.

First, an analysis of genes in our DNA of particular importance for eye- and hair-color, including the genes OCA2, HERC2, TYR, MC1R, SLC24A4 and SLC45A2, which showed that the Vikings were more highly disposed to dark hair and eyes than is the case for Danes today. Second, the above conclusion is supported by another type of genetic test, termed polygenic risk score analyses, that examines the entire genome (rather than specific genes); this analysis also shows that Vikings are more disposed to dark hair than present day Danes.

(Dansk) Spørgsmål fra Weekendavisen, og vores punkt-for-punkt svar

1. Når du omtaler, at jeres studie påviser en indvandring fra Sydeuropa i vikingetiden, og at der er sydeuropæiske gener i hos vikingerne, skyldes det så DNA-overlap mellem de fem skeletter i Foggia og skeletter fra Skandinavien?

- Nej, Foggia individerne har ikke bidraget til den konklusion og har intet med analyserne af sydeuropæisk DNA i vikingerne at gøre. Som vi tydeligt skriver i artiklen er konklusionen baseret på en sammenligning mellem 1462 moderne individer og DNA fra skeletter fra Skandinavien (se Figur 4 og den Table S6 i artiklen). Konklusionerne er støttet af to forskellige slags analyser baseret på programmet 'Chromopainter' og på såkaldte f4 statistikker, som begge er standard populationsgenetiske statistiske metoder.

2. Har I undersøgt, om de fem skeletter fra Foggia kunne have en anden baggrund, der ikke er lokal?

- Ja, naturligvis; og det er rapporteret i Table S6. De fem individer fra Foggia har en lokal, genetisk profil uden betydende skandinavisk islæt.

3. Var I under jeres studie bekendt med, at byen Foggia i d. 11. og 12. århundrede var regeret af normannerne?

- Yes, of course, we did; in fact, this was precisely the reason that we obtained skeleton samples from this particular area and examined their genetic profile.
- Ja, naturligvis; det var netop grunden til at vi fik skelet-prøver fra det pågældende område og undersøgte deres genetiske profil.

4. Var I bekendt med, at normannerne (der regerede Foggia i perioden jeres skeletter stammer fra) var udvandrede vikinger fra blandt andet Danmark?

- Ja, det er helt almen viden, og som nævnt grunden til at vi fik skelet-prøver fra det pågældende område og undersøgte deres genetiske profil. Det skal påpeges, at der ved studiet begyndelse ikke var viden om, hvorvidt den almene befolkning havde normannisk (genetisk) oprindelse, eller om det kun var den herskende elite. Også dette motiverede analyserne af disse prøver.

5. Kan det efter jeres vurdering være en mulighed, at skeletterne fra Foggia har normannisk baggrund og således ikke er lokal, sydeuropæisk DNA?

- Nej, det er som skrevet i artiklen så finder vi ikke nogen signifikante genetiske tegn på skandinavisk oprindelse i de fem prøver fra Foggia. Men denne observation har ingen relevans for konklusionerne vedr. sydeuropæisk DNA i Skandinavien.

6. Når du taler om et "kæmpe genflow" fra Sydeuropa i vikingetiden i diverse interviews, er det så baseret på andet end de fem skeletter fra Foggia?

- Spørgsmålets præmis er ukorrekt, da disse konklusioner på ingen som helst måde er baseret på analyser af de fem skeletter fra Foggia; og det afspejler den uvidenhed, der har givet anledning til spørgsmålene. Vores konklusioner er baseret på sammenligninger mellem DNA fra vikingeskeletter fundet flere steder i Danmark og

Sverige, som sammenlignes med meget detaljeret viden om DNA-profilerne hos nutids-europæere. Det er præcis den samme type analyse, som såkaldte Direct-to-Consumer genetik-firmaer (f.eks. Veritas Genetics, Ancestry, 23andMe, MyHeritage) anvender når de på baggrund af en spytp prøve kan afgøre hvorfra i verden, at en persons forfædre kommer.

- Der er tale om simple standard analyser, som også anvendes i retsgenetik, og som studerende lærer om relativt tidligt på studiet. Tanken om, at vi skulle have brugt vores studies egne eksperimentelle prøver fra Italien, som reference for vikingeanalyser er absurd og afspejler endnu et element af fundamental uvidenhed om studiet helt basale design.
- Til orientering så har vi adskillige vikingep prøver med mere end 50% sydeuropæisk genetisk profil (svarende til en sydlandsk forælder) f.eks. prøverne VK365 og VK286 (fra Danmark), VK442 and VK35 (fra det sydlige Sverige), og VK265 (fra Kärda).
- Den sydeuropæisk genetisk baggrund, som vi finder i vikingep prøver, har vi også fundet i prøver fra skeletter fra perioden lige før vikingetiden og i den endnu tidligere jernalder, om end graden af sydeuropæiske genetik er noget mindre i disse ældre prøver. Så vores fund fra sydeuropæisk genetisk profil vikingetiden står på ingen måde alene.

7. Er det med baggrund i match mellem Foggia-skeletterne og vikinger i Skandinavien, at du udleder, at vikingerne næppe var blonde?

- Nej, slet ikke. Som nævnte flere gange ovenfor, så hviler disse konklusioner på ingen måde på undersøgelserne af Foggia-skeletterne. Dernæst hævder vi ikke, at vikinger næppe var blonde; det er en groft fordrejet gengivelse af vores konklusion. Vi konkluderer, at de undersøgte vikingerne var mere genetisk disponerede for mørkt hår og øjne end danskere er i dag. Den konklusion baserer sig på to komplementære analyser som sammenligner (a) DNA fra vikingerne i Danmark og Sverige, og (b) viden om DNA hos danskere i dag. Dels er der tale om analyse af gener i vores arvemasse af særlig betydning for øjenfarve og hårfarve, bl.a. generne OCA2, HERC2, TYR, MC1R, SLC24A4 and SLC45A2, som viste at nogle af vikinger var meget disponerede for mørkt hår og øjne end danskere i dag. Denne konklusion blev støttet af en anden type genetisk test, kaldet polygenic score analyser som undersøger hele arvemasse (i stedet for konkrete gener), og som også viser at vikinger var mere disponerede for mørkt hår end nutidsdanskere.