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The last sea nomads of the Indonesian archipelago : Genomic origins and dispersal

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INTRODUCTION

The Bajo, the world's largest remaining sea nomad group, are scattered across hundreds of recently settled communities in Island Southeast Asia with all speaking single language: the **Sama-Bajau**. With a significant role in historical trading, the Bajo lived until recently as nomads, spending their entire lives on houseboats while moving long distances to fish and trade. Along the routes they traveled, the Bajo settled and intermarried with local land-based groups, leading to '**maritime creolization**', a process whereby Bajo communities retained their culture, but assimilated – and frequently married into – local groups. The origins of the Bajo have remained unclear despite several hypotheses from oral tradition, culture and language, all currently without supporting genetic evidence.

Figure 1. Map showing the distribution of Bajo communities across Island Southeast Asia (yellow), together with the location of sampled Bajo villages (red dots) and sampled historically related communities (blue dots), with in total 230,800 overlapped autosomal SNPs analyzed in the dataset.

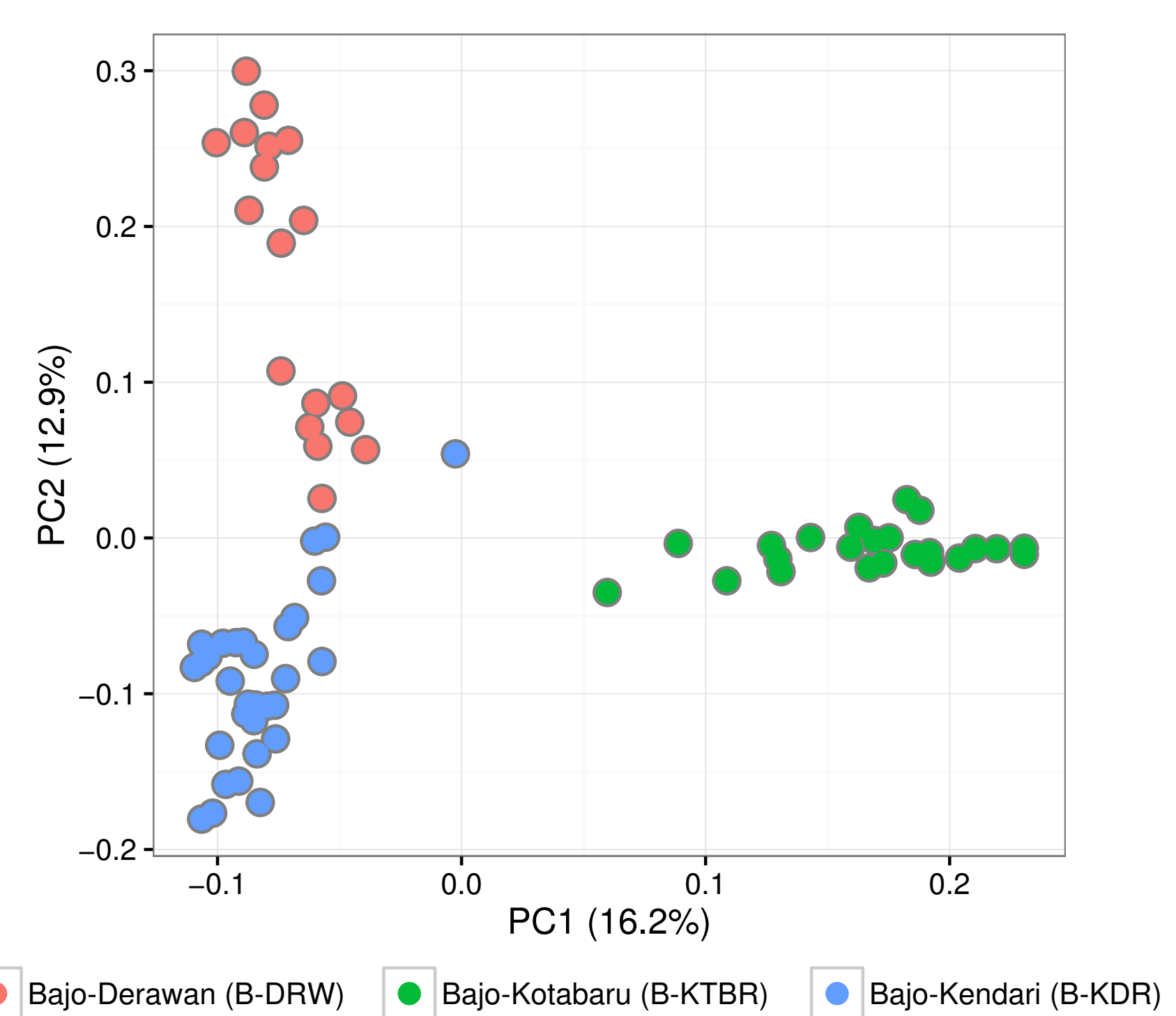
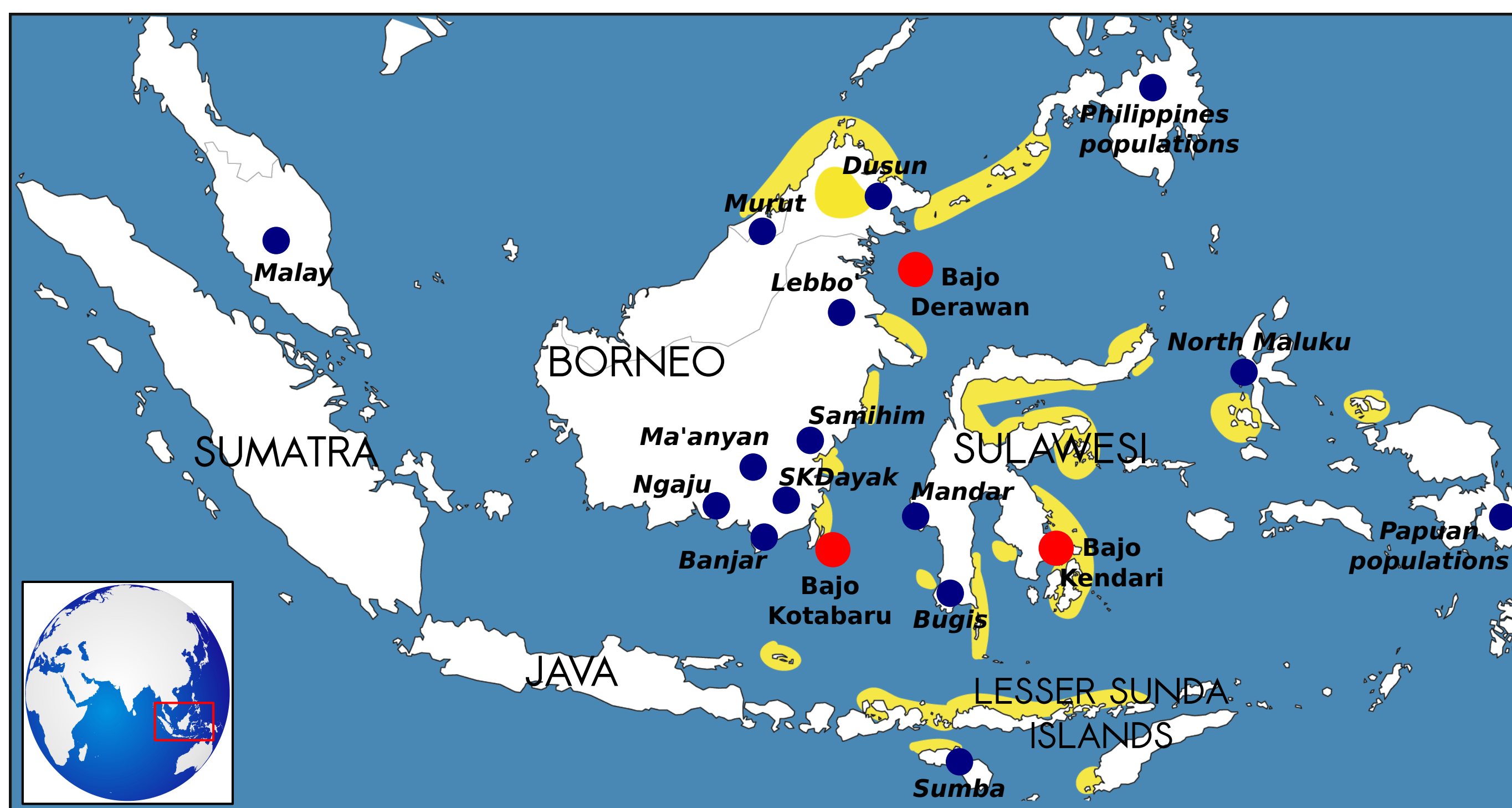


Figure 2. Principal Component Analyses of the three Bajo communities (Kendari, blue; Kotabaru, green; Derawan, red) showing independent clustering and limited overlap between individuals from different Bajo communities, despite similar language that they speak.

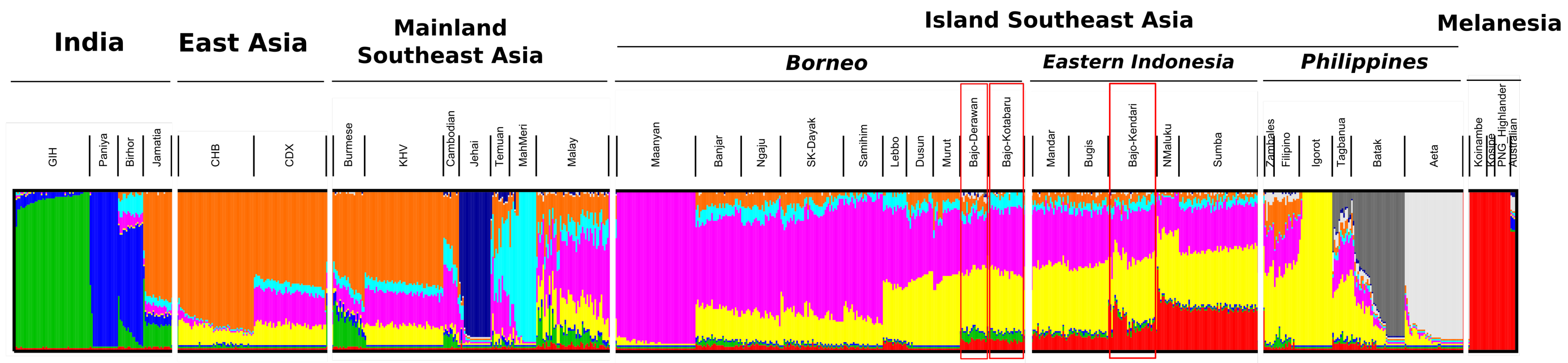


Figure 3. ADMIXTURE plot at K=10 depicting admixture of ancestral components in Derawan, Kotabaru and Kendari Bajo (red boxes), composed of East Asian, Austronesian, Papuan and minor Indian components.

STRUCTURE AND SEX BIAS

Individuals from the three sea nomad groups **form distinguishable clusters** (Fig 2). Interestingly, there is no overlap between the groups presently living in Borneo. The PCA results are consistent with F_{ST} calculation and the fineSTRUCTURE clustering on phased genotype data, which shows that each Bajo community forms a single group, but tend towards their close geographic neighbors, supporting the maritime creolization where non-Bajo speakers ('land owners') adopted Bajo languages and intermarried with the original Bajo. Likely with **sex biased admixture** between men from local mainland population and women from the Bajo ancestral population (Fig 4).

ANCESTRAL COMPONENT

The three Bajo communities have an admixed profile with major **Asian components** and a **Papuan component**, but in varying proportions (Fig 3). The Kendari Bajo have more of the Papuan component (red) than the two Borneo Bajo groups, in keeping with their location further east. Minor **Negrito Philippine components** are observed in the Derawan Bajo (~1-2%); and an **Indian component** is detected in both the Derawan Bajo and Kotabaru Bajo (~6%).

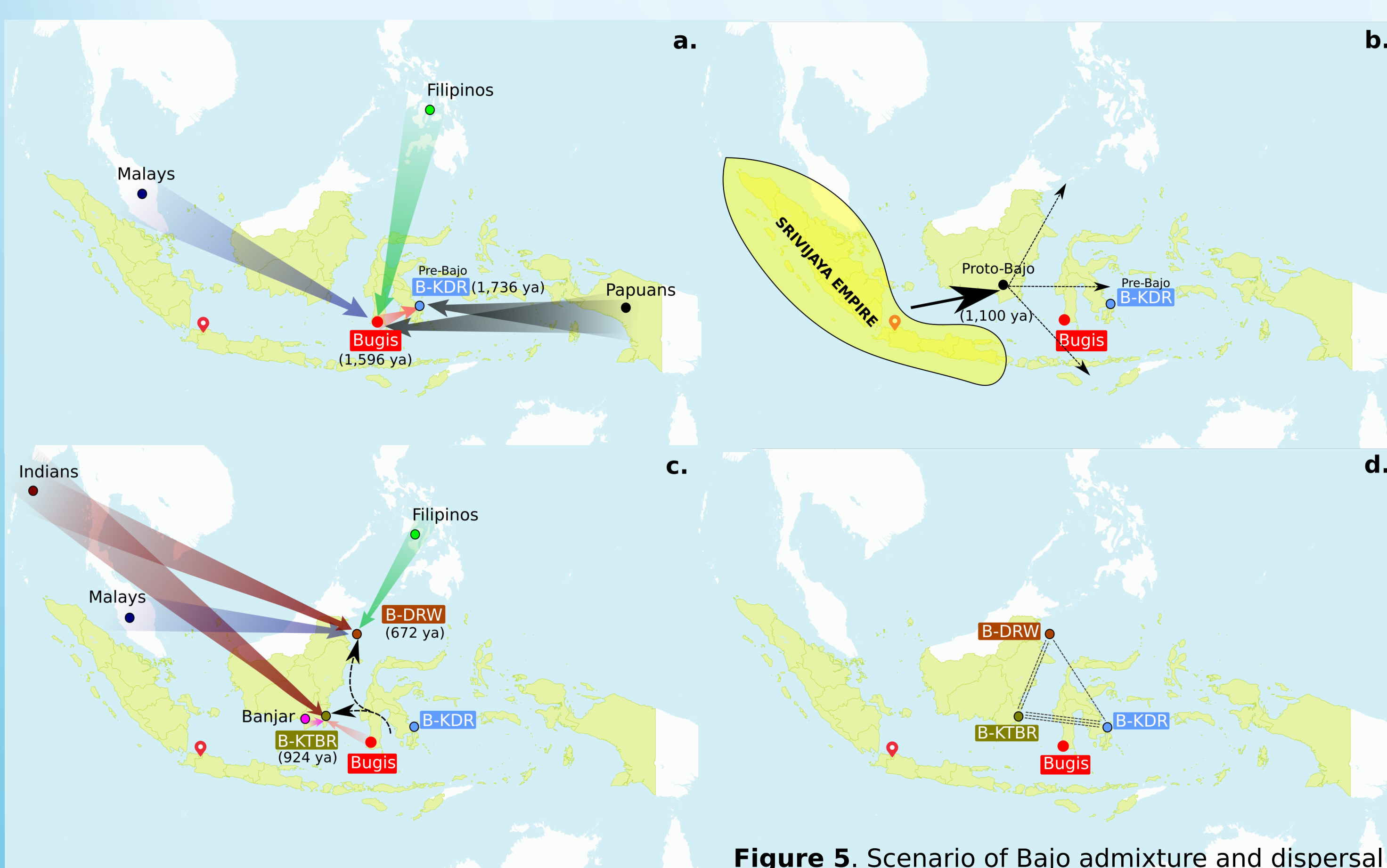


Figure 5. Scenario of Bajo admixture and dispersal

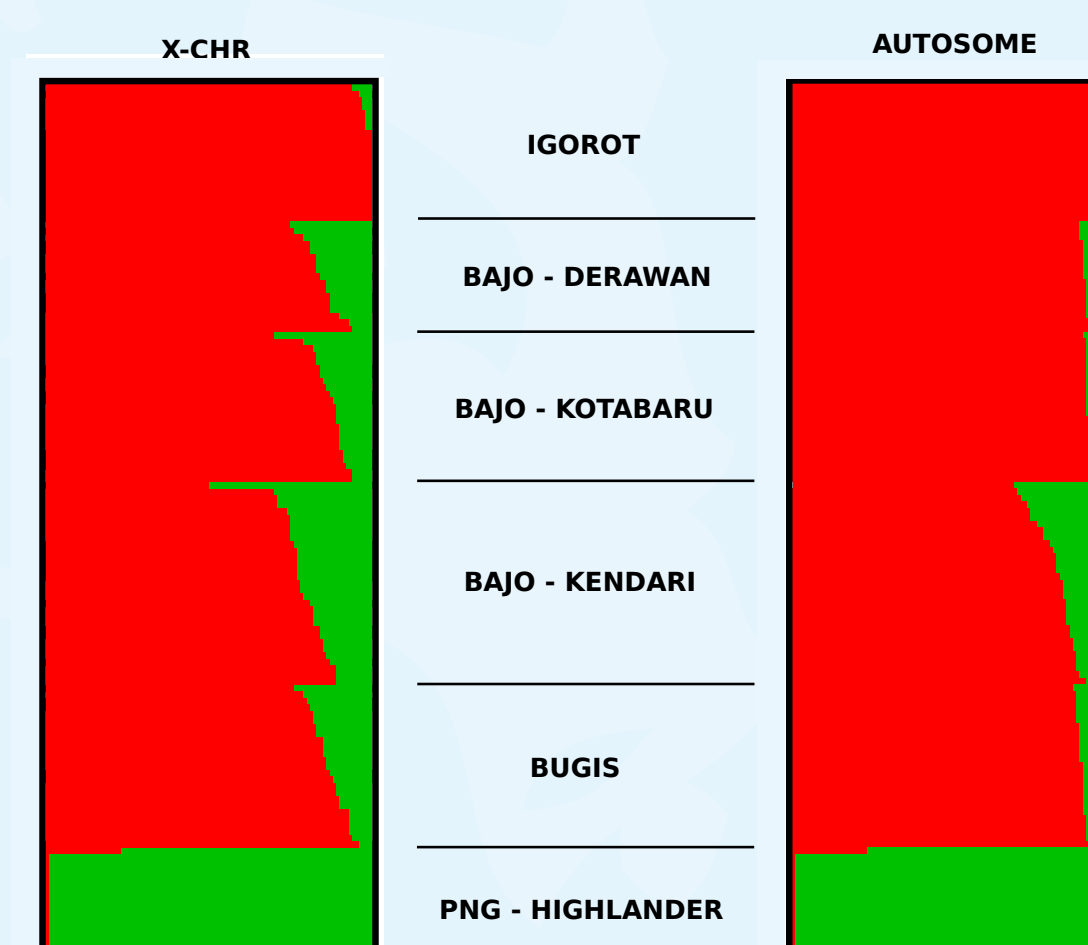


Figure 4. Comparisons of estimated autosomal and X ancestry on the basis of unsupervised clustering using ADMIXTURE. There is no significant difference between autosomal and X-chromosome of East Asian/Papuan ancestry in Kendari Bajo and Bugis (one-tailed Wilcoxon test $P > 0.05$), but there is significance difference, leading to potential Bajo ancestral female-bias admixture, in Derawan and Kotabaru Bajo (one-tailed Wilcoxon test $P < 0.01$), traced by the Papuan component brought by Bajo ancestral women from Sulawesi to Borneo.

ADMIXTURE AND DISPERSAL SCENARIO

Despite a complex genetic history involving creolization and multiple admixture events, the genomic data (based on GLOBETROTTER & MALDER analyses) are suggestive of a **single population origin** for the Bajo, converging on Southern Sulawesi, estimated admixture event dates to the 4th century CE between local Sulawesi population (90%) and Papuan (10%) (Fig 5a). The movement of Proto-Bajo from South Borneo to Sulawesi was triggered by the **invasion of Srivijaya Malay Kingdom** (Fig 5b). The two Bajo communities on Borneo appear to have emerged later, around the 12th century (KTBR) and the 14th century (DRW) perhaps suggesting that Bajo communities lived in Southern Sulawesi for nearly eight hundred years before spreading west to Borneo (Fig 5c). In addition, Identity-by-Descent sharing analysis suggesting that the Bajo communities did intermarry until their recent land-based resettlement (Fig 5d).

CONCLUSION

The complexity of the Bajo genomic profile provides a striking reflection of their history, mediated by both migratory and local admixture events, and emphasizing their unique lifestyle played out across multiple geographical scales. Despite speaking same language, the Bajo prove to be diverse, encompassing rich genetic inputs from many groups, each distributed differently in the major Bajo communities, **but homogenous for individuals within each community.**

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