ANTHROPOLOGICAL REVIEW

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The Official Publication of the Polish Anthropological Society

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ANTHROPOLOGICAL REVIEW

WYDAWNICTWO
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ŁÓDZKIEGO

ANTHROPOLOGICAL REVIEW

The Official Publication of
the Polish Anthropological Society

Volume 88/2025
Issue 4

POLSKIE TOWARZYSTWO ANTROPOLOGICZNE

WYDAWNICTWO UNIWERSYTETU ŁÓDZKIEGO
Łódź 2025

Published by Łódź University Press
Publisher’s sheets 11,65
W.11925.25.0.C
ISSN 2083-4594
e-ISSN 1898-6773

Contents

Anthropological Review • Vol. 88(4), 1–29 (2025)

ANTHROPOLOGICAL REVIEW

Available online at: https://doi.org/10.18778/1898-6773.88.4.01

Predicting Prosociality in Primates: Socio-Ecological Influences and a Framework of Inter-Brain Neural Synchronization

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Abstract: Prosocial co-operation is critical for evolution and survival on Earth and has crucially shaped the development of *Homo sapiens*. Inter-brain neural synchronization (IBNS) has been shown to enhance prosocial co-operation in mammals and avians. The selection pressures which led to the development of IBNS throughout primate evolution are currently unknown. This paper aims to expand the understanding of IBNS in non-human primates by reviewing the literature on various primate populations that display prosocial behaviors that could correlate with IBNS. Binary logit modelling using machine learning methods was applied to social, ecological, morphological, and biological (SEMB) variables correlated with prosocial behaviors to obtain probabilities of prosociality. Our results suggest that select SEMB variables such as daily socialisation, food-sharing and hierarchy structure are strong predictors of prosocial behaviors in primates. We provide a framework that offers testable hypotheses for the existence of IBNS in primates based on the correlations between SEMB variables and prosocial behaviors. We also offer ideas of the ecological/behavioral forces that may correlate with neural activation patterns of primate IBNS. Through comparison to *Homo sapiens* models, these findings suggest IBNS in primates may exist beyond cercopithecids and may be evoked by similar socio-ecological contexts. However, some key neurological distinctions between the two groups exist, influencing which distinct patterns of behavior may evoke IBNS (relative to their socio-ecological context).

Keywords: prosociality, comparative behavior, inter-brain neural synchronization, neural systems, machine learning

Original article

Received: 24.03.2025; Revised: 24.07.2025; Accepted: 14.08.2025

Introduction

When analysing the evolution of life on Earth, a common trend prevails – co-operation can become a vital key to reproductive success. From the smallest amoeba to *Homo sapiens*, co-operation birthed longevity (Kreider et al. 2022; Zhu et al. 2023). In retrospect, if co-operation in the Hominidae clade disappeared some 3 million years ago, *H. sapiens* could not have evolved. Our hominin ancestors needed co-operation as a survival tool to combat harsh environments that posed risks to their small population numbers (Townsend et al. 2023). Evolution of the *Homo* genus was dependent on the cooperative behaviors of our ancestors, who evolved from Miocene primates. Most extant primates still rely on cooperation to survive (Boyd and Richerson 2009).

From this point forward, when we refer to primates we exclude the tribe Hominini of which *H. sapiens* and their immediate ancestors are members. Primates are faced with a myriad of unique threats to their survival in various environments including predators, terrain, food security, and so on. However, using co-operation as a tool to protect against these forces is a common strategy used in prosocial behaviors such as unified defence against predators or foraging as a group to increase food collection (Garber 1987; Treves 2000; Boinski and Garber 2001). Though co-operative behaviors can be quite varied, all can be collectively classified as prosocial behaviors as they benefit the group instead of (or as well as) the individual primate (De Waal and Suchak 2010). The nature of primate prosocial behavior is different when compared to *H. sapiens*. Prosociality in *H. sapiens* is distinguished by a stronger empathic drive that employs a wider range of enforcement mechanisms, allowing for more stable cooperation to form in larger groups of unrelated individuals (Melis and Semmann 2010). This enabled *H. sapiens* to flourish in the late Pleistocene (Sterelny 2021; Townsend et al. 2023), leading to the large population size increase seen today. How then do extant non-human primates sustain prosocial behavior without the usage of complex enforcement mechanisms cognate to *H. sapiens*? One answer to this question may be found in inter-brain neural synchronization (IBNS).

Inter-brain neural synchronization is an unconscious mechanism; where neural oscillatory activity is synchronized between people, so that recorded neural behavior across brain regions and bandwidths associated with prosocial tasks is identical (Valencia and Froese 2020; Lotter et al. 2023). Observational and experimental studies in mammals (including *H. sapiens*) describe IBNS as a neural behavior pattern evoked by prosocial behaviors such as alloparenting, physical co-ordination and group tasks serving a common goal (Tseng et al. 2018; Kingsbury et al. 2019; Rose et al. 2021; Zhang et al. 2022; Ogawa and Shimada. 2023). A distinction between mirror neuron activity and IBNS must be made here, with implications to identify IBNS as a facilitative process for the achievement of social goals. As mirror neurons are grounded in motor-based behavior (inter-personal motor synchrony) it is difficult to generalise their synchronization effect to abstract situations between people (e.g. conversational turn-taking) (Hasson and Frith 2016). However, IBNS does result in cortical synchronization between areas representing abstract processes and even correlates to enhancements of abstract cognition (e.g. shared intentionality) (Fishburn et al. 2018; Gvirtz-Provolovski and Perlmutter 2021). Thus, IBNS is distinct from mirror neurons as there is no proof that it is a static process; it is more likely that IBNS fluctuates between synchronized and desynchronized periods (Froese et al. 2024). Wang et al. (2025) demonstrate that by separating the effects of motor synchronization (mirroring) from genuine IBNS, brain activity synchronized specifically to abstract cognition (e.g. emotion) can be isolated. Therefore, IBNS is characterized by the synchronization of neural activity underpinning abstract cognition. Prosociality often requires abstract cognition as it involves understanding and acting on shared goals, beliefs, or expectations; considering the perspectives or needs of others (Houwelingen and Dijke 2023). Considering this, IBNS is more than a computed correlation of synchronized brain regions, as previous hyper-scanning studies strongly indicate that prosociality mediates the IBNS process.

In *H.* sapiens, IBNS is a typical response associated with prosocial activity requiring shared intention and is suggested to enhance co-operation and cohesion in prosocial tasks, especially when compared to the same scenarios where IBNS is weak or not evoked between people (Rennung and Goritz 2016; Hu et al. 2017; Lu et al. 2023; Wass et al. 2020; Wang et al. 2025). Considering these benefits, IBNS could play a crucial, facilitative role in the co-operation of primates where there is an absence of similar levels of enforcement mechanisms which motivate stable prosocial behavior in *H. sapiens* (Koski and Sterck 2009; Melis and Semmann 2010).

Little information on IBNS in primates exists (Ramakrishnan et al. 2015; Tseng et al. 2018). It should be noted that the current IBNS literature in primates is based solely on macaques (cercopithecids). None of these studies examine IBNS elicited through natural engagement in prosocial behaviors, and thus overlook aspects of the socio-ecological contexts that select for such behaviors. In this paper, it is proposed that our IBNS framework in primates will help researchers identify populations where IBNS may be easily observed. These assumptions are based on predictive correlations using the overarching socio-ecological contexts of primates, which are likely to elicit displays of prosociality. The proposed framework could also be made falsifiable by fieldwork that reports consistent prosocial behavior in primates that does not evoke IBNS. Both outcomes would provide distinct insight into the evolution of IBNS in *Homo sapiens*.

A study of IBNS in *Macaca mulatta* dyads performing a socio-motor task where one member came into the vicinity of a food item while the other observed, showed that *M. mulatta* exhibited IBNS that was dependent on specific aspects of social interaction and cognition (Tseng et al. 2018). Ecological conditions such as the food reward (and its location) and the presence of conspecifics influenced the IBNS response, underpinned possibly by dopaminergic reward-response pathways critical to social learning and adaptation in primates (Murray et al. 2011; Beeler and Dryer. 2019; Wise 2020). Tseng et al. (2018) present a possible relationship between primate IBNS and specific stimuli/co-operative behaviors influencing IBNS activation patterns (with socio-ecological forces potentially acting as a mediating factor). An identical framework for IBNS is found in *H. sapiens* (Valencia and Froese 2020). However, this paper offers a broader hypothetical framework for primate IBNS that derives from analysis of potential differences in the elicitation and manifestation of this function across a wide range of primate species. We suggest that future research based on hypotheses proposed here may lead to the verification of IBNS in a wide range of primates.

Inter-Brain Neural Synchronization in animals extends beyond the primates; bats, rats and birds also demonstrate IBNS concomitant with increased cooperation and social adaptation (Hoffman et al. 2019; Kingsbury et al. 2019; Zhang and Yartsev 2019; Rose et al. 2021; Zhang et al.,2022). Notably, no modern reptile has been documented to exhibit IBNS, though social complexity influenced by ecological variables has been recorded (Brattstrom 1974). Though reptiles are stereotypically labelled as non-social, both current and ancient reptilians present valid cases of prosocial behavior (Doody et al. 2012; Titus et al. 2021). Therefore, their potential for IBNS should not be overlooked, which raises two important considerations: 1. Ecology influences the emergence of prosociality and 2. The absence of a prosocial behavior does not preclude any species from having a latent aptitude for IBNS. Considering this, we cannot say whether IBNS may exist as a homoplasy or homology in evolution (in part due to the absence of IBNS research in reptiles and other non-mammalian vertebrates such as fish). So far IBNS has been recorded in some animals of mammalian ancestry; within this lineage there also exist animals who display little prosociality. The naturally solitary *Pongo abelli* is a prime example, though they are still capable of prosocial behavior and even display conflict resolution skills under crowded living conditions with conspecifics (an example of prosocial behavior influenced by socio-ecological forces) (Kopp and Liebal 2018). This fact could further the argument of IBNS as a homoplasy; a latent ability of all vertebrates with a central nervous system and the capacity for abstract cognition, where socio-ecological selective pressures for prosociality evoke the IBNS response. Future research into vertebrates outside the class Mammalia will provide further insight so assumptions made here are tentative. Generally, however, social adaptation to environmental cues appears to be the crux of IBNS. Therefore, by creating a framework where socio-ecological forces predicting prosocial behavior are a necessary condition to evoke IBNS, we offer a predictive model of IBNS which can be applied to all primates.

Past research in primates exploring the link between prosociality and environment mainly used cause-and-effect models of explanation (Tennie et al. 2016; Kuroshima and Fujita 2018; Shultz and Dunbar 2022). However, there is a lack of predictive correlational modelling and machine learning within this research area. This type of method would allow for a broader understanding of prosociality and IBNS in primates by creating probability estimates of prosocial behavior predicted by correlated socio-ecological variables. Predictive modelling and machine learning can use natural observations to calculate these probabilities and their stability when generalized from the model, which may broaden our knowledge of factors influencing the evocation of prosociality and IBNS in primates. In comparison, cause-and-effect models cannot predict behavioral relationships in the absence of an intervention and are restricted to explanatory analyses in niche or laboratory environments, detracting from generalizability (De Waal & Suchak 2010, Lopresti-Goodman & Villatoro-Sorto 2022). In behavioral research, establishing causality for a specific behavior requires a complete understanding of context and record of all environmental variables which is beyond the scope of the current study. Correlational models are therefore more effective at predicting outcomes as the statistical relationship between variables can be analysed and validated without a causal link (Allison 1999). Our exploratory study aims to achieve a broader conceptualization of IBNS in primates by using predictive modelling techniques to outline which generalizable prosocial behaviors could theoretically evoke IBNS (mediated by socio-ecological factors). Our findings may provide a foundation for both natural and experimental IBNS research in primatology, where so far, the topic has been neglected.

Method

We used data from existing literature to demonstrate the likely presence of IBNS in primates in multiple socio-ecological contexts. We first measured select prosocial behaviors. Forms of prosociality vary greatly and can become niche behaviors, reducing their generalizability between primate species and resulting in non-standardized measurements (Polit and Beck 2010). Accordingly, six prosocial behavioral traits that can be generally measured in primates were chosen: (i) consolation behavior, (ii) group-hunting, (iii) group-foraging, (iv) formation of coalitions, (v) food-sharing, and (vi) alloparenting. These prosocial variables are distinct behavioral markers of social cooperation and have been previously studied across primates (Boesch 2009; Burkart et al. 2014; De Waal and Van Roosmalen 1979; De Waal, Luttrell, and Canfield 1993; De Waal et al. 2008; De Waal and Suchak 2010; Hohn et al. 2024; Fuente et al. 2021; Van Leeuwen et al. 2021). We feel it is necessary to note here that we are not analysing specifically proactive prosociality, as all forms of prosocial behavior are currently theorized to evoke IBNS in *H. sapiens*. We correlated these six variables against forty-nine variables measuring social, ecological, morphological, and biological (SEMB) conditions.

The sample consisted of 41 primate species from a random stratified collection, representing approximately 8% of total extant primate species (NB: logit modelling only requires a sample of at least N = 20 for model stability; Concato et al. 1995). Stratification was necessary as information on individual primates is unbalanced; more popularly studied primates, such as the great apes or macaques, retain far more information on SEMB variables over less studied primates such as the *Cacajao calvus* or *Galago senegalensis*. Regardless, missing observations still occurred and were marked "N.A." for easy translation into the R programming language. Power analyses are not necessary for this sample as there is no specific hypothesis that we are aiming to test, the data are non-explanatory, and we only aim to predict the occurrence of prosocial traits and IBNS based on associations between prosocial and SEMB variables. However, we offer hypotheses for further investigation based on the results of these predictions.

We gathered data on each primate species primarily from the Wisconsin

National Primate Centre Primate Information Network (2023) and San Diego Zoo Wildlife Alliance Library (2023), two open-access databases which record primate information on behavior, biology, and ecology from observational studies. If no information on a specific variable existed in either of these databases, primary sources such as journal articles, academic books and textbooks were used to gather information on SEMB variables. These sources were accessed through keyword searches within the Zoological Record database. Objective, observational recordings of all primate data were dummy coded into arbitrary classifiers (ordinal or binary), while observations of variables on a continuous scale (e.g., amount of daily socialization) were not recoded as they need no categorical classification for statistical analysis. Some ordinal variables were dummy coded based on quartile distribution analyses. Predation pressure and resource competition variables were calculated from existing models which were used as predictive equations and were coded into the data table (van Schaik 1989; Hart 2007). A list of recodes can be found in Supplementary File 1 (Supplementary materials Table S1). A significant limitation of this dataset lies in the disparate observational sources used to inform it. There is no specific, standard reporting practice for observational studies of primates to follow, with varying quality and quantity of information between sources. This caveat introduces possible biases into the dataset, such as errors in reporting and lower reporting reliability based on more subjective interpretations of behavior.

All statistical analyses took place in R Studio (R Core Team 2024); all variables were imported from an initial CSV worksheet (Sevastidis, 2024). Naturally, the size of this dataset cannot be properly fitted into a binary logit model for each dependent variable (Harrell 2015). Thus, Kendall's correlations were performed correlating each prosocial variable with all 52 independent SEMB variables. We used Kendall's Tau (τ) for all correlations due to its flexibility in measuring non-normal variables of continuous, ordinal, and binary scales (Newson 2006). The lower τ-coefficient margin was set at 0.3 (fair association) to select associations between prosocial and SEMB variables that were suitable for predictive analyses using machine learning models. Variable selection through correlative analysis also assists in preventing the analysis of redundant variables where associations are multicollinear, which avoids over-fitting regression models (Montesinos-López, Montesinos-López and Crossa 2022). We set alpha (α) to 0.05 as the level of significance for all statistical analyses. Within binary predictive modelling of natural data, the confidence estimates of probability performance models are more relevant to identifying whether modelled values have occurred by random chance (Gardner and Altman 1986; Du Prel et al. 2009). Additionally, explicit testing of false positives using dedicated algorithms (e.g. AUROC) trumps the usage of an arbitrary p-value benchmark that is most applicable to two-tailed hypotheses, which are not investigated in this manuscript (merely offered for future research) (Kim and Bang, 2016; Jafari and Ansari-Pour 2018).

After we screened variable pairs via both correlation and significance measures, binary logit modelling using the prosocial variables could begin. Binary logit models were used for predictive modelling of binomial prosocial behavioral traits as dependent variables (Harrell 2015). We input each prosocial variable into its own logit regression with all SEMB traits that were significantly correlated to that prosocial variable. Generally, logit model equations cannot contain more than one predictor variable per ten observations in the dataset or they incur significant risk of overfitting the model and increasing Type 1 Error rates (Concato et al. 1995; Peduzzi et al. 1995). Since the dataset contains 41 total observations, it was only suitable to include four predictor variables in every model equation for each prosocial dependent variable. Thus, we used a combination of a priori knowledge of variable associations and step-AIC (Akaike Information Criterion) algorithm to remove excess predictor variables. We recommend that any step-wise method is used in conjunction with a priori analysis, as automatic functions can remove critical predictors from model equations (Heinze et al. 2015). Therefore, we formed models based on predictors previously associated with prosocial variables and comparisons between AIC values between-models, resulting in a best-fit model with the most relevant predictors. It should be noted here that removed predictors were significant, but less relevant than others. We checked models for multicollinearity through variance inflation factor (VIF) scores with an exclusion cut-off of 5; only variables below the exclusion cut-off were included in models (Marcoulides and Raykov 2019).

We used the initial model output to calculate the predicted probability of each prosocial behavior occurring in relation to its correlated socio-ecological (SEMB) variables. We obtained probabilities through exponentiation of modelled odds ratios. In models with more than one predictor variable, we used the full variation of all predictor value combinations to create predicted probabilities of prosocial behaviors associated with correlated socio-ecological (SEMB) variables. In models where two or more continuous predictor variables were present, separate model outputs were produced where each continuous predictor was variably held at its mean. This allowed deeper insight into each continuous variable's association with a prosocial behavior by modelling its full range. We then plotted predicted probabilities of prosocial variables with associated SEMB variables using the ggplot2 package (Wickham 2016) in R Studio (R Core Team 2024). Where multiple variable values were missing or removed in a model predictor (due to statistical incompatibility), we used imputational binary logit modelling to establish estimates of likelihood and significance using the MICE package (Van Buuren and Groothuis-Oudshoorn 2011).

We reported McFadden's pseudo-R^2-values summarising the overall fit of each model using guidelines from Hensher and Stopher (1979), where McFadden reports ρ^2-values between 0.2 and 0.4 a good fit (above 0.4 is considered an excellent fit). We also used confusion matrices to identify the ratio of false negatives and positives output by binary logit models, the results of which were displayed through fourfold plots for ease of interpretation.

Based on these values, we created an Area Under the Receiver Operating Characteristic Curve (AUROC) to display the overall accuracy of model predictions, comparing AUC scores with leave one out cross validation (LOOCV) computations for each model. Comparison to each model's LOOCV AUC allows us to validate that predictive performance should remain stable when applied to similar populations external to the model. LOOCV uses N-1 iterations of the sample size for each model (40 iterations for each model) to train the model on all data points. The AUC output ranges within a 0-1 scale (compared against a random model at 0.5) and is a commonly used performance metric for model discrimination between specific classifiers. Confidence estimates of probability within the AUROC were distribution-independent as approximations on the link (logit) scale are unlikely to yield valid results for non-normal data, and binary data intervals have coverage equal to 0 (Cortes and Mohri 2005). Therefore, confidence estimates were avoided in binary logit models and were instead the focal point of AUROCs which reflect model accuracy of predicting true positives.

Results

Correlation coefficients of selected SEMB variables to prosocial behaviors were all statistically significant ($p = <0.05$) (Sevastidis 2025). Due to the size of the correlation table, only variables included in modelling were displayed in the following heatmap (Figure 1).

All results of original AUROC comparisons to LOOCV models can be seen below in Figure 2.

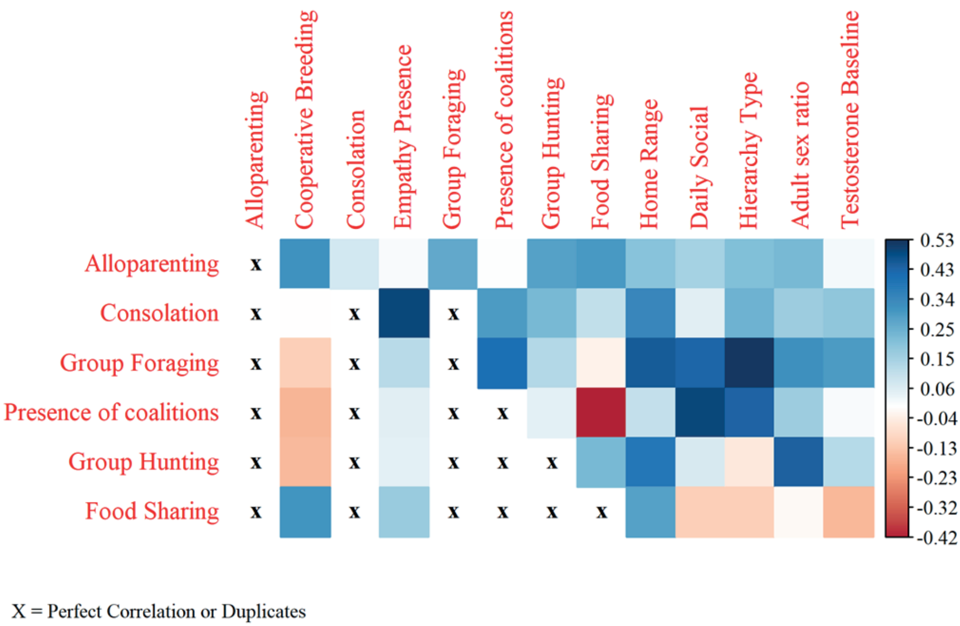

Figure 1. Correlation Heatmap of Modelled Variables. Prosocial variables of interest are displayed on the y-axis and social, environmental, morphological and biological (SEMB) variables on the x-axis. The side legend represents correlation statistics for each variable pair on a gradient colour scale. Both the upper and lower triangles contain unique combinations of prosocial/SEMB variables

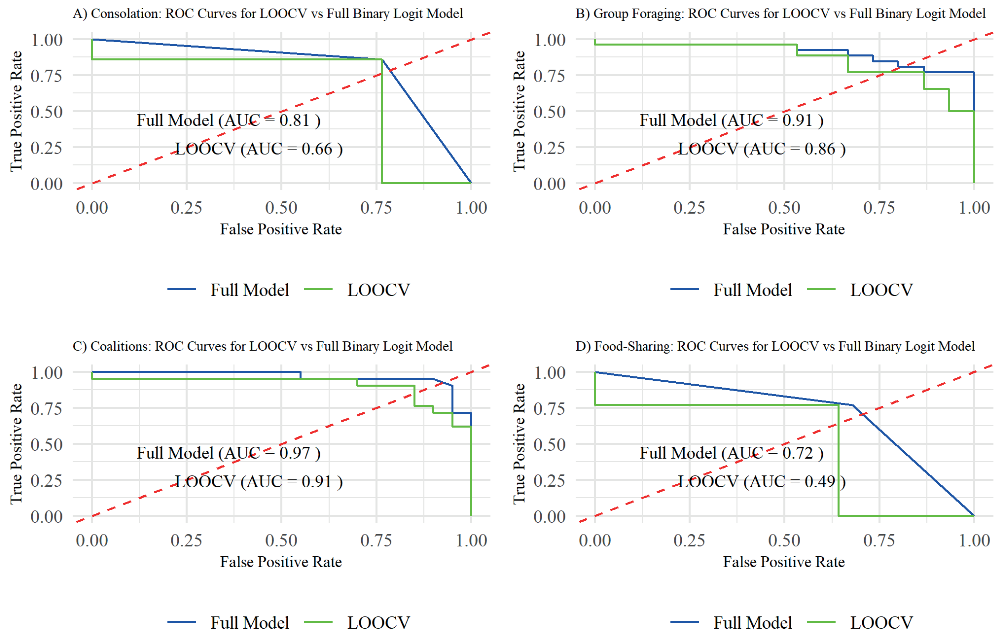

Figure 2. A collated figure of all Area Under the Receiver Operating Characteristic curve (AUROC) models analysed. AUROC of full model is presented in blue, while AUROC of Leave One Out Cross Validation (LOOCV) is presented in green. An AUROC score above 0.5 indicates that the model predicts more accurately than random chance. Plotline represents the ability of classifiers within the model to distinguish between sensitivity/specificity at all possible thresholds (values beyond those which belong to a particular class). AUROC is plotted against a random model (red diagonal dashed line). 2A) AUROC of empathy predicting consolation compared to a random model (LOOCV vs Full Model). 2B) AUROC of home range and daily socialising predicting group foraging compared to a random model (LOOCV vs Full Model). 2C) AUROC of hierarchy type, food-sharing & daily socialising predicting coalitionary behavior (LOOCV vs Full Model), and 2D) AUROC of coalitionary behavior predicting food-sharing (LOOCV vs Full Model)

Alloparenting

Recorded observations of co-operative breeding in primates were not significantly predictive of alloparenting behavior (p = >0.05) (Supplementary materials Table S2). Perfect separation was detected between the variables, where all recorded co-operative breeding societies also displayed alloparenting behavior (Supplementary materials Figure S1). McFadden's pseudo-R^2 ($\rho^2 = 0.11$), indicated poor model fit (Table B3).

Consolation

Consolation behavior in primate species was significantly predicted by observations of empathetic behavior; variables showed an excellent fit for the model (p = 0.01, $\rho^2 = 0.26$) (Supplementary materials Tables S3 and S4). Observed empathetic behaviour was defined as any behaviors that are recorded in the literature as empathetic or observations of behaviors which are commonly described as empathetic (e.g.

social contagions, targeted helping and so on) (Campbell and De Waal, 2014; Yamamoto, 2016). We did not include observations where empathy was assumed through abstract terms e.g. perspective taking, that did not accompany an accepted form of empathetic primate behavior. The absence of observed empathetic behavior resulted in a 3.7% probability that any given primate species would display consolation behaviors, while displays of empathy resulted in a 43% likelihood of consolation behaviors being present (Supplementary materials Table S5).

A four-fold plot displayed the rates of Type 1 and 2 Errors for the model (Supplementary materials Figure S2). Full model AUROC results indicated that the model has good predictive accuracy, outputting a true positive rate of 81% before producing any false positives (AUC = 0.81) (Figure 2A). However, once cross validated the AUC estimate was reduced to 0.66, indicating that while within-model prediction is excellent, applied to external populations predictions may only result in true positives 66% of the time. While confidence estimates for the full model are slim (95% CI = 0.8 to 1), the LOOCV model retains a wide interval (95% CI = 0.4 to 0.9) (Supplementary materials Table S6; generalizations from this model should be made cautiously.

Group Foraging

Both home range and daily socialising (as a % of a 24-hour day) significantly predicted the probability of group foraging behavior in primate species; model fit was excellent (home range $p = 0.03$, daily social $p = 0.02$, $\rho^2 = 0.48$) (Supplementary materials Table S7). At their means, home range ($M = 7.83km^2$) exceeded $7km^2$ and daily socialising ($M = 5.84\%$) exceeded 5% of total time in the day, where primate species had a 93.4% probability of being group foragers. Since home range and daily socialising are continuous variables with a binary response, two separate plots were produced where one variable was held at its mean and vice versa (Supplementary materials Figure S3).

The AUROC for the full group foraging model inferred excellent predictive performance of the SEMB variables on group foraging behavior, outputting a true positive rate of 90.8% before encountering any Type 1 Errors (AUC = 0.908, 95% CI = 0.81 to 1) (Figure 2B, Supplementary materials Table S6). A Four-Fold plot of the binary confusion matrix showed that the model output four Type 1 and four Type 2 Errors out of 41 total predictions (Supplementary materials Figure S4). The LOOCV AUC comparison yielded a similar result (AUC = 0.86), validating the excellent predictive performance of this model when generalized to similar populations (95% CI = 0.74 to 0.96) (Supplementary materials Table S6).

Presence of Coalitions

Societies with no indication of strict despotism and egalitarianism were used as reference for these analyses. We aimed to measure predictive correlations of coalitionary behavior to distinct hierarchy types for clarity of analyses, but recognise that such behaviors are not universal to all primates. Daily socialising, food-sharing and despotic hierarchies were modelled with a statistically significant relationship to coalitionary behavior (daily social $p = 0.04$, food-sharing $p = 0.04$, hierarchy type 2 (despotic) $p = 0.01$,

$\rho^2 = 0.51$). Hierarchy type 3 (egalitarian) was not significantly related to coalitionary behavior in the model ($p = 0.22$), however is still important to be included in the model to classify data accurately (Supplementary materials Table S8). AUROCs displayed an excellent predictive accuracy for both full-model and the LOOCV model (full model AUC = 0.96, LOOCV AUC = 0.91) (Figure 2C) with high confidence estimates (full model 95% CI = 0.88 to 1, LOOCV 95% CI = 0.80 to 1) (Supplementary materials Table S6).

Figure 3 shows that food-sharing was a mediating variable influencing the ability of daily socialising to predict if primate species display coalitionary behavior. Food-sharing primates required higher levels of socialising to reach higher probabilities of coalition formation compared to primates where food-sharing has not been recorded. Additionally, rates of daily socialising reflecting similar predicted probabilities of coalition formation vary between hierarchy types and could indicate an inferential relationship to coalition formation in a despotic hierarchy. A Four-Fold confusion plot showed that the model produced two Type 1 and one Type 2 Errors (Supplementary materials Figure S5).

Group Hunting

Due to validity issues caused by missing values of testosterone baseline and adult sex ratio, imputational data were used to model both variables when predicting group hunting in primates. The imputed data resulted in both adult sex ratio and testosterone not being significant predictors of group hunting (adult sex ratio, $p = 0.22$; testosterone baseline, $p = 0.60$) shown in Table S9 (Supplementary materials). Density plots comparing iterations of imputed data showed that simulated values variably followed the general trend of real values within the original dataset (Supplementary materials Figure S6). A discussion on improving this model can be found in the Supplementary File 2.

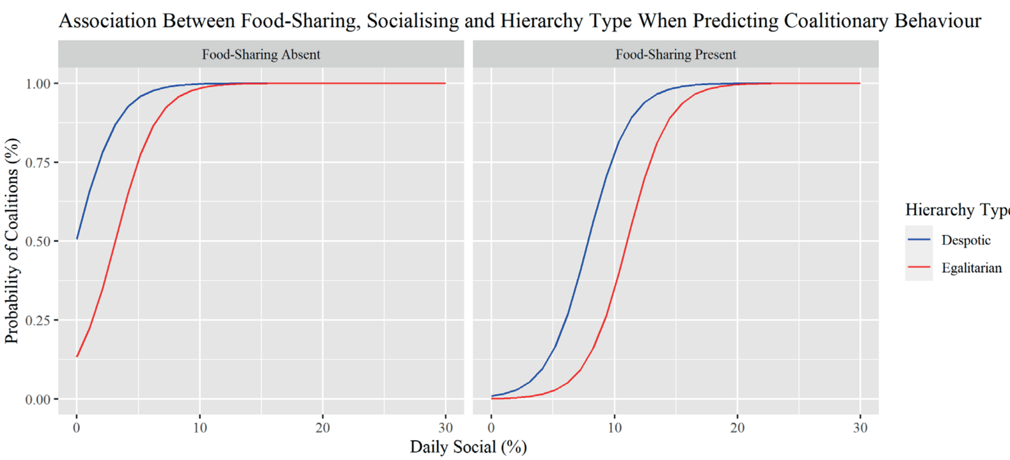

Figure 3. Food-Sharing Mediates the Relationship Between Daily Socialization and Probability of Coalitions. Egalitarian hierarchies displayed more socialization in each food sharing condition to achieve higher probabilities of coalition presence compared to despotic hierarchies

Food Sharing

Food-sharing in primates was significantly predicted by the presence of coalitions ($p = 0.01$, $\rho^2 = 0.14$) (Supplementary materials Table S10). Primates who display coalitionary behavior had a 13.6% probability of being food-sharing species, whereas the absence of coalitions resulted in a 52.6% probability of food-sharing in primates (Supplementary materials Table S11). AUROC results of the full model in Figure 2D displayed a good level of predictive accuracy (AUC = 0.72), however the LOOCV AUC displayed poor predictive accuracy for the model (AUC =0.49). Confidence estimates for the full model and LOOCV AUC are wide (95% CI = 0.57 to 0.87, LOOCV 95% CI = 0.28 to 0.7) (Supplementary materials Table S6), indicating a low reliability of predictions made both within and external to the model. A Four-Fold confusion plot showed that the model produced eleven Type 1 and three Type 2 Errors (Supplementary materials Figure S7).

Discussion

This research suggests that certain socio-ecological contexts may predict prosocial behaviors in primates. We proceed to discuss possible inferential relationships within our models and explore how prosociality within these contexts could provide a framework to test IBNS generally within this taxon. While the discussions on IBNS presented here are theoretical, it is hoped that our findings and hypotheses are tested through future IBNS research in primates, especially in species that naturally fulfil socio-ecological conditions that select for prosocial behaviors.

We note that alloparenting and co-operative breeding are erroneously used as interchangeable terms in much of the current primate literature. While the two are semantically similar, in this paper alloparenting is defined as a society with non-restrictive breeding and care provided by non-parents, whereas co-operative breeding is used for societies where alloparents are a by-product (or possibly forced consequence) of reproductive skew to dominant breeders (Lukas and Clutton-Brock 2012). However, the definitive usage for each term is still debated (Mocha et al. 2023).

The predictive relationship between co-operative breeding and alloparenting was not significant; considering the logical and frequently observed relationship between the two, this result seems surprising. However, the raw data suggest a perfect separation between the two variables. No co-operative breeding was recorded in primate societies without alloparenting; the statistical model could not calculate a significant difference between the two variables as no variance between them existed. Therefore, no predictive modelling could be extracted from these data, though readers should note that logically, a co-operative breeding society will always alloparent; otherwise, the purpose of co-operative breeding is lost and the behavior would likely not exist. Based on this assumption, we can infer that primate species which practice co-operative breeding also practice alloparenting. Future studies should consider exploring if distinct behaviors associated with alloparenting (which vary between primate species) have any correlations to SEMB variables and potentially IBNS (Cerrito and Spear 2022; Isler and van Schaik 2012).

Interplay Between Home Range and Daily Socialization When Predicting Group Foraging

Our study found that the likelihood of a primate being a group forager increased to nearly 100% when the daily time spent socialising was at 10% or more (Supplementary materials Figure S3a). Group or social foraging is a cohesive action that depends on physical and temporal co-ordination, making it an optimal variable to discriminate between primates that could hypothetically display IBNS. This also provides an opportunity for researchers to investigate if cortical synchronization is varied during IBNS in different co-operative tasks. While group foraging is a widespread and effective behavior in the animal world, its presence in primate species is variable (Swedell 2012). Group foraging behaviors can display uniquely in each primate and can depend on the decision of leading party members to secure vegetation (Strandburg-Peshkin et al. 2015; Williams et al. 2022).

Consider the group foraging methods of *Pan paniscus*. Mixed sex groups of five to six conspecifics forage for fruits in tall trees (Janson 1992); when fruits are secured, they can become euphoric and begin to chase, greet, copulate, vocalise, and eat (Kano and Mulavwa, 1984). Though not part of the actual foraging strategy, the process denotes a key part of group foraging behavior – social cohesion (Sterelny 2021; Williams et al. 2022). Consider another group foraging strategy from *P. anubis*; these primates travel and forage in large groups of up to 200 individuals (Kiffner et al. 2022). With such a large population, group foraging operates through party leaders, who decide the direction of the group and time spent at a single foraging site (Strandburg-Peshkin et al. 2015). Each group member must cooperate with the choices made by leaders of the foraging party to maximise individual foraging efficiency and reward in a species where home ranges can reach 19km^2 (Barton et al. 1992). All group foraging is dependent on constant socialising and cooperation between group members. It is therefore unsurprising that group foraging forms a strong predictive relationship with daily time spent socialising (Supplementary materials Figure S3a). Group foraging behaviors in primates with high daily rates of socialization indicate an elevated social cohesiveness, thus making them optimal candidates to potentially observe IBNS between conspecifics. However, there are group foraging primates that reflect an inverse of the relationship displayed in (Supplementary materials) Figure S3a.

Lagothrix lagothricha and *Erythrocebus patas* are two examples of the conflicting patterns that emerge when using daily socialising to predict the presence of group foraging in primates. *E. patas* only spends 3% of its day socialising and is a group forager, whereas *L. lagothricha* spends 10% of its day socialising, but does not forage in groups. One explanation for this difference may be found in the home range of each primate; another predictive condition of group foraging behavior in primates. In Figure S3b (Supplementary materials), the model shows that when daily socialising is held at its mean, a wider home range predicts an increased probability of group foraging. *L. lagothricha* lives within a home range of approximately 0.6km^2 compared to *E. patas* home range of approximately 4km^2. In Figure S3a (Supplementary materials), a home range of 4km^2 results in a group foraging probability estimate of 80%. Therefore, even when primates socialise for 10% or more of their day, their home range can potentially decrease the effect of daily socialising as a predictive condition for group foraging. On the other hand, primates who are not intense socialisers like *E. patas* are certainly not bereft of the ability to act prosocially. To use group foraging as an indicator of IBNS, ecological/behavioral predictive factors of home range and daily socialising must be considered together with the theoretical implications discussed here. These socio-ecological forces predicting group-foraging behaviors may also influence IBNS, potentially altering the number/loci of synchronized cortices between primates where a different motivator (i.e., the presence or absence of regular socialization) spurs IBNS. Specific analysis of the number of loci synchronized between conspecifics should be compared on a gradient from solitary to highly social primates; IBNS most likely exists on such a gradient underpinned by familiarity with conspecifics as seen in humans (Kinreich et al. 2017; Kurihara et al. 2024). Therefore, future research should also consider analysing IBNS within group-foraging primates like *E. patas* that are not highly social.

How Food-Sharing Could Mediate Coalition Formation in Different Primate Hierarchies

Figure 3 suggested that food-sharing may play a mediating role in the probability of primates displaying coalitionary behavior when measured with daily time spent socialising. Higher probabilities of coalition presence in non-food-sharing primates are achieved at lower levels of socialising compared to food-sharing primates. Hierarchical structure was also shown to be significant to this result. Generally, food-sharing in primates (which is rarely observed) serves one of two functions; to reinforce relationships (through reciprocity or ally consolidation) or to reduce harassment (tolerated theft) (Silk et al. 2013). Both require complex cognitive abilities including the capacity for reciprocity, understanding of social relationships and even anticipatory behavior of conspecifics, suggesting abstract thinking beyond immediate needs (Legg, Ostojić and Clayton 2014). To gain allies, elevated social tolerance between conspecifics (indexed by increased socialization) is required (Tai et al. 2012).

Top-down despotic societies create rigid social boundaries caused by dominance and kinship behaviors, which greatly narrow the opportunities for social relationships and limit socialising in general compared to egalitarian primates (Tombak et al. 2019). Typically, aggression reduces tolerance between conspecifics and forces subordinates in despotic societies to seek coping strategies, especially via social support in the form of coalitions (Sapolsky 2005). Considering this, a likely coalition where food-sharing would take place in despotic societies would be within kin and reciprocal relationships, as bachelor groups are competitive and prone to intra-aggression, and food-sharing is not known to take place during despotic reconciliation (Palagi and Norscia 2015). It must be noted here that food-type alone is not a predictor for any certain behavioral outcome (though it can be associated with certain behaviors) (Jaeggi and Schaik 2011).

Female-cryptic mate choice is an exemplary strategy that mixes both kinship and long-term investment in conspecifics, which can be mediated by food-sharing in both *Pan troglodytes* and *M. mulatta* (Dubuc et al. 2012; Crick et al. 2013). Firstly, by creating the illusion of paternity through sexual intercourse with variably ranked fathers, cryptic females can theoretically expand their social matrix and acquire multiple mate-guards. This inter-sexual coalition is highlighted by Sapolsky (2005) as a subordinate coping strategy in a despotic society. These relationships are usually prefaced by intense social affiliation such as grooming and physical contact (including sexual engagement), establishing a foundation for reciprocity following Bronsan and De Waal's (2002) proposed three levels of reciprocity. In the highly despotic *M. mulatta*, female consorts are allowed to co-feed more often (Dubuc et al. 2012) at the same site as their male counterpart. In *P. troglodytes*, females receive higher quality food after copulation with a male food possessor even outside of peak fertility; this did not consolidate food-sharing with the same male for the next oestrus period (Crick et al. 2013). Therefore, by participating in bouts of intense socialization, despotic females can temporarily expand their social matrix and consolidate coalitions through transient reciprocal relationships which manipulate paternity, thus using food-sharing as a short-term investment strategy. We note here that the relationship between coalitionary behavior and egalitarian societies was not statistically significant. Accordingly, we discuss the non-relationship between egalitarianism and food-sharing predicting the presence of coalitions.

Primate egalitarianism strives to maintain higher levels of constant social tolerance between conspecifics (Boehm 1993; Pandit and Van Schaik 2003; Tombak et al. 2019; Harrod et al. 2020), thus eliminating the need for intense bouts of socialization to form coalitions. Therefore, should the need for coalitions ever arise (such as those seen in *P. paniscus* female coalitions against aggressive males) (Tokuyama and Furuichi 2016) preceding socialization (before coalitionary behavior) would theoretically be less intense compared to despotic primates as investment strategies that strengthen cohesion between conspecifics such as food-sharing could permanently exist as a feature of reciprocity in an egalitarian society (Jaeggi and Gurven 2013; Toombak et al. 2019). This makes egalitarian coalitionary support not a matter requiring increased bouts of intense socialising, but a social enforcement mechanism built on long-term investment in conspecifics which maintains egalitarianism. In *H. sapiens*, small-scale egalitarian societies such as the Hadza of Tanzania share food to maintain egalitarianism; with individuals levelling inter-group asymmetries in food income after acquisition (Pinheiro 2021). Therefore, while egalitarian long-term investment in conspecifics using food-sharing could contribute to coalitionary behavior, the basis of coalitions may change dependent on hierarchy type, so much so that a generalized inferential relationship between the two cannot be made. These differences between hierarchical contexts shaping coalition formation and food-sharing between primate populations reiterate that ultimately, prosocial behavior manifests in accordance with the overarching socio-ecological context. This reinforces the previously mentioned notion that IBNS in primates would also uniquely manifest based on the relationship between socio-ecological context and prosocial behavior; like *H. sapiens* (Sáez et al. 2015; Valencia and Froese 2020; Kurihara et al. 2024). We make this assumption in reference to our gradient theory of primate IBNS – social familiarity mediated by overarching socio-ecological factors will likely influence the manifestation and strength of IBNS in primates.

Why is Food-Sharing more Likely Outside of Primate Coalitions?

When predicting the probability of food-sharing using the presence of coalitions in primate societies, an inverse relationship was found indicating that food-sharing is a prosocial trait more likely to occur in the absence of any coalitionary behavior (Supplementary materials Table S11).

Though the model itself was unstable and cannot reliably predict the relationship between these two variables, it is worth noting that instances of food-sharing occur outside of primate coalitions e.g. tolerated theft and kin selection. The inferential relationship between food-sharing occurring outside of primate coalitions still has value to understanding different contexts underpinning prosocial primate behavior. However, it is apparent that food-sharing as a general label is not a suitable classifier to use in predictive analyses and we acknowledge this as a weakness of our model. Instead, we recommend that the food-sharing variable be further operationalized to reflect the distinct contexts in which this behavior takes place. Using a model with a more refined food-sharing variable may increase the accuracy and reliability of predicting the occurrence of this behavior in a general primate population.

Predicting Consolation Behaviors Through Empathy Presence in Primates

The presence of empathetic behavior in primates indicated a 40% likelihood of consolation behaviors being present within a primate species, whereas the absence of empathy inferred a less than 5% likelihood of any consolation behavior. It should be noted here that the empathy presence variable contained observations which reflected of both cognitive and affective empathy. Though either type of empathetic behavior can still lead to consolation, cognitive empathy has been shown in *H. sapiens* to motivate consolatory behavior to a greater extent (Abraham et al. 2014). Both cognitive and affective empathy have been theorized to underpin sympathetic concern and consolatory behaviors in great apes, but no data explicitly discriminating these factors exist (Clay and De Waal 2013; Webb et al. 2017). To evaluate the correlations/predictive relationships of empathy to consolation behaviors, more detailed data discriminating between cognitive and affective empathic styles in primates are needed. Furthermore, it is recommended that data on empathy are de-centralized from the great apes to achieve a wider perspective of empathic cognition in primates. Numerous studies in *H. sapiens* have detailed the connection between empathetic behavior and IBNS (Valencia and Froese 2020). Therefore, primates that display empathy and consolation behaviors could be optimal candidates to observe IBNS in future research.

Comparing Inter-Brain Neural Synchronization and Key Prosocial Behaviors Between Primates and *Homo sapiens*

So far, we have discussed predicted prosocial behaviors in primates which may guide researchers to species (outside of macaques) that exhibit unique patterns of IBNS in a range of socio-ecological contexts. We will go on to discuss the theoretical justification of IBNS related to these prosocial behaviors within primates, and identify key similarities and differences between *H. sapiens* and primate IBNS. We do this with the goal to highlight how IBNS may uniquely manifest with distinct prosocial behaviors influenced by environment and neurobiology in a range of primates.

Many of the prosocial variables presented in the discussion were predicted by daily socialising with an overarching theme of co-ordinated group activity. Group foraging and coalition formation are both behaviors that require large-scale co-operation to achieve common goals, underpinned by increased socialization. Similar patterns of prosociality are seen in modern *H. sapiens*, where group behaviors increase the success of common goals and efficiency of co-operation (Sinha et al. 2016; Szymanski et al. 2017). In *H. sapiens*, such group activities are underscored by IBNS elicited through socialization during co-operation (Valencia and Froese 2020). For example, coalitionary scenarios in *H. sapiens* (such as team sports) evoke IBNS via intense socialization (vocal/physical communication) and co-ordination to achieve a common goal of victory over opponents (an example of shared intentionality), potentially mediated by dopaminergic systems (Li et al. 2020; Liu et al. 2021; Probolovski and Dahan, 2021).

Considering the influence of cooperative group scenarios on the cortical manifestation of IBNS within *H. sapiens*, (Tseng et al. 2018; Valencia and Froese 2020) it is plausible that similar scenarios in non-human primates may elicit unique patterns of IBNS. When food-acquisition becomes the primary goal of primate co-operative teams (typically seen in group foraging primates) identical patterns of co-operation to *H. sapiens* may emerge. A primate group-foraging party may cooperate by synchronising behavior to commands from a party leader, with the common goal to increase foraging efficiency and success (a form of shared intentionality) (Hintz and Lonzarich 2018; Williams et al. 2022). Similar scenarios have been created with *M. mulatta* in a laboratory setting where observer-participant dyads completed motor courses to achieve food rewards (Tseng et al. 2018). Translation of these results to natural group foraging scenarios (where an even greater scale of teamwork is required in response to dynamic environments) would suggest that IBNS is active during group foraging, with activation patterns possibly being influenced by natural socio-ecological contexts.

However, distinct neuroendocrine systems differentially influence *H. sapiens* and primate prosocial behaviors which may evoke IBNS. Levels of dopamine (critical to *H. sapiens* prosociality) are much higher in the nucleus accumbens (NAcc) and striatum of *H. sapiens* compared to great apes (Raghanti et al. 2018; Hirter et al. 2021). Additionally, great apes retain a higher density of acetylcholine receptors (linked to dominance and territorialism) compared to *H. sapiens* (Raghanti et al. 2018). Interactive analyses have shown that dopamine in *H. sapiens* brain is modulated by both acetylcholine and glutamate and is responsible for increases in prosocial behavior (Lester et al. 2010; Sáez et al. 2015). Furthermore, increases in dopamine are rewarded through interaction with oxytocin, creating a distinct neurochemical positive feedback loop for prosociality in *H. sapiens* (Love 2013). Serotonergic systems in the orbito-frontal region of great apes also show correlation to pro-social behavior and inhibition of anti-social behaviors; comparatively hominins' striatal serotonin levels show marked increases and correlations with prosocial behavior (Saniotis et al. 2021). The function and interaction of up-regulated oxytocin, dopaminergic and serotonergic systems within *H. sapiens* creates distinct enforcement mechanisms for co-operative and prosocial behavior, leading to distinct manifestations of IBNS (though these may not be critical to its elicitation; only cortical activation patterns) (Mu et al. 2016; Lotter et al. 2023).

In comparison, dopamine receptor modulation was shown to have no significant effect on prosociality in *M. mulatta* (Wendland et al. 2006). This suggests that IBNS could potentially be modulated by distinct neuroendocrine systems which selected for increased co-operation in *H. sapiens* (Clark and Henneberg 2021). Notably, cooperation is much less prominent in great apes compared to *H. sapiens*, highlighting a potential implication of differing neuroendocrine systems supporting prosociality (Tomasello 2023). However, the current literature on primate IBNS is extremely limited so far and no studies have presented direct evidence for a relationship between neurohormones and IBNS in primates. Group foraging practices of *P. paniscus* could provide future researchers with a case for dopamine-induced IBNS (in reference to implications of dopaminergic influence on primate IBNS patterns by Tsung et al. 2018) and vitally expand the existing literature on the neuroendocrine systems that could support primate IBNS.

However, prosocial activity does not always have to involve large coalitions or teams striving to achieve a common goal. Co-operation is also realized on a smaller scale in both the primates and *H. sapiens* in individuals who take on roles as alloparents or carers, sometimes subserved by empathic or socio-cultural motivations. Parenting in modern *H. sapiens* strongly elicits IBNS, mediated by communication and distress between parent and child (Liu et al. 2024), usually in the form of crying and distress vocalizations. Parent responses to infant distress are mediated by empathy in *H. sapiens*, particularly cognitive empathy (Abraham et al. 2014). Cortical areas responsible for cognitive empathy are synchronously activated in parental dyads by IBNS during observation of infant distress, an example of sympathetic concern (Wever et al. 2021). Sympathetic concern is followed by consolatory behavior in *H. sapiens* which evokes IBNS via inter-parental neural coupling (Liu et al. 2024). Consolation behavior motivated by IBNS and empathy has also been documented to increase social closeness in *H. sapiens* (Turner and Turner 2013).

Notably, *H. sapiens* parental concern-consolation reaction can result from several unique social scenarios involving infants and conspecifics; possibly following hominin behavioral adaptations due to erect posture and further development of the Default Mode Network (DMN). Early hominin erection of the trunk may have significantly reduced the tactile relationship between mother and infant, resulting in more frequent bouts of infant distress (via crying or vocalizations) richer in semantic meaning and empathic manipulation compared to great ape predecessors (Falk 2004). This may have led to the distinct behavioral displays of concern-consolation behaviors seen uniquely in *H. sapiens* such as feeding or *motherese* to alleviate distress, as well as the usage of distal communication to soothe infants (Falk, 2004; Hayashi and Matsuzawa 2017).

Primates also have the capacity for cognitive empathy and show sympathetic concern to socially close conspecifics in distress (De Waal 2008; De Waal 2011; Palagi et al. 2014), which can be followed by engagement in consolatory behaviors for the distressed (e.g., licking, grooming). Consolation behaviors in primates also predict improved social closeness and integration, reflecting the same pattern of empathy-motivated behavior seen in *H. sapiens* (Webb et al. 2017). However, consolation in this sense may occur through two different neuroanatomical pathways between primates and H. *sapiens*. The topography of *H. sapiens* and *P. troglodytes* prefrontal cortex shows distinct anatomical differences in relation to the DMN, namely the absence of the dorso-medial prefrontal cortex (D-MPFC) in *P. troglodytes* (Rilling 2014). The D-MPFC has functional relevance to language and theory of mind behaviors within *H. sapiens,* a distinct form of cognitive empathy which has been shown to facilitate IBNS (Decety 2010; Fishburn et al. 2018).

Although, great apes may lack this specific neuroanatomical pathway, they are still capable of using cognitive empathy that is rudimentary in comparison to *H. sapiens (*Hare et al. 2000). Advances in the anatomical development of the DMN may have occurred in early hominins with the development of language and more advanced forms of tool-making (Rilling 2014). This highlights the importance of Falk's (2004) *motherese* hypothesis and Dissanayake's (1999; 2003; 2004) work in hominin mother-infant interaction, when analysing the potential differences in patterns of cortical activity (during IBNS) between primates and *H. sapien*s. Notably, these works highlight an epoch in the hominin lineage where unique prosocial behaviors arose from exapted features of increasingly prosocial mother-infant interactions. This idea extends to neurohormonal regulation of prosociality (e.g., oxytocin pathways to regulate cohesion) and advancements in socio-cognitive architecture – including the DMN and advanced forms of empathy. Recent studies have compared the superior temporal sulcus (STS) of non-human primates to the temporoparietal junction (part of the DMN) in *H. sapien*s, particularly the circuit connecting the STS, amygdala and lateral intraparietal area in non-human primates which may be a precursor to the evolution of theory of mind in *H. sapien*s (Ong, Madlon-Kay and Platt 2021; Platt, Seyfarth and Cheney 2016). Focus should be given to brain areas showing protracted development correlated to prosocial behaviors as these are hypothesized to subserve increased prosocial interaction (and neural responsivity) in non-human primates and thus may be easier to measure for IBNS during prosocial interaction (Cerrito et al. 2024).

No studies to date have shown a relationship between theory of mind and IBNS in primates. It can be argued that neuroanatomical differences resulting from early hominin selection pressures have influenced the formation of distinct prosocial behaviors unavailable to other primates which elicit IBNS in *H. sapiens*. Considering that both primate and *H. sapiens* consolation behavior is activated via sympathetic empathy, especially towards infants, future studies should aim to investigate the presence of IBNS in alloparental primates who show high investment in the offspring of related individuals. It should be noted here that the current study did not use phylogenetic comparative analysis to correlate

SEMB variables with complex prosocial behaviors, therefore limiting evolutionary tracing and analysis of them. However, we recommend that future research uses trait mapping and predictive modelling of paleoneurology associated with SEMB variables (see Pearson and Polly, 2023; Pearson and Polly 2024) to provide a richer description of behavioral phylogeny.

Using modelled predictions of prosociality in a diverse sample of primate species, we compared prosociality between primates and *H. sapiens* to explore the idea that IBNS may be possible in all primates. Primates behave within similar prosocial contexts that precede IBNS in *H. sapiens*, ranging from empathetic concern and consolation to group-based behaviors that require higher levels of socialising. Additionally, the current studies on primate IBNS clearly demonstrate the existence of this function within this taxon (though limited only to macaques), potentially underpinned by similar neurohormones to *H. sapiens.* However, key differences between these groups may exist in relation to how IBNS is evoked. The factors that differentiate IBNS between primates and *H. sapiens* have likely been shaped by early hominin selection pressures. This research has implications for investigating the presence of IBNS in hominins. In our study, we provide a framework on how IBNS could exist in all primate populations which fulfill socio-ecological conditions that elicit prosocial behaviors, and the potential distinctions of IBNS between primates and *H. sapiens.* We have provided multiple hypotheses for future researchers to test the existence of IBNS in a diverse range of primates; potentially expanding our understanding of IBNS in non-human primates, which could further extend our knowledge on IBNS in *H. sapiens*.

Acknowledgements

We thank Dr. Scott Coussens for his contributions to discussions concerning the current research topic. This research was supported by the University of Adelaide, South Australia (Australia). We also thank the reviewers and editors of the International Journal of Primatology for their comments which helped revise the manuscript.

Conflict of interest

The authors declare that Maciej Henneberg is an Editor of Anthropological Review, but was not involved in the handling of this manuscript**.**

Author contributions

All authors contributed to study conceptualization, discussed results, and made critical contributions to revisions/editing, resulting in the final manuscript. JS was the lead researcher, conceived the study concept and design, acquired all data for data analysis, performed all data analysis, and wrote the entire manuscript. GC provided many materials for the study. MH contributed to the design of statistical methods.

Ethics statement

Not applicable.

Data availability

Data on primate species used for this study are freely accessible in online repositories (Wisconsin National Primate Research Center and San Diego Zoo Wildlife Alliance Library) or through online literature.

Funding

No funding was acquired for the current study.

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Anthropological Review • Vol. 88(4), 31–51 (2025)

ANTHROPOLOGICAL REVIEW

Available online at: https://doi.org/10.18778/1898-6773.88.4.02

The Critical Role of Dopamine in the Evolution of Human Intelligence and Thermal Tolerance

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ABSTRACT: Modern humans are unique among anthropoids in many key features, including our advanced intelligence, large brain-body size, thermal tolerance, and endurance capability. The objective of this theoretical review is to update the theory of Previc (1999) postulating the importance of dopamine in human evolution by synthesizing newer findings concerning dopamine's role in human intellectual and endurance capabilities. Recent evidence further supports the putative role of dopamine in advanced human intelligence (especially cognitive flexibility) and thermal tolerance and endurance. One key breakthrough is a collection of recent studies demonstrating a uniquely human dopaminergic innervation of the striatum and prefrontal cortex—both essential to human cognition. Another potentially important finding is the human-specific mutation of an enhancer to the EN1 gene that controls eccrine gland formation and plays a major role in the development of dopaminergic brain systems. A plausible evolutionary scenario is put forth in which the enhanced thermal capabilities linked to dopaminergic evolution may have gradually led to the enhanced intellects of modern humans.

KEYWORDS: dopamine, intelligence, endurance, evolution, human

Original article

Received: 2.04.2025; Revised: 25.08.2025; Accepted: 20.10.2025

Introduction

Humans are unique among primates and even most mammals in several key respects, most importantly our advanced intelligence and thermal endurance capacity during exercise. When these various traits emerged during hominin evolution remains speculative, but the theory presented in this paper—updated from that of Previc (1999)—is that, because of their synergistic relationships, most traits must have emerged concurrently between~ 2.8 million years ago (mya) (just prior to the emergence of *Homo habilis*) and ~1.2 mya (after the emergence of *Homo erectus*).

One key synergy is in the area of human thermal tolerance, which largely depends on the combined advantages of reduced body hair cover and predominantly eccrine sweating; one without the other would be much less advantageous (Lieberman 2015). Other linkages such as bipedalism and increased stature would further enhance thermal tolerance by decreasing exposure to solar irradiance (Wheeler 1985), and thermal exchange via the eccrine glands would be aided by the increased surface-to-mass ratio (Allen's rule) (Tilkens et al. 2007). In turn, the ability to travel long distances in the heat of the midday sun would allow early humans to scavenge and possibly chase-hunt for meat while predators would be resting to avoid hyperthermia (Carrier 1984; Bortz 1985; Lieberman 2015). The switch to a tyrosine-rich carnivorous diet would increase the brain-body ratio due to the combination of a larger brain (Previc 1999) and reduced intestinal mass characteristic of carnivores (Henneberg and Sarafis 1998) and lead to a concomitant increase in dopamine-mediated advanced intelligence.

This paper will postulate that all of these unique features of humans were caused, causal to, or correlated with increases in the neurotransmitter dopamine and its precursor tyrosine during human evolution. The key roles of dopamine in the evolution of advanced intelligence and thermal tolerance were previously postulated (Previc 1999), but more recent findings to be reviewed here provide a more complete and compelling synthesis of the dopaminergic role in these interleaved components of human evolution. For one, massive and unique increases in dopamine innervation and activity in the human striatum and frontal lobes of humans—key areas involved in higher-level cognition—have been recently found. The importance of dopamine in speech, abstract representations, creativity and a host of other key intellectual functions has also been further demonstrated (see next section). In terms of thermal tolerance, new findings have documented the role of dopamine in creating hair loss and the genetic overlap between the formation of both brain dopaminergic systems and eccrine sweat glands during human evolution (see "The Role of Dopamine in Human Thermal Endurance—New Findings"). And, the importance of meat consumption—previously documented by cut marks on and stone-flaked tools near animal bones in early *Homo* sites—has been supported by genetic analyses of human tapeworms (Hoberg et al. 2001) and pH levels (Beasley et al. 2015) in the human stomach and gut.

Brain Dopamine and Human Intelligence – New Findings Dopamine and Human Intelligence

Previc (1999) theorized the importance of neurochemical changes involving the neurotransmitter dopamine in the evolution of human intelligence, highlighting six key traits essential to human intelligence and human language—motor planning, working memory, cognitive flexibility, abstract reasoning, temporal analysis/sequencing, and generativity. Previc (1999) argued against the role of brain size and genetic factors in determining human intelligence, instead emphasizing the importance of epigenetic transmission during human evolution. He noted the role of prenatal factors in the creation of brain lateralization in humans (see also Previc 1991), which in most individuals is associated with profound differences in intellectual and other abilities between the left and right hemispheres despite their identical anatomical size and the absence of any known genetic influence. The importance of nongenetic factors in intelligence is supported by recent genome-wide analyses that have consistently shown that only about 5% of the variance in intelligence as measured through standard tests is directly attributable to genes (Benyamin et al. 2014; Davies et al. 2016; Sniekers et al. 2017; Kaminski et al. 2018), with many of the key ones involved in dopaminergic synaptic transmission (DeYoung et al. 2011; Zabelina et al. 2016; Kaminski et al. 2018). Indeed, epigenetic and genetic influences on just six genes involving the synthesis, transmission, breakdown, and re-uptake of dopamine at the synapse can predict much of the variance in childhood intelligence accounted by genome-wide models (Kaminski et al. 2018).

The critical role of dopamine in key "executive" abilities such as working memory, creativity and language has also been confirmed in numerous recent studies and reviews: working memory (D'Esposito and Postle 2015; Matzel and Sauce 2023); creativity/divergent thinking (Takeuchi et al. 2014; Lhommee et al. 2014; Zabelina et al. 2016); cognitive flexibility and set-shifting (Ko et al. 2008; Garcia-Garcia et al. 2010); speech (Simoyan et al. 2013; Fuertinger et al. 2018; Rusz et al. 2024); future goals and planning (Hart et al. 2024); and time perception and future orientation (Mitchell et al. 2018). An underlying component of dopamine's role in most of these abilities is cognitive flexibility—the ability to update processing and actions on the basis of new information and contexts. For example, working memory requires constant updating and attentional disengagement when new information is processed (Matzel and Sauce 2023), divergent thinking requires switching to new mental models and approaches (Palmiero et al. 2022), and choice and switching of goals is correlated with cognitive flexibility scores (Leclercq et al. 2023). Cognitive flexibility stems from dopamine's dual role in the prefrontal cortex, promoting the inhibition required to stop ongoing behavior and the excitation required to engage in new behavior and processing (Mitchell et al. 2018; Di Domenico and Mapelli 2023). This inhibition is carried out by interneurons in the prefrontal cortex, which are preferentially innervated by dopamine in humans (see next section).

Unique Dopaminergic Features of the Human Brain

As of 1999, there was little direct evidence that dopaminergic innervation of the human brain had selectively increased relative to other hominids. A lone study by Ikemoto et al. (1997) showed many more neurons staining for dopa-decarboxylase, the enzyme that converts the precursor

L-dopa to dopamine, in the striatum of humans relative to monkeys. But the evolutionary significance of this finding was unclear since neither chimpanzee nor gorilla brains were used as comparisons.

Beginning in 2009, a series of studies carried out by Raghanti and colleagues (2009) found large increases in dopaminergic innervation in areas of the human brain critical to intelligence. All of these studies used stains for tyrosine hydroxylase (TH), the enzyme responsible for converting tyrosine to L-dopa, the immediate precursor to dopamine that crosses the blood-brain barrier.

Raghanti et al. (2009) showed substantial TH staining in human but not chimpanzee and gorilla prefrontal interneurons, suggesting selective catecholaminergic activity in humans. However, because TH is a precursor to noradrenaline via dopamine, no firm conclusion could be drawn as to the selectivity of dopaminergic innervation of human prefrontal cortex. Raghanti et al. (2016) later showed, using TH staining and a measure of axonal length to neuronal density, over twice as much dopaminergic innervation in the medial caudate portion of the dopamine-rich human dorsal striatum compared to that of gorillas and chimpanzees. The noradrenergic contribution to the TH increase in this case could be ruled out because noradrenaline concentrations in the human caudate are ~50 times less than those of dopamine (Tong et al. 2006), despite both catecholamines constituting only a tiny overall percentage of the total neurons in the caudate nucleus and dorsal striatum, the latter containing both the caudate and putamen. The reason for the huge difference in catecholamine concentrations is because of the extraordinary arborization of dopamine axons emanating from the midbrain substantia nigra, with a single nigrostriatal axon on average contacting up to 75,000 striatal neurons, or 2.7% of the total volume of the neostriatum of the rat (Matsuda et al. 2009). Tyrosine hydroxylase staining in other subcortical dopamine-rich regions was generally greater in humans but less dramatically so than in the medial caudate nucleus. The differences between humans and other hominids in dopamine innervation in the medial caudate were especially impressive in Raghanti et al. (2016) due to the remarkably low variability in human TH levels in that region (Raghanti et al. 2016, Fig. 3).

Sousa et al. (2017) reported elevated TH expression as well as that of dopamine decarboxylase in a wide range of brain areas in humans relative to chimpanzees. The largest differences overall were in the dorsal striatum, but there were also major differences in prefrontal interneurons, with almost no ape prefrontal interneurons staining for TH. In yet another study using TH staining, Hirter et al. (2021) showed significantly greater dopaminergic innervation in the ventral striatum (ventral palladium and nucleus accumbens) of humans relative to chimpanzees and gorillas. Finally, Ma et al. (2022) showed, based on the relative staining for TH vs. somatostatin (SST), that a remarkable substitution of dopamine for SST occurred during human evolution in prefrontal interneurons, with only 2.4% of human TH-stained interneurons co-localized with SST, in contrast to almost 50% in the macaque monkey. The percentage of TH staining could not even be calculated in the interneurons of chimpanzees and gorillas because it was essentially nonexistent (Ma et al. 2022), in line with the findings of Raghanti et al. (2009) and Sousa et al.

(2017). The significance of this intriguing substitution of SST for dopamine in the very interneurons presumed to be involved in the key ability of cognitive flexibility (see earlier section) remains unclear, however.

Doll et al. (2024) in their Figure 1b summarize the expansion of dopaminergic systems in the human brain that has been documented using TH staining as well as staining for dopa decarboxylase and DAT, which reabsorbs synaptic dopamine back into presynaptic neurons. Additional evidence of a dopaminergic-intelligence link in humans are the significant correlations between volume of the dopamine-rich dorsal striatum and intelligence (Grazioplene et al. 2015; Kaminski et al. 2018). (By contrast, overall brain volume predicts only a small amount of the variance in human intelligence—Pietschnig et al. 2015.) These findings confirm the previously documented importance of the integrity of striatal-frontal circuits (Kling and Tucker 1967) and of the striatum in particular (Goldman and Rosvold 1972) for primate cognitive development. Moreover, selective destruction of dopamine neurons (Brozoski et al. 1979) or blockade of D1 and D2 post-synaptic dopamine receptors (Ranganath and Jacob 2016) essentially replicates the cognitive deficits following lesioning of the prefrontal cortex.

In contrast to the expansion of dopaminergic innervation in the prefrontal cortex and striatum, expression of other major neurotransmitters such as norepinephrine, GABA, glutamate and acetylcholine appears either unchanged or even reduced in humans (Sousa et al. 2017; Raghanti et al. 2018). For example, TH staining in prefrontal interneurons did not co-locate with staining for dopamine beta-hydroxylase (Sousa et al. 2017), which converts dopamine into norepinephrine, indicating that brain levels of norepinephrine are conserved in hominin evolution. While serotonergic innervation may have increased in certain areas of the human brain (Raghanti et al. 2009; Saniotis et al. 2021), there is little evidence that serotonin contributes to the advanced human cognitive skills listed by Previc (1999), as it even opposes dopamine action in the striatum and prefrontal cortex during learning and memory (Luciana et al. 1998; Daw et al. 2002; Olvera-Cortes et al. 2008). Also, unlike dopamine, serotonin in most humans does not more densely innervate the left hemisphere housing speech and analytical intelligence, nor can the hyperthermic action of serotonin (Tormoehlen and Rusyniak 2018) be reconciled with the greater thermal tolerance and endurance capabilities developed in early hominin evolution (see next section). However, brain serotonin does foster social cooperation and other prosocial behaviors (Crockett 2009), which may have facilitated the use of language and contributed to cultural and technological exchange during later human evolution (Raghanti et al. 2018; Saniotis et al. 2021).

Finally, the large increases in dopamine innervation of the human prefrontal cortex and striatum overall parallel the greater dopaminergic activity in the left hemisphere of most humans (Larisch et al. 1998; Previc 1999; Cho and Strafella 2009)—the citadel of advanced human thought with its dominance in speech, grammar, motor sequencing, abstract reasoning, analytical intelligence, and other unique characteristics of human cognition (Previc 1999; Simonyan et al. 2013; Fuertinger et al. 2018; Rusz et al. 2024). At least two of these cognitive abilities—speech and cognitive flexibility—have been shown to involve dopamine circuits specifically in the left hemisphere (Ko et al. 2008; Simonyan et al. 2013; Fuertinger et al. 2018).

The Role of Dopamine in Human Thermal Endurance—New Findings

It has long been theorized that the emergence of *Homo* coincided with an enhanced ability to endure strenuous activity over large distances and tolerate heat, useful in persistence hunting or scavenging (Carrier 1984; Bortz 1985; Wheeler 1985; Bramble and Lieberman 2004; Lieberman 2015). It is still debated whether early humans engaged in chase hunting (more likely to be associated with endurance running), active scavenging, or passive scavenging (Pobiner 2020), but all of these would have required great energy expenditures in the midday heat, when other predators would be inactive. Regardless of the specific means of procuring the meat, the ability of early *Homo* to tolerate heat would have been critical to overcoming these energetic demands.

Besides its direct role in intellectual functioning, a crucial role of dopamine in humans is to prevent hyperthermia during endurance activity. Dopamine levels are elevated during high-intensity and endurance activity (Bortz et al. 1981; Marques et al. 1984; Tyler et al. 2023), and dopamine cells in tissue slices from the anterior hypothalamus, important in temperature regulation, are mostly sensitive to temperature increases (Scott and Boulant 1984). The importance of dopamine in preventing hyperthermia during endurance exercise has been documented in many past studies (e.g., Cox and Lee 1980; Marques et al. 1984; Lee et al. 1985; Bauer et al. 1989), and its benefits in sustaining endurance performance have been confirmed by more recent ones (Balthazar et al. 2010; Zheng and Hasegawa 2016). Recent clinical findings have also substantiated the important effects of reduced dopaminergic activity in hyperthermic syndromes such as the Parkinsonism Hyperpyrexia Syndrome (Newman et al. 2009; Linares et al. 2016; Coon and Low 2018) and the Neuroleptic Malignant Syndrome associated with anti-psychotic treatments in schizophrenia (Tormoehlen and Rusyniak 2018; Hirschbeck et al. 2022), both in contrast to the hypothermic effect of disinhibited dopamine activity in Huntington Disease (Weydt et al. 2018).

How dopamine transiently achieves its hypothermic action during endurance activity is unclear, since dopamine evidently does not directly control sweating (Shibasaki and Crandall 2010); rather, hyperhidrosis (excessive sweating) is part of the Dopamine Withdrawal Syndrome (Chaudhuri et al. 2015). Dopamine-induced vasodilation (Brodde 1982; Brown et al. 2007) is one potential mode of action, since shunting of the blood to extremities allows for more effective heat transfer (Charkoudian 2003). However, dopaminergic effects are complex in that they may be temperature dependent—hypothermic at high temperatures, hyperthermic at low ones (Brown et al. 2007)—and it has even been argued that there are beneficial effects of brain dopamine on endurance activity aside from its effects on temperatures (e.g., Balthazar et al. 2010; Zheng and Hasegawa 2016, Fig. 2). Previc (1999) speculated that dopamine's role in motor behavior may activate a caudate-hypothalamic axis (Lee et al. 1985) during exercise that enhances oxygen metabolism and delivery in advance of an actual rise in temperature.

Previc (1999) proposed that the enhanced endurance capability of humans gave rise to a surge in brain dopamine during early human evolution, mainly due to the increase in meat consumption, which would have provided a substantially greater amount of tyrosine in the diet. The evidence for increased meat consumption beginning around 2 mya is compelling (Ferraro et al. 2013; Zink and Lieberman 2016; Pobiner 2020), although sampling biases may distort some of the archaeological findings (Barr et al. 2022). The evidence for meat-eating includes: 1) stone artifacts and bone cut marks in close proximity to early human remains, suggesting meat extraction from carcasses (Pobiner 2020); 2) the reduced size of the modern human large intestine (Henneberg and Sarafis 1998) and an increase in stomach acidity (Beasley et al. 2015), both associated with carnivorous diets; 3) changes in dentition (smaller teeth, especially canines; more bite strength in molars) that could have reflected the consumption of softer, processed meat (Dean and Cole 2013; Zink and Lieberman 2016); and 4) the evolution of human-specific tapeworms linked to African fauna around 1.7 mya (Hoberg et al. 2001). The increased tyrosine in the diet of early *Homo* would have major consequences in that it could have stimulated growth hormone (Tam et al. 2020), thereby increasing stature and brain volume (Yuan et al. 2020), which are significantly correlated (Taki et al. 2012). The effect of meat consumption on height has been demonstrated in past as well as recent large-scale studies (Suzuki 1981; Desmond et al. 2021; Mosites et al. 2017). The enhancement of growth hormone by tyrosine may be mediated by dopamine, although not all evidence is supportive. But it is clear that dopamine itself, in the brain and elsewhere, is dependent on tyrosine availability (Montgomery et al. 2003), as is cognitive capability, especially cognitive inhibition (Bloemendaal et al. 2018; Hase et al. 2015; Kuhn et al. 2019).

Despite dopamine's important role in thermal tolerance, a key issue was left unanswered in Previc (1999): How could brain dopamine have been a major force in the evolution of human endurance if it was *dependent* on that endurance capability and the consequent increase in meat consumption? A possible solution to this conundrum is the recent finding that the ENGRAILED gene (EN1), a transcription factor that facilitates the formation of eccrine sweat glands (Aldea et al. 2021; Aldea and Kamberov 2022), underwent an evolutionary change in humans due to repeated human-specific mutations of a key enhancer, ECE18. These mutations likely contributed to increasing eccrine density in humans ~10-fold relative to chimpanzees (Aldea and Kamberov 2022), which facilitates the phenomenal ability of humans to eliminate up to one liter of water per hour (Smith et al. 2021) and 12 liters per day by means of evaporative cooling in the skin. It is generally acknowledged that 90% of heat loss occurs through the skin, mostly by radiation and convection; however, evaporative cooling through the eccrine glands becomes more critical at high temperatures (Wang et al. 2016). What is intriguing about the EN1 evolutionary progression is that this gene is also important in the development of midbrain dopaminergic systems (Simon et al. 2004; LePen et al. 2008; Nordstroma et al. 2018; Nouri and Awatramani 2017), the primary source of dopamine in the forebrain. EN1 is part of a constellation of genes and pathways with many diverse effects in the human body but which all interact to influence both sweating and exercise tolerance as well as the formation and sustenance of brain dopamine systems. These include NURR1 (Amoasii et al. 2019), the WNT family (Alves dos Santos and Smidt 2011), and especially FOXA1 (Ferri et al. 2007; Cui et al. 2012), the latter of which helps regulate both EN1 and NURR1 (Ferri et al. 2007). However, only EN1 via mutations of its enhancer ECE18 is confirmed to have undergone a major functional alteration in humans (Aldea et al. 2021).

Given the fact that each of these genes has multiple regulatory functions in human development, it is possible that the links between these key dopaminergic genes and sweating are coincidental. Or, the EN1 mutation may have affected dopamine and eccrine sweating independently, since eccrine function is largely controlled by cholinergic rather than dopaminergic transmission (Shibasaki and Crandall 2010). Regardless, mutations of an enhancer to a major gene regulating both sweat gland formation and dopaminergic brain development offers a tantalizing clue as to how dopamine and thermal tolerance linked up during human evolution.

In contrast, the reduced body hair cover may have been more directly influenced by dopamine in that dopamine agonists are known to decrease hair cover by stimulating catagen (Langan et al. 2013), which prevents the transformation of fine vellus hair into fully mature terminal hair. The role of dopamine in hair loss is demonstrated by the hair loss in >50% of all Parkinson's patients receiving dopaminergic therapy (Lee et al. 2024). Decreased hair cover would combine with increased dopaminergic vasodilation (Brodde 1982; Brown et al. 2007) to dissipate heat through the skin via the eccrine glands. A final thermal advantage possibly conferred by the tyrosine-dopamine link is the elongation of the human body, which would decrease solar irradiance and increase surface-to-mass ratio, thereby enhancing dermal heat transfer. While Wheeler's original theory posited that bipedalism per se—which preceded the evolution of the *Homo* genus—increased thermal tolerance and endurance, this remains a contentious issue (see David-Barrett and Dunbar (2016) vs. Ruxton and Wilkinson (2011)). But bipedalism associated with an elongated body would certainly have provided a greater means of dissipating heat, in line with Allen's rule. Allen's rule is supported by both experimental studies of limb length and metabolism (Tilkens et al. 2007) as well as the negative association between body height and risk of heat stroke (Taylor et al. 2024).

Many other changes in the human physique, discussed by Bramble and Lieberman (2004), may have simply been associated with the elongation of the body in humans. Others such as changes in dentition and the shape of the foot (Bramble and Lieberman 2004; Zink and Lieberman 2016) have less clear evolutionary origins, but epigenetic factors may have played a role in these as well (Quinn 2012; Khalaf et al. 2022). One adaptation that is more likely to have coincided with the loss of terminal body hair is the increased melanin content of the skin, which would have offset the dangers of increased solar irradiation due to the loss of hair cover (Jablonski 2021). Without such pigmentation, folate metabolism would be seriously impaired, threatening hominin reproductive success (Jablonski 2021; Lucock

2023). Melanin synthesis is influenced by many factors, but it is ultimately dependent on tyrosine and its conversion to L-dopa and then dopaquinone (Maranduca et al. 2019), consistent with evidence that L-dopa treatment for Parkinson's disease has stimulating effects on melanogenesis (Bougea et al. 2019). In line with the hypothesized link between skin pigmentation and reduced hair cover during early *Homo* evolution, significant inverse correlations exist between skin pigmentation and hair follicle density and hair length in extant humans, with the former accounting for over 28% of the variance in follicle density (Dhugga et al. 2014).

Implications for Human Evolution

The linkage between EN1 and associated genes and dopaminergic brain development suggests that the mutations of the EN1-enhancer ECE18 may have been a catalyst for ensuing evolutionary changes in early *Homo*. Several rationales support the view that the enormous increase in eccrine sweat glands occurred before many other evolutionary changes such as decreased hair cover and increased stature. Of the three factors unique to human thermal tolerance, elongation of the body occurred later in the period from 2.5 to 1.5 mya, based on the skeletal record (Will et al. 2017). The other factor—reduced hair cover due to a retraction of terminal hair—may have occurred secondarily as well, for in the absence of copious sweating capabilities a loss of hair cover would have exposed humans to damaging solar radiation, with mixed thermoregulatory effects (David-Barrett and Dunbar 2016). (By contrast, the benefits of an increase in eccrine sweat glands would also have been limited without a concomitant decrease in hair cover (Lieberman 2015), but at least expanded eccrine sweating by itself would not have proven harmful). An additional reason for believing in the primacy of eccrine gland evolution is that greater eccrine activation and perhaps density is associated with hotter climates (Best and Kamilar 2018; Best et al. 2019), and the climate of the savanna was hotter at the beginning of hominin evolution than after 2.5 mya, when worldwide climate underwent a cooling trend (Stanley 1995). On the other hand, as the climate cooled and dried and forests in East Africa gave way to grassland, arboreal creatures such as the Australopithecines would have had more trouble adapting to the new climate than early *Homo*, the latter having a greater surface-to-mass area, reduced hair cover, and a more advantageous foot structure (Bramble and Lieberman 2004). Because EN1 influences both eccrine and hair follicle development, it cannot be ruled out that the eccrine increase and loss of hair cover occurred simultaneously; however, hair follicle density per se has not changed in humans relative to chimpanzees (Kamberov et al. 2018), and there is no evidence that EN1 promotes the catagen-induced loss of terminal hair.

One plausible evolutionary scenario is portrayed in Figure 1. An initial genetic adaptation involving ECE18 and the EN1 gene could have independently increased eccrine sweat gland density and dopaminergic brain innervation. The latter's elevation would then contribute to reduced human hair cover and increased peripheral vasodilation to further enhance human thermal tolerance.

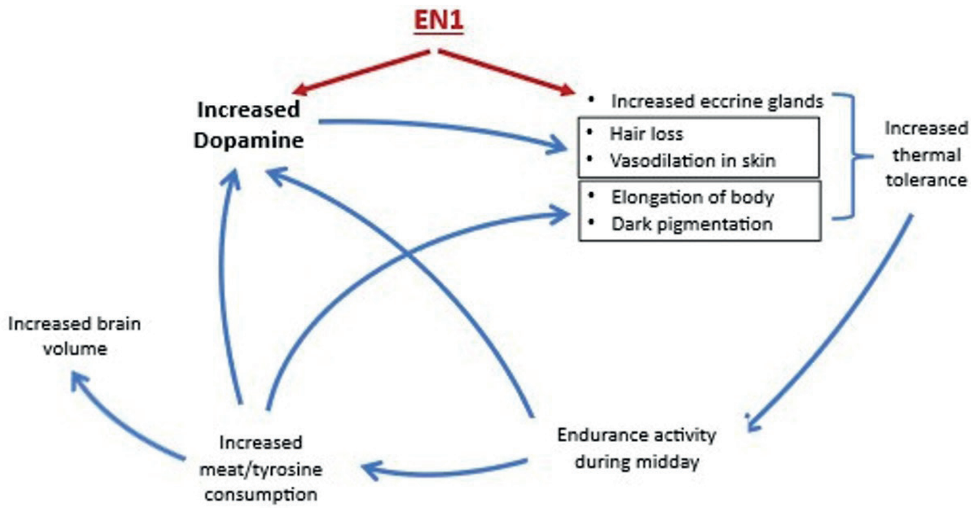

Figure 1. A hypothetical scenario for the rise of human intelligence and endurance capabilities in early human evolution. A mutation of the ECE18 enhancer to the regulatory gene EN1 could have expanded both eccrine gland density and brain dopaminergic systems. In turn, dopamine would facilitate complementary heat loss mechanisms that allowed for increased endurance capabilities and the ability of early humans to exploit the African savanna for procurement of meat. The tyrosine and other proteins contained in the more carnivorous diet would lead to an increase in brain size, height, melaninization of the skin, and further increases in brain dopamine

This facilitated the greater exploitation of the savanna grasslands by permitting travel over longer distances under thermally stressful conditions to procure meat, rich in tyrosine. The increase in tyrosine would have further increased brain dopamine, physical stature, and brain size along with increasing the melanin content of the human skin to protect it against the increased solar absorption due to the loss of hair cover. Once begun, the entire cyclical process could have been a gradual one, as suggested by Jablonski (2021, Fig. 1). A gradualist scenario is consistent with evidence that dopamine levels can be altered by epigenetic mechanisms and easily traverse the placenta, steadily accumulating over generations (see Previc 2009). The gradualist view of dopaminergic expansion is also consistent with recent re-appraisals of the cognitive capabilities of *Homo erectus* and archaic humans, given evidence of advanced lithic technology, abstract designs, food processing, and the use of fire dating back hundreds of thousands of years and, in some cases, even longer (Bednarik 1995; DeLouize et al. 2017; Clark and Henneberg 2021).

The putative rise in brain dopamine in conjunction with eccrine gland expansion and a less hairy and darkened skin is necessarily speculative and cannot yet be linked to a specific timeframe, since all scientists can currently decipher about soft tissue changes during human evolution is the difference between extant humans and chimpanzees.

That divergence is believed to have occurred about 6–7 mya, and each species has evolved since then. The presence of the ECE18 mutations in the Neanderthal genome might push its existence as far back as back as 800 kya and perhaps somewhat plausibly even to the emergence of *Homo erectus*, but in the progression from *Homo habilis* to *Homo erectus* all that can be determined from the fossil and archaeological record is that more advanced tools were used to extract meat from carcasses, elongation of the body occurred, cranial capacity increased, and dentition evolved with ingestion of softer foods (Dean and Cole 2013). Aside from some limited genetic evidence related to tapeworm mutations, suggesting meat-eating as early as ~2 mya (Hoberg et al. 2001), there is little else available to capture precisely the evolutionary past other than theoretical analyses. Chemical composition in bone—especially relative zinc isotopes (Z^{66} to Z^{64}) and carbon and nitrogen amino acid isotopes—offers promise in determining when greater carnivory occurred (Jaouen 2016; Jaouen et al. 2022; Larsen 2022), but these measures are difficult to interpret with remains dating back millions of years. So, definitive findings concerning when the putative rise in dopamine first occurred during hominin evolution is still lacking.

According to Previc (2009), the hominin progression leading from *Homo habilis* to *Homo erectus* was a major step in establishing the "dopaminergic mind", but it was not the final stage. Despite large migrations of *Homo erectus* to different latitudes and regions with vastly different climates along with the thermal effect of clothing wear beginning around 170 kya (Toups et al. 2011), human intelligence, brain size, meat-eating, body height, sweat gland density, and many other distinguishing features of modern humans never retreated to pre-*erectus* levels. It may be presumed, as Previc (2009) argued, that dopamine levels in the human lineage continued to increase to the present, possibly epigenetically, as dopamine levels in individuals can be altered through diet, exercise, and psychological factors (e.g., stress) and can be easily passed on to offspring through placental transmission (Horackova et al. 2022). In the end, *Homo sapiens* acquired a large dopaminergic brain innervation and an impressive intelligence and thermal tolerance without parallel among mammals.

Conclusion

Recent findings have confirmed three of the major tenets of Previc (1999): the key roles of dopamine in human intelligence; the expansion of dopaminergic innervation of brain areas essential to human cognitive abilities; and the criticality of dopamine in thermal tolerance. Which uniquely human traits evolved after the divergence with chimpanzees is much better understood than how and when those traits evolved. But recent findings also offer a clearer glimpse than ever before as to what might plausibly constitute the progression of events during hominin evolution from *Homo habilis* to *Homo erectus.* Almost certainly, the neurotransmitter dopamine exerts a paramount influence on that evolutionary course.

Acknowledgements

The author wishes to acknowledge the assistance of Dr. Britt Bousman in the conceptual stage of this paper.

Conflict of interest statement

There are no conflicts of interest associated with this paper.

Author contribution

Sole author responsible for conceptualization, literature synthesis, writing and editing of the manuscript.

Ethics statement

Not applicable.

Data availability statement

Not applicable.

Financial disclosure

No outside funding sources were involved.

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Anthropological Review • Vol. 88(4), 53–67 (2025)

ANTHROPOLOGICAL REVIEW

Available online at: https://doi.org/10.18778/1898-6773.88.4.03

Predicting Facial Anthropometry: A Novel Guide for Facial Reconstruction Using a Nigerian Igbo Sample

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Abstract: The present study was conducted to generate facial anthropometry baseline data for adult males and females of Igbo ethnicity in south-eastern Nigeria and to develop facial anthropometric prediction and correlation models. This cross-sectional, descriptive study design involved using 200 males and 200 females. The study criteria included subjects with no history of facial surgery and were within the age interval of 18–35 years. With the aid of spreading and digital caliper, different percutaneous facial measurements were obtained and data collected were analyzed both descriptively and inferentially. There were statistically significant sex differences in all metrics. Mandibular width (MW) correlated with both forehead width (FHW), lower facial height (LFH) and nasal width (NW) for both sexes. Total facial height (TFH) correlated with NW, upper facial height (UFH), mid-facial height (MFH), and lower facial height (LFH), while NW correlated with MW, UFH, MFH, and LFH. Predictive models developed using univariate regression analysis for both sexes showed that MW was a strong predictor of FHW, while UFH, MFH, and LFH were individually strong predictors of TFH ($p<0.05$). Further, MFH and LFH were significant predictors of FH for both sexes. By using multivariate regression analysis, it was revealed that the combination of both FW and FHW were strong predictors of MW, while the combination of UFH, MFH, and LFH were significant predictors of TFH. Conclusively, these new data should aid forensic and surgical efforts in Nigerian contexts. Our models can be tested on other underrepresented populations to better understand current methods in facial anthropometry.

Keywords: facial morphometry, predictive models, Igbo ethnicity, baseline data, Nigerian anthropometry

Original article

Received: 11.03.2025; Revised: 4.08.2025; Accepted: 26.11.2025

Introduction

The human face holds significant importance in biological anthropology due to its role in conveying essential information about an individual's evolutionary history, health, behavior, and social interactions (Gračanin et al. 2018; Jones 2018). It exhibits considerable morphological diversity across populations due to genetic, environmental, and cultural influences (Darkwah et al., 2018). Facial anthropometry deals with the quantitative measurement and analysis of facial features and their proportions and how these features play significant roles in understanding and evaluating facial morphs in various ethnicities (Ulrich et al. 2019; Virdi et al. 2019; Rostovtseva et al. 2024). In developing countries such as Nigeria and parts of sub-Saharan Africa, facial anthropometrics provides a scientific basis for understanding facial variations considering how cultural perceptions of beauty and facial aesthetics do vary significantly in comparison to most European and Asian ancestries (Virdi et al. 2019; Monteiro et al. 2023; Sarna et al. 2023). These metrics also provide reliable information to craniofacial surgeons who practice in these countries to tailor reconstructive procedures to meet the specific facial aesthetic preferences of their populations. The use of standardized facial anthropometric measurements can help establish protocols for facial reconstruction surgeries, hence improving the consistency and predictability of surgical outcomes (Kundu et al. 2021).

From a biological anthropology perspective, the adherence of European-esque reconstructive skills on African individuals residing in major parts of sub-Saharan Africa presents a unique challenge, particularly when addressing facial surgeries since it has been established that facial morphs differ among ancestral groups globally. In accordance with several studies, African populations often exhibit distinctive facial characteristics such as broader forehead, wider mandible, and larger facial and nasal widths, as well as shorter upper and greater lower facial heights compared to most European and some Asian populations – which are highly attributed to genetic and environmental factors that collectively influence craniofacial development (e.g., Alam et al. 2015; Zacharopoulos et al. 2016; Virdi et al. 2019). With regards to sex differences across ancestral populations globally, males generally tend to have greater facial heights and widths, wider and larger nasal widths compared to females (Richmond et al. 2018; Kleisner et al. 2021). Based on an earlier report by Adekunle et al. (2021), which applied the use of 3-dimensional stereophotogrammetry to obtain facial metrics among selected Nigerian populations, Igbo males had the highest upper facial height, midfacial height, lower facial height, and total facial height measurements compared to their Yoruba and the Hausa counterparts.

While the use of 3-dimensional stereophotogrammetry is currently encouraged globally, its accuracy in most regions like Nigeria could often be affected by factors such as environmental conditions, as well as misrepresentation of facial bony architecture from obtained soft tissue data as conventional direct anthropometry often focuses more on bony landmarks and provide a more reliable assessment of skeletal dimensions. Along with other facial anthropometrics, a related study done among Nigerian adults selected from three major ethnic groups combined (Igbo, Yoruba and Hausa) revealed that men exhibited higher facial, forehead and nasal widths compared to women (Ernest et al. 2018). However, the study showed certain discrepancies in sample size when studied ethnicities were compared which could be influenced by selection bias as the Yorubas made up about 78% of the total studied population despite using a direct conventional anthropometry technique.

The aim of the present study was to provide baseline data of certain facial anthropometrics for adult males and females of south-eastern Nigeria and to develop prediction and correlation models using these metrics that would be relevant for sex-based reconstructive surgeries. The implications of this study will also flow to forensic identification efforts applied to the Nigerian Igbo population.

Material and Methods

Study Design

Ethical clearance was obtained from the Research Ethics Committee of the University of Port Harcourt (with registration number UPH/CEREMAD/REC/MM/91/005). All subjects gave their informed consent, and their personal information was kept confidential. A cross-sectional descriptive study design was used to obtain the facial metrics of n = 400 Indigenous people of the Igbo ethnic group of Nigeria between September 2024 to December 2024. The study population includes 200 males and 200 females of Indigenous Igbo with no/any history of facial surgery and are within the age interval of 18–35 years. This age interval accounted for soft and hard tissue changes in the face. The study subjects (of Igbo extraction) were recruited using the multi-stage random proportionate sampling technique and the minimum sample size was calculated using the Taro Yamane formula for quantitative studies as shown in previous studies (Asiwe et al. 2024; Fawehinmi et al. 2024).

Assessment of Facial Parameters

In line with Gupta et al. (2019), the following facial measurements were studied (based on the reference points as shown in Figure 1)

a) Forehead width (FHW): FHW is defined as a horizontal distance that lies between the temporal ridges (tr) (the bony ridges above the outer edges of the eyebrows) with reference to the glabella (g).
b) Mandibular width (MW): MW is a horizontal distance that is defined between the left and right gonion points (go) (the gonions are located at the outermost angles where the lower jaw curves upward) for consistency the mental protuberance is used for alignment purposes.
c) Facial width (FW): FW is a horizontal facial metric measured between the left and right zygomatic bones (zy).
d) Upper facial height (UFH): UFH is a vertical facial metric defined between the trichion (the sagittal midpoint of the forehead that borders the hairline) and nasion (the point in the middle line located at the nasal root).
e) Mid-facial height (MFH): MFH is defined as a vertical distance between the nasion and the sub-nasale (sbn) (the point where the upper lip joins the columella).
f) Lower facial height (LFH): LFH is defined as a vertical distance between the sub-nasal and the menton (the most inferior point of the inferior edge of the chin).

g) Total facial height (TFH): TFH, also known as Physiological Facial height, is defined as a vertical facial metric between the trichion (tr) and the Menton (mt).
h) Facial height (FH): FH is defined as the measurement between the nasion (n) and the menton (me).
i) Nasal width (NW): NW is a horizontal facial metric defined as the distance between the alars (al) of the nose (the most lateral point of the alar contour of the nose).

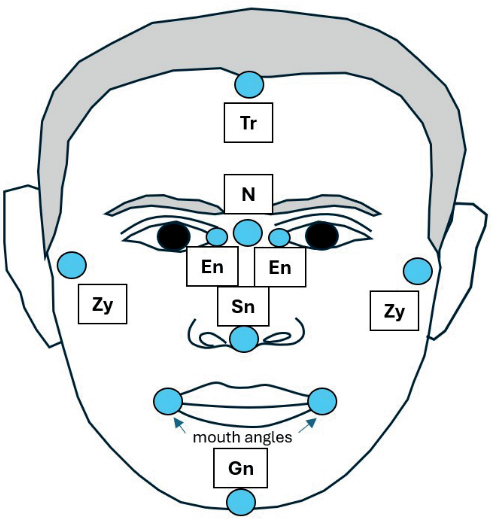

Figure 1. Reference points for facial measurements (adopted from Gupta et al. 2019)

Data Collection

A written consent form was administered to all respondents and only those who consented were allowed to participate in the research, they were issued a semi-structured questionnaire followed by face-to-face interviews to ensure the subjects met the inclusion criteria. Afterward, the age and sex were recorded, and using a direct anthropometric approach, the facial parameters were measured with the aid of spreading and digital calipers following the soft cutaneous landmarks of the face. Each measurement was conducted twice for reliability purposes.

Reliability of Data

The reliability of the instrument and result was examined using two statistical methods. Firstly, a paired t-test was used to compare the data collected, and secondly, we employed the use of the Cronbach alpha to evaluate the consistency of our results. The outcome presented that the reliability scale was 0.78, which indicates that our results were consistent.

Data Analysis

The data obtained in this study were subjected to statistical analysis using the International Business Machine of Statistical Package for Social Sciences (IBM SPSS version 25) and results are present descriptively in the form of means, standard errors of estimate (SEE), standard deviation, minimum and maximum values. Inferentially, t-tests, Pearson's correlation tests, and regression model analysis were used to analyze the relationships between metrics across sexes. A probability of less than 0.05 was considered statistically significant.

Results

Descriptive Statistics, Differences and Correlation of Facial Metrics for Both Sexes

Table 1 shows the descriptive statistics of facial metrics for the male and female sample. The age findings present that the average for males was 22.11±4.30 years while females was 21.81±2.82 years. The average FHW was 10.43±0.91 cm in males while it was 9.64±0.95 cm for females. The mean MW for males was 10.88±0.73 cm while it was 10.20±0.72cm for females. The mean FW was 15.49±1.33 cm in males while for females, it was 14.51±2.03 cm. Mean UFH was 7.05±0.81 cm and 6.77±0.94 cm for males and females, respectively. Average MFH was 5.32±0.63 cm and 5.28±0.58 cm for males and females, correspondingly. Mean LFH in males was 8.89±0.81 cm while it was 8.45±0.94 cm in females. The mean TFH was 23.46±1.50 cm and 22.54±2.26 cm for males and females, respectively. In males, the mean FH was 14.21±1.10 cm, though in females, it was 13.70±1.24 cm, and the mean NW was 5.53±0.64 cm in males and 5.30±0.57 cm in females.

Table 2 shows the mean value of facial metrics based on sexes and the finding that there were observable statistically significant differences between the male and female in FHW, MW, FW, UFH, LFH, TFH, FH, and NW. This indicates that men had significantly higher mean values in all parameters except MFH ($p>0.05$).

Table 1. Descriptive statistics of facial metrics for male and female Igbo sample

Parameter	Sex	Mean	SEM	SD	Min	Max
Age	Male	22.11	0.35	4.30	18	35
	Female	21.81	0.23	2.82	18.0	33.0
FHW	Male	10.43	0.07	0.91	8.30	15.00
	Female	9.64	0.08	0.95	7.30	11.32
MW	Male	10.88	0.06	0.73	8.00	12.00
	Female	10.20	0.06	0.72	7.40	12.00
FW	Male	15.49	0.11	1.33	12.90	18.78
	Female	14.51	0.17	2.03	10.38	18.68
UFH	Male	7.05	0.07	0.81	4.86	9.06
	Female	6.77	0.08	0.94	4.41	8.89
MFH	Male	5.32	0.05	0.63	4.02	6.95
	Female	5.28	0.05	0.58	3.54	6.94
LFH	Male	8.89	0.07	0.81	7.19	11.28
	Female	8.45	0.08	0.94	5.78	11.97
TFH	Male	23.46	0.12	1.50	17.03	26.14
	Female	22.54	0.19	2.26	13.79	25.86
FH	Male	14.21	0.09	1.10	11.86	16.43
	Female	13.70	0.10	1.24	10.92	16.76
NW	Male	5.53	0.05	0.64	4.03	6.90
	Female	5.30	0.05	0.57	3.67	6.78

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, SEM: standard error of mean, SD: standard deviation, Min: minimum, Max: maximum.

Table 2. Sex-related differences in facial metrics in the present study

Parameter	Male	Female	t-test	*p*	Statistical Inference
FHW	10.43±0.91	9.64±0.94	-6.73	<0.0001	Significant
MW	10.88±0.72	10.20±0.71	-8.040	<0.0001	Significant
FW	15.49±1.32	14.51±2.02	-4.857	<0.0001	Significant
UFH	7.05±0.80	6.77±0.94	-2.717	0.007	Significant
MFH	5.32±0.63	5.28±0.58	-0.472	0.637	Not Significant
LFH	8.89±0.81	8.45±0.94	-4.344	<0.0001	Significant
TFH	23.46±1.50	22.54±2.26	-4.170	<0.0001	Significant
FH	14.21±1.10	13.70±1.23	-3.771	<0.0001	Significant
NW	5.53±0.64	5.30±0.57	-3.232	0.001	Significant

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width.

Table 3 shows the correlation of facial metrics for the males and the findings present that MW and FHW, FW and FHW, LFH and MW, TFH and MW, NW and MW, FW, UFH, MFH, LFH, TFH, FH, FW and MW, FW and MFH, LFH. UFH and FW were statistically significant while for the female category, MW and FHW, LFH and MW, NW and MW, FW and MFH, LFH, TFH, FH, UFH and TFH, MFH and TFH, FH, NW, LFH and TFH, FH, NW, TFH and FH, NW were statistically significant (Table 4).

Table 3. Correlation between facial metrics for males in the present study

Parameter		FHW	MW	FW	UFH	MFH	LFH	TFH	FH	NW
FHW	r	1	0.231**	0.089	0.155	0.121	0.162	0.075	0.224**	0.055
	p		0.006	0.304	0.067	0.147	0.051	0.373	0.007	0.516
MW	r	0.231**	1	0.069	0.003	0.100	0.345**	0.173*	0.304**	0.213*
	p	0.006		0.425	0.976	0.231	<0.0001	0.037	<0.0001	0.010
FW	r	0.089	0.069	1	0.318**	-0.105	0.148	0.228**	0.059	0.524**
	p	0.304	0.425		<0.0001	0.221	0.081	0.007	0.490	<0.0001
UFH	r	0.155	0.003	0.318**	1	0.083	0.029	0.430**	0.060	0.226**
	p	0.067	0.976	<0.0001		0.326	0.733	<0.0001	0.475	0.007
MFH	r	0.121	0.100	-0.105	0.083	1	0.345**	0.203*	0.727**	0.242**
	p	0.147	0.231	0.221	0.326		<0.0001	0.014	<0.0001	0.003
LFH	r	0.162	0.345**	0.148	0.029	0.345**	1	0.370**	0.810**	0.480**
	p	0.051	<0.0001	0.081	0.733	<0.0001		<0.0001	<0.0001	<0.0001
TFH	r	0.075	0.173*	0.228**	0.430**	0.203*	0.370**	1	0.396**	0.357**
	p	0.373	0.037	0.007	<0.0001	0.014	<0.0001		<0.0001	<0.0001
FH	r	0.224**	0.304**	0.059	0.060	0.727**	0.810**	0.396**	1	0.406**
	p	0.007	<0.0001	0.490	0.475	<0.0001	<0.0001	<0.0001		<0.0001
NW	r	0.055	0.213*	0.524**	0.226**	0.242**	0.480**	0.357**	0.406**	1
	p	0.516	0.010	<0.0001	0.007	0.003	<0.0001	<0.0001	<0.0001	

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, **p*<0.01, ***p*<0.05.

Table 4. Correlation between facial metrics for females in the present study

Parameter		FHW	MW	FW	UFH	MFH	LFH	TFH	FH	NW
FHW	r	1	0.230**	-0.145	0.108	-0.067	0.045	0.014	-0.006	0.081
	p		0.005	0.078	0.186	0.414	0.584	0.866	0.946	0.322
MW	r	0.230**	1	0.025	0.155	-0.051	0.180*	0.127	0.103	0.186*
	p	0.005		0.768	0.062	0.542	0.029	0.126	0.216	0.025
FW	r	-0.145	0.025	1	0.057	0.534**	0.166*	0.224**	0.427**	-0.043
	p	0.078	0.768		0.495	<0.0001	0.044	0.006	<0.0001	0.604
UFH	r	0.108	0.155	0.057	1	0.057	-0.042	0.523**	0.002	0.039
	p	0.186	0.062	0.495		0.485	0.609	<0.0001	0.985	0.634
MFH	r	-0.067	-0.051	0.534**	0.057	1	0.156	0.393**	0.689**	-0.192*
	p	0.414	0.542	<0.0001	0.485		0.056	<0.0001	<0.0001	0.019
LFH	r	0.045	0.180*	0.166*	-0.042	0.156	1	0.647**	0.824**	0.170*
	p	0.584	0.029	0.044	0.609	0.056		<0.0001	<0.0001	0.037
TFH	r	0.014	0.127	0.224**	0.523**	0.393**	0.647**	1	0.701**	0.166*
	p	0.866	0.126	0.006	<0.0001	<0.0001	<0.0001		<0.0001	0.043
FH	r	-0.006	0.103	0.427**	0.002	0.689**	0.824**	0.701**	1	0.015
	p	0.946	0.216	<0.0001	0.985	<0.0001	<0.0001	<0.0001		0.855
NW	r	0.081	0.186*	-0.043	0.039	-0.192*	0.170*	0.166*	0.015	1
	p	0.322	0.025	0.604	0.634	0.019	0.037	0.043	0.855	

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, *$p<0.01$, **$p<0.05$.

Prediction of Facial Metrics for Female Sample Using Regression Models

Table 5 shows the summary of the univariate regression model of facial metrics for the female sample. The findings show that the correlation between FHW and FW was poor (r=0.08, r^2=0.006, SEE=0.92, p<0.001):

FHW = 9.05+FW (0.04)

When predicted with MW, the correlation was still weak (r=0.23, r^2=0.05, SEE=0.92, p<0.001):

FHW=6.51+MW (0.30)

The correlation between FW and FHW was poorly correlated (r=0.08, r^2=0.006, SEE=2.04, p=0.30) and FW was predicted as:

FW = 12.62+FHW (0.19)

When predicted with MW, the correlation was poorly correlated (r=0.06, r^2=0.004, SEE=2.04, p=0.42), FW was predicted as

FW = 12.51+MW (0.19)

When MW and FHW were also weakly correlated (r=0.23, r^2=0.05, SEE=0.70, p=0.01), with the following prediction of MW:

MW = 8.50+FHW (0.17)

Using FW, there was no good correlation (r=0.06, r^2=0.004, SEE=0.72, p=0.42) with the prediction of MW as:

MW = 9.83+FW (0.02)

When TFH was estimated using UFH, the correlation was moderate ($r=0.43$, $r^2=0.18$, SEE=1.92, $p<0.001$) and the prediction was as follows:

TFH=16.13+UFH (0.96)

Using MFH, the correlation was weak ($r=0.20$, $r^2=0.04$, SEE= 2.22, $p=0.01$) and the estimation of TFH was:

TFH = 18.38+MFH (0.78)

Using LFH, the correlation was moderate ($r=0.37$, $r^2=0.14$, SEE= 2.11, $p<0.001$) with the estimation as follows:

TFH = 15.02+LFH (0.88)

Estimating FH using MFH and LFH, the correlation of FH and MFH was strong ($r=0.72$, $r^2=0.52$, SEE=0.84, $p<0.001$):

FH = 5.62+MFH (1.53)

Estimation of FH with LFH was also associated with a strong correlation ($r=0.81$, $r^2=0.66$, SEE= 0.72, $p<0.001$):

FH = 4.73+LFH (1.06)

Table 6 shows the multivariate regression model of facial metrics for the female sample. The findings show that FHW could be estimated with FW and MW through a weak correlation ($r=0.23$, $r^2=0.05$, SEE=0.89, $p=0.28$):

FHW = 6.39+MW (0.27) +FW (0.03)

Estimating FW with FHW and MW the correlation was also weak ($r=0.10$, $r^2=0.01$, SEE=2.07, $p=0.51$):

FW = 11.33+MW (0.15) + FHW (0.16)

When MW was estimated with FW and FHW, the correlation was still weak ($r=0.22$, $r^2=0.05$, SEE=0.71, $p=0.03$):

MW = 8.25 – FW (0.02) +FHW (0.17)

The total facial height was estimated using the multivariate approach with UFH, MFH and LFH with a strong correlation ($r=0.64$, $r^2=0.41$, SEE=1.64, $p<0.001$):

TFH = 5.91+UFH (0.92) +MFH (0.33) +LFH (1.04)

Table 5. Summary of univariate regression models for predicting facial metrics for females in the present study

Parameters	r	R^2	SEE	*p*	Equations
FHW vs FW	0.08	0.006	0.92	<0.001	FHW = 9.05+FW (0.04)
FHW vs MW	0.23	0.05	0.92	<0.001	FHW = 6.51+MW (0.30)
FW vs FHW	0.08	0.006	2.04	0.30	FW = 12.62+FHW (0.19)
FW vs MW	0.06	0.004	2.04	0.42	FW = 12.51+MW (0.19)
MW vs FHW	0.23	0.05	0.70	0.01	MW = 8.50+FHW (0.17)
MW vs FW	0.06	0.004	0.72	0.42	MW = 9.83+FW (0.02)
TFH vs UFH	0.43	0.18	1.92	<0.001	TFH = 16.13+UFH (0.96)
TFH vs MFH	0.20	0.04	2.22	0.01	TFH = 18.38+MFH (0.78)
TFH vs LFH	0.37	0.14	2.11	<0.001	TFH = 15.02+LFH (0.88)
FH vs MFH	0.72	0.52	0.84	<0.001	FH = 5.62+MFH (1.53)
FH vs LFH	0.81	0.66	0.72	<0.001	FH = 4.73+LFH (1.06)

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, SEE: standard error of estimate.

Table 6. Summary of multivariate regression models for predicting facial metrics for females in the present study

Parameters	r	R^2	SEE	*p*	Equations
FHW vs FW+MW	0.23	0.05	0.89	0.28	FHW = 6.39+MW (0.27) +FW (0.03)
FW vs FHW + MW	0.10	0.01	2.07	0.51	FW = 11.33+MW (0.15) +FHW (0.16)
MW vs FW +FHW	0.22	0.05	0.71	0.03	MW = 8.25 – FW (0.02) +FHW (0.17)
TFH vs UFH+MFH+LFH	0.64	0.41	1.64	<0.001	TFH = 5.91+UFH (0.92) +MFH (0.33) +LFH (1.04)

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, SEE: standard error of estimate.

Prediction of Facial Metrics for Male Sample Using Regression Models

Table 7 shows the summary of the univariate regression model of facial metrics for males. The findings present that FHW was estimated using FW through a weak correlation ($r=0.14$, $r^2=0.02$, SEE=0.91, $p=0.07$):

FHW = 11.96 – FW (0.10)

When FHW was estimated with MW there was also a weak correlation ($r=0.23$, $r^2=0.05$, SEE=0.90, $p=0.005$)

FHW = 7.23+MW (0.29)

When FW was estimated using FHW, the correlation was weak ($r=0.14$, $r^2=0.02$, SEE=1.31, $p=0.08$):

FW = 17.67 – FHW (0.21)

Estimating FW with MW, there was no correlation ($r=0.03$, $r^2=0.001$, SEE=1.31, $p=0.76$):

FW = 14.94+MW (0.045)

Further estimates of MW in males, using FHW and FW, gave a weak correlation ($r=0.23$, $r^2=0.53$, SEE=0.70; $p=0.005$):

MW = 9.00+FHW (0.18)

Estimating MW using FW had no correlation ($r=0.025$, $r^2=0.001$, SEE=0.73, $p=0.76$):

MW = 10.67+FW (0.014)

Estimating TFH using UFH, MFH and LFH had the following correlations: UFH and TFH= moderate, $r=0.52$, $r^2=0.27$, SEE=1.21, $p<0.001$), TFH and MFH (moderate, $r=0.39$, $r^2=0.15$, SEE=1.38 and $p<0.001$), and TFH and LFH (strong, $r=0.64$, $r^2=0.41$, SEE=1.14, $p<0.001$):

TFH = 17.06+UFH (0.92)

TFH = 18.51+MFH (0.93)

TFH = 12.78+LFH (1.20)

Estimating FH using MFH and LFH found strong correlations for FW ($r=0.68$, $r^2=0.47$, SEE=0.80, $p<0.001$) and LFH ($r=0.82$, $r^2=0.67$, SEE=0.62, $p<0.001$):

FH = 7.836+MFH (1.19)

FH = 4.23+LFH (1.12)

Table 7. Summary of univariate regression for predicting facial metrics for males

Parameters	r	R^2	SEE	p	Equations
FHW vs FW	0.14	0.02	0.91	0.07	FHW=11.96 – FW (0.10)
FHW vs MW	0.23	0.05	0.90	0.005	FHW=7.23+MW (0.29)
FW vs FHW	0.14	0.02	1.31	0.08	FW=17.67 – FHW (0.21)
FW vs MW	0.03	0.001	1.31	0.76	FW=14.94+MW (0.045)
MW vs FHW	0.23	0.53	0.70	0.005	MW=9.00+FHW (0.18)
MW vs FW	0.03	0.001	0.73	0.76	MW=10.67+FW (0.014)
TFH vs UFH	0.52	0.27	1.21	<0.001	TFH=17.06+UFH (0.92)
TFH vs MFH	0.39	0.15	1.38	<0.001	TFH =18.51+MFH (0.93)
TFH vs LFH	0.64	0.41	1.14	<0.001	TFH =12.78+LFH (1.20)
FH vs MFH	0.68	0.46	0.80	<0.001	FH=7.836+MFH (1.19)
FH vs LFH	0.82	0.67	0.62	<0.001	FH=4.23+LFH (1.12)

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, SEE: standard error of estimate.

Table 8 shows the multivariate regression analysis of facial metrics for males. The findings present that FHW could be estimated using FW and MW through a strong correlation ($r=2.88$, $r^2=8.29$, SEE=0.89, $p=0.002$):

FHW = 8.89+MW (0.31) – FW (0.12)

Estimating FW with FHW and MW had a weak correlation ($r=0.17$, $r^2=0.03$, SEE=1.29, $p=0.12$).

FW = 16.70+MW (0.12) – FHW (0.24)

Estimating MW with FHW and FW had a weak correlation ($r=0.24$, $r^2=0.06$, SEE=0.71, $p<0.05$)

MW = 8.32+FHW (0.19) + FW (0.03)

Estimating TFH using UFH, MFH, and LFH had a strong correlation ($r=0.94$, $r^2=0.88$, SEE=0.47, $p<0.001$).

TFH = 2.76+UFH (0.92) +MFH (0.82) +LFH (1.11)

Table 8. Summary of multivariate regression models for predicting facial metrics for males

Parameters	r	R^2	SEE	*p*	Equations
FHW vs FW+MW	0.28	0.08	0.89	0.002	FHW = 8.89+MW (0.31) – FW (0.12)
FW vs FHW + MW	0.17	0.03	1.29	0.12	FW = 16.70+MW (0.12) – FHW (0.24)
MW vs FW +FHW	0.24	0.06	0.71	0.014	MW = 8.32+FHW (0.19) +FW (0.03)
TFH vs UF-H+MFH+LFH	0.94	0.88	0.47	<0.001	TFH = 2.76+UFH (0.92) +MFH (0.82) +LFH (1.11)

FHW: forehead width, MW: mandibular width, FW: facial width, UFH: upper facial height, MFH: mid-facial height, LFH: lower facial height, TFH: total facial height, FH: facial height, NW: nasal width, SEE: standard error of estimate.

Discussion

Although applying 3D stereophotogrammetry can generate reproducible measurements, its precision is greatly dependent on accurate landmark placement in the software being used, and that can be challenging for African populations. Hence, the direct measurement approach was utilized for this current study. Based on the results, the present study found that there were notable significant sex differences in facial metrics apart from mid-facial height, as males generally had slightly higher facial metrics than females. In line with this study, Zacharopoulos et al. (2016) and Ernest et al. (2018) both reported significant sex differences in facial measurements as men exhibited greater dimensions in most parameters, in comparison to women. Findings from a similar study done using a Greek sample had reported that FH and MW were significantly larger in Greek males (Zacharopoulos et al. 2016). Zhuang et al. (2010) showed, from a European-based study conducted in North America, that both mean values of FW and TFH were smaller in females than males. In comparison with another study conducted among an Iranian sample, there were significant sex differences found in the studied facial parameters such as TFH, UFH, and FW (Dodangheh et al. 2018). It is explained that males generally tend to have greater facial heights and widths, wider and larger nasal widths compared to females across racial populations (Richmond et al. 2018; Kleisner et al. 2021).

Adekunle et al. (2021) showed, from a similar study conducted on a combined male sample from three major Nigerian ethnic groups (Yoruba, Igbo and Hausa), that the mean values for UFH, MFH, LFH, and TFH were 71.30 mm, 51.40 mm, 71.33 mm, and 194.04 mm, respectively. However, in comparison with our study, that focused on only Igbo subjects, the mean values that were somewhat close was only for UFH, as MFH, LFH, and TFH were higher than that of the findings of Adekunle et al. (2021). This inference seeks to deepen our understanding on the ethnic variations in facial metrics between the three major Nigerian ethnicities. The study carried out by Andrades et al. (2018), using a European sample, found that the mean MFH was 64.39 ± 3.55 mm – which is higher than that of the present study conducted using a Nigerian sample.

Furthermore, a Nepalese study showed that there were significant differences in FW and NW between males and females (Rokaya et al. 2018). Hamid et al. (2021) reported, from a Saudi population-based study, that significant differences in NW between males and females were observed. Another research showed, from their findings in a Ghanaian sample, that the mean FH, FW, and NW for males were 117.1 mm, 130.8 mm and 36.3 mm, which was slightly higher in females that had mean FH, FW, and NW of 110.4 mm and 127.2 mm. There were significant differences between males and females for FH, FW, and NW of the Ghanaian population (Appiah et al. 2023). In an Indian study that was reported by Pandey et al. (2015), the mean FW for males was 129.2 mm, while mean FW for females was 130.2 mm. Furthermore, the assertions from studies conducted in Nigerian, Ghanaian, Nepalese, Indian, and Saudi samples, underscore the need to consider ethnic and cultural variations in facial anatomy.

The findings in the current study, which mirror some of these results, can inform a more global perspective in plastic surgery and forensic efforts based on facial identification. For instance, when working with diverse patient populations, understanding the specific facial characteristics prevalent in those groups can guide surgeons in achieving results that align with the aesthetic standards and expectations of those communities (Brielmann & Pelli 2018). The significant differences in FW and NW between sexes noted in various studies suggest that postoperative assessments of surgical outcomes may also need to be stratified based on sex, and this could assist in tailoring outcome evaluations to reflect these sex differences towards better understanding patient satisfaction and the functional aspects of surgery, as evaluating success with a universal approach may not accurately reflect the diverse anatomical realities faced by different sexes. In line with Ernest et al. (2018), as it applies to its relevance in forensic facial reconstruction, their findings revealed that vertical facial measurements such as TFH, UFH and LFH, seemed to be more reliable facial parameters for distinguishing people of Igbo ethnicity from other Nigerian ethnicities such as Hausa and Yoruba, thus reflecting differences in craniofacial growth patterns associated with ethno-geographical attributes.

In this present study for both sexes, FHW correlated with MW, as well as MW correlating with LFH, and NW. Facial width showed a positive association with TFH, as well as TFH correlating strongly with parameters such as UFH, MFH, LFH, FH, and NW. Furthermore, both MFH and LFH were strongly associated with FH and NW, while NW correlated positively and strongly with MW, MFH, LFH, and TFH. Earlier research conducted by Iroanya et al. (2019) revealed that FH correlated with FW, and LFH significantly for both sexes – which is in line with our study.

We applied the use of both univariate and multivariate regression analyses to develop prediction models for determining facial metrics for each sex. We obtained a combination of models based on strong, moderate, and some weak correlations. With respect to the models that were developed using univariate regression analysis for both sexes, MW was a strong predictor of FHW, while UFH, MFH, and LFH were individually strong predictors of TFH ($p<0.05$). In addition, facial parameters such as MFH and LFH were individually significant predictors of FH for both sexes. However, the sex disparity was observed where FW was a strong predictor of FHW in females but not in males. Finally, the prediction models that were developed using multivariate regression analysis revealed similarities for both sexes whereby the combination of both FW and FHW were strong predictors of MW, while the combination of UFH, MFH, and LFH were considered to be significant predictors of TFH, although, the only disparity was observed in males where the combination of both FW and MW were strong predictors of FHW and not in females.

A limitation in this study was that orbital measurements were not considered to be suitable correlates with other facial measurements. We also obtained facial measurements from a young adult sample, aged between 18 – 35 years, meaning either younger or older age groups were not considered. Future investigations into similar analyses of facial anthropometric measurements should target all ages, or a wider age range.

Conclusion

The findings of this study revealed that apart from mid-facial height (MFH), all facial metrics showed significant differences across both sexes of the Igbo population. Prediction models for distinguishing between both sexes were more reliable when predicting facial parameters such as MW and TFH when using the variables such as FW, FHW, UFH, MFH, and LFH. These baseline results suggest that surgeons should adopt a personalized approach to reconstructive procedures, as well as recognizing these differences allows for tailored interventions that respect the unique anatomical features of each sex, thus enhancing aesthetic outcomes. Furthermore, this study has contributed to the creation of standardized data for forensic facial reconstruction that are specific to the Nigerian Igbo people.

Conflict of interest

Authors declared that there were no conflicts of interest.

Contributions from individual authors

NA was the lead researcher, conceived the concept of the study and design, performed the data collection, compilation and statistical analysis, provided some materials for the study and wrote the manuscript; OMA was the co-lead researcher, contributed to the concept of the study and design and did critical revision of the article for important intellectual content. Both MO and JSH provided some materials for the study and carried out some critical revision of the article. All authors discussed the results and contributed to the final manuscript for publication.

Ethics statement

Ethical clearance was obtained from the Research Ethics Committee of the University of Port Harcourt (with registration number UPH/CEREMAD/REC/MM/91/005). All subjects gave their informed consent, and their personal information was kept confidential.

Data availability statement

Due to ethical restrictions on sharing respondent data, the complete dataset cannot be made publicly available. Researchers can seek ethics approval and request access to anonymized data for re-analysis by contacting the corresponding author.

Financial disclosure

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

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Anthropological Review • Vol. 88(4), 69–76 (2025)

ANTHROPOLOGICAL REVIEW

Available online at: https://doi.org/10.18778/1898-6773.88.4.04

Assessment of the Internal Consistency of Two Polish References in Detecting Short Stature and Obesity in Children and Adolescents

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ABSTRACT: In paediatric practice, growth references are used by doctors and nurses to evaluate a child's growth status. We present an assessment of the internal consistency of two Polish references in detecting short stature and obesity in children and adolescents. Key diagnostic thresholds, the 3rd percentile for height and the 95th for Body Mass Index (BMI), were selected for comparison. Percentiles were calculated for hypothetical heights 0.2 cm lower than the third percentile of specific references and 0.1 units lower than the 95th percentile of specific references, in the case of height and BMI references, respectively. The z-scores were calculated and converted to percentiles. MS Excel was used. Around the 3rd percentile of height and the 95th percentile of BMI, there is a discrepancy in the Warsaw growth reference for measured height and BMI, respectively, and the calculated percentile. In the case of the Polish 2010 and 2012 growth references, a hypothetical height 0.2 cm below the third percentile of height-for-age reference yielded percentiles below 3 for all ages in both sexes. The Polish 2010 and 2012 growth references for measurements 0.1 units below the obesity threshold yielded percentiles of 94.69–94.86 in boys and girls. The Polish 2010 and 2012 growth references provide consistent and coherent calculation results for the 3rd percentile of height and the 95th percentile of BMI for children and adolescents aged 3–18 years.

KEYWORDS: growth references, children, z-score, percentile

Original article

Received: 1.08.2025; Revised: 2.12.2025; Accepted: 4.12.2025

Introduction

The growth of a child is a crucial indicator of health (WHO 1995; Gelander 2006). Monitoring growth to identify health- or nutrition-related problems is a vital task in many medical areas in primary health care (Ministry of Health 2023). Growth references have practical significance as doctors and nurses use them in relation to individual children part of medical assessments evaluating growth status. In Poland, growth references based on a representative national sample of children and adolescents were first developed during OLAF and OLA studies and reported as the Polish 2010 and 2012 growth references for school-aged and preschool children, respectively (Kułaga 2011; 2013). However, references from the years 1996–1999, based on measurements of children from Poland's capital city—hereinafter: "Warsaw growth references"/"Warsaw growth charts"—are still in use (Palczewska and Niedźwiedzka 2001). There are several key differences between the two reference systems, not only in the years of development (more recent vs older ones), population (whole country, including rural populations, vs capital city) but also the method of statistical elaboration (crude percentiles without accounting for data skewness vs LMS, which enables accounting for skew data distribution and smoothing reference curves) (Cole 1990). The biological data including anthropometry like weight, height, and Body Mass Index (BMI), often have asymmetric (skewed) distribution. Calculation of z-score, which is first step in determining the percentile is based on normal (Gaussian) distribution. This is why accounting for the skewed distribution of anthropometric data is crucial for creating accurate growth references. Table 1 provides a summary comparison of the two Polish growth reference systems.

Table 1. Summary characteristics of the Warsaw growth references and the Polish 2010 and 2012 growth references

	Warsaw growth references	Polish 2010 and 2012 growth references
Years of development	1996–1999	2007–2012
Reference population	urban population – Warsaw children and youth	urban and rural – whole country population
Method of study subjects drawing	random sampling	random sampling
Age range	0–18 years	3–18 years
Sample size	6,366	22,292
Statistical method of percentile development	Crude percentiles (calculation without accounting for skewness)	LMS method for constructing normalized growth standards (Cole 1990)
z-score calculation	Based on mean and standard deviation, which does not account for skewness	Based on LMS parameters, a Box-Cox power transformation was used to normalize the data at each age (Cole 1990)
Percentile	Based on the z-score normal distribution	Based on the z-score normal distribution

L = Box-Cox power; *M* = median; *S* = coefficient of variation.

Usually, a result of the measurement is marked on a growth chart (percentile chart). Medical calculators are becoming increasingly popular, and children's growth assessment with a mathematical formula is possible using hospital information systems and online calculators: https://antek.exploreit.io/pl, https://nauka.czd.pl/kalkulator-2/, https://www.jakicentyl.pl/. These calculators use parameters of a growth reference system to calculate percentiles: mean and standard deviation (SD) or LMS if the reference used is constructed according to the LMS method (Cole 1990). A precise calculation of height, weight and BMI percentile is required. The z-score is calculated for this purpose, and based on normal distribution, the percentile associated with the calculated z-score is derived. These approaches are also applicable in scientific analyses, which usually involve processing significant volumes of growth data. It is important to note that different growth reference systems yield different results, which may be of significance in particular cases. This paper aims to provide evidence regarding noteworthy differences in height-for-age and BMI-for-age percentile calculation resulting from the application of two Polish growth references.

Materials and Methods

The internal consistency of calculation percentile values was compared between two reference ranges: 1) the Warsaw growth reference (Palczewska and Niedźwiedzka 2001), 2) the Polish 2010 and 2012 growth references (Kułaga 2011; 2013). Key diagnostic thresholds, the 3rd percentile for height and the 95th for BMI, were selected for comparison. The height-for-age percentiles were calculated for hypothetical heights 2 mm lower than the third percentile of the specific reference. The BMI-for-age percentiles were calculated for a hypothetical BMI 0.1 units lower than the 95th percentile of specific reference (Jodkowska et al. 2007; Kułaga 2011; 2013). The 95th percentile of BMI-for-age is considered to indicate the obesity threshold in childhood and adolescence (Mazur et al. 2024). In the case of the Warsaw growth reference, the following formula was used to calculate the z-score (z):

$$z = \frac{measurement - mean}{standard\, deviation} \quad (1)$$

For the Polish 2010 and 2012 growth references, the formula for z-score calculation was:

$$z = \frac{\left[\frac{measurement}{M}\right]^{L} - 1}{LS} \quad (2)$$

where L = Box-Cox power; M = median; S = coefficient of variation.

Finally, the obtained z-scores were converted to percentiles based on normal distribution using the NORM.S.DIST function and tabulated according to age and sex. All calculations were done using an MS Excel spreadsheet (Microsoft Corporation).

Results

For the Warsaw growth reference, a hypothetical height below the 3rd percentile yielded a calculated percentile above 3.0 for numerous age groups in both boys and girls (Table 2). In the case of the Polish 2010 and 2012 growth references, a hypothetical height 0.2 cm below the third percentile of height-for-age reference yielded percentiles below 3 (2.54–2.90) for all ages in both sexes (Table 2).

Table 2. Height-for-age percentiles calculated for hypothetical height measurement 0.2 cm below the 3rd percentile with the use of the Warsaw growth reference and the Polish 2010 and 2012 growth reference. The values in bold signify a discrepancy around the 3rd percentile calculated for hypothetical height

The Warsaw growth reference						
	boys			girls		
Age (years)	The 3rd percentile (cm)	Hypothetical Height (cm)	Percentile calculated for hypothetical height	The 3rd percentile (cm)	Hypothetical Height (cm)	Percentile calculated for hypothetical height
3	89.8	89.6	2.24	90.0	89.8	**4.48**
4	96.5	96.3	1.90	96.6	96.4	**4.76**
5	103.6	103.4	**4.15**	102.4	102.2	**3.82**
6	109.7	109.5	**5.73**	107.5	107.3	**5.32**
7	115.0	114.8	**4.02**	113.0	112.8	**3.72**
8	119.5	119.3	**3.92**	118.8	118.6	1.69
9	124.3	124.1	1.63	123.9	123.7	2.99
10	128.5	128.3	2.84	128.0	127.8	**3.07**
11	133.7	133.5	**3.03**	134.1	133.9	2.95
12	139.5	139.3	1.87	140.1	139.9	2.60
13	144.5	144.3	**4.07**	146.5	146.3	1.85
14	151.0	150.8	**4.55**	150.0	149.8	2.54
15	158.0	157.8	2.31	151.8	151.6	2.75
16	164.5	164.3	**3.34**	153.0	152.8	2.16
17	166.4	166.2	2.89	153.5	153.3	1.39
18	166.7	166.5	**3.10**	154.0	153.8	2.78
The Polish 2010 and 2012 growth references						
	boys			girls		
3	90.5	90.3	2.60	89.1	88.9	2.74
4	97.2	97.0	2.67	95.8	95.6	2.54
5	103.3	103.1	2.88	101.9	101.7	2.90
6	109.0	108.8	2.68	107.6	107.4	2.82
7	115.0	114.8	2.69	113.3	113.1	2.72
8	120.1	119.9	2.70	118.7	118.5	2.81
9	125.0	124.8	2.82	123.6	123.4	2.77
10	129.3	129.1	2.79	128.3	128.1	2.79
11	133.7	133.5	2.81	134.1	133.9	2.84
12	138.6	138.4	2.84	141.0	140.8	2.84
13	144.8	144.6	2.83	146.9	146.7	2.77
14	152.1	151.9	2.85	150.6	150.4	2.74
15	158.5	158.3	2.78	152.4	152.2	2.77
16	162.8	162.6	2.84	153.1	152.9	2.75
17	165.2	165.0	2.76	153.6	153.4	2.79
18	166.7	166.5	2.81	154.0	153.8	2.84

In the case of children and adolescent BMI obesity threshold, the Warsaw growth reference yielded a percentile over the 95th for measurements 0.1 units below the threshold for most ages in boys and all ages in girls. The Polish 2010 and 2012 growth references for measurements 0.1 units below the obesity threshold yielded percentiles of 94.69–94.86 in boys and girls (Table 3).

Table 3. BMI-for-age percentiles calculated for hypothetical measurement of BMI 0.1 unit below the 95th percentile with the use of the Warsaw growth reference and the Polish 2010 and 2012 growth reference. The values in bold signify a discrepancy around the 95th percentile calculated for hypothetical BMI

The Warsaw growth reference						
	boys			girls		
Age (years)	The 95th percentile (kg/m^2)	Hypothetical BMI (kg/m^2)	Percentile calculated for hypothetical BMI	The 95th percentile (kg/m^2)	Hypothetical BMI (kg/m^2)	Percentile calculated for hypothetical BMI
6	18.3	18.2	91.59	18.5	18.4	**96.86**
7	19.0	18.9	**98.02**	20.2	20.1	**95.72**
8	21.0	20.9	94.15	21.3	21.2	**97.22**
9	22.2	22.1	**96.75**	22.2	22.1	**98.74**
10	23.3	23.2	**97.15**	22.8	22.7	**97.28**
11	24.0	23.9	**98.33**	23.5	23.4	**97.67**
12	24.8	24.7	**95.74**	24.1	24.0	**96.60**
13	25.4	25.3	**96.69**	24.5	24.4	**97.30**
14	25.7	25.6	**96.03**	24.9	24.8	**97.53**
15	25.7	25.6	**97.08**	25.4	25.3	**97.70**
16	25.7	25.6	**96.07**	25.7	25.6	**96.78**
17	25.8	25.7	94.60	25.9	25.8	94.57
18	26.3	26.2	**95.50**	26.1	26.0	**97.75**
The Polish 2010 and 2012 growth references						
	boys			girls		
6	19.8	19.6	94.73	19.6	19.4	94.69
7	20.6	20.4	94.77	20.2	20.0	94.73
8	21.6	21.4	94.80	21.1	20.9	94.76
9	22.7	22.5	94.83	22.0	21.8	94.79
10	23.8	23.6	94.85	22.9	22.7	94.81
11	24.7	24.5	94.86	23.9	23.7	94.82
12	25.4	25.2	94.86	24.7	24.5	94.82
13	25.8	25.6	94.85	25.3	25.1	94.82
14	26.2	26.0	94.84	25.8	25.6	94.82
15	26.6	26.4	94.83	26.1	25.9	94.81
16	27.1	26.9	94.82	26.3	26.1	94.80
17	27.6	27.4	94.81	26.5	26.3	94.80
18	28.1	27.9	94.80	26.7	26.5	94.80

Discussion

Routine monitoring of children's growth relies on age- and sex-specific reference intervals "where interest lies in the detection of extreme values, possibly indicating abnormality" (Wright and Royston 1997: 47). An example of such an abnormality is growth hormone deficiency, for which an auxological criterion, namely height below the third percentile for age and sex, is one of the requirements to qualify for the growth hormone programme in Poland (Ministry of Health 2024). From this perspective, the discrepancy between the results of height percentile calculations (percentile over 3) and the measurement result (below the third percentile), as presented in Table 2, is a major drawback, especially for systems using the Warsaw growth reference parameters (Palczewska and Niedźwiedzka 2001). A child could be wrongly disqualified from the growth hormone programme based on a height-for-age percentile calculated in this way. Fortunately, the more recent Polish growth reference system from 2010 and 2012 (Kułaga 2011; 2013) provides consistent and coherent results between height measurement below the third percentile and the result of percentile calculation.

The BMI by age and sex reference is currently the most widely used metric for estimating obesity among children and adolescents (Reilly et al. 2002). Monitoring a child's BMI in relation to population-based reference is crucial in the era of the childhood obesity pandemic (González-Álvarez et al. 2020). Overestimating BMI percentiles across all age ranges in girls and the majority of ages in boys is viewed as a critical limitation of the Warsaw growth reference: when applied, it would categorize as obese those children who are not obese according to the 95th BMI percentile.

Both height-for-age reference and BMI-for-age reference are tools used in child growth and development monitoring. The tools should be accurate, meaning that the result obtained by a tool is a true or accepted value. Our analysis provides evidence that the Warsaw growth reference system is not accurate enough around the third percentile of height and the 95th percentile of BMI, while the Polish 2010 and 2012 growth references are accurate.

One limitation of the Polish 2010 and 2012 growth references is the lack of parameters for children under 3 years of age. Nevertheless, it is important to note that growth reference based on measurements taken from children who were not optimally fed in infancy, i.e. exclusively breastfed for at least 4 months, is now not recommended (Woynarowska et al. 2012). In many countries, including Poland, there are no available national growth references for infants and toddlers optimally fed in infancy. To solve this problem, the World Health Organization (WHO) Child Growth Standards for Children aged 0–5 years were adapted and used in over 100 countries (Woynarowska et al. 2012; de Onis et al. 2006). In 2011, recommendations for implementing the WHO growth standards were signed by the Committee of Human Development and the Committee of Anthropology of the Polish Academy of Sciences, the Main Board of the Polish Anthropological Society, the Institute of Mother and Child, and the Institute of Food and Nutrition (Woynarowska et al. 2012).

Conclusions

Around the 3rd percentile of height and the 95th percentile of BMI, there is a discrepancy in the Warsaw references for measured height and BMI and the calculated percentile. The Polish 2010 and 2012 growth references provide consistent and coherent calculation results for the 3rd percentile of height and the 95th percentile of BMI for children and adolescents aged 3–18 years. Therefore, to ensure accurate patient classification and avoid potential clinical errors, the Polish 2010 and 2012 growth references should be exclusively adopted in all clinical settings for children aged 3 to 18 years.

Acknowledgments

We thank the anonymous reviewer for valuable remarks and comments which improved the paper.

Author contributions

ZK designed the work, contributed to analysis, and interpretation of data, drafted the work. AK contributed to analysis, and interpretation of data and revised the manuscript critically for important intellectual content. All authors gave final approval of the version to be published.

Ethics statement

Not applicable.

Data availability statement

Data are available upon request from the corresponding author.

Financial disclosure

Not applicable.

Conflict of interest

The authors have no conflicts of interest to disclose.

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Anthropological Review • Vol. 88(4), 77–135 (2025)

ANTHROPOLOGICAL REVIEW

Available online at: https://doi.org/10.18778/1898-6773.88.4.05

Biological Anthropology in Poland: Its History and Short Scientific Biographies of the Contributing Professors

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Abstract: The year 2025 marks exactly one hundred years since the founding of the Polish Anthropological Society in Poznań (November 12, 1925), initiated by Professor Adam Wrzosek of the University of Poznań, who became its first president, as well as the 150th anniversary of Adam Wrzosek's birth. This year also marks the 120th anniversary of the establishment, on the initiative of Kazimierz Stołyhwo, of the first institution devoted to physical anthropology in Poland and the first in Eastern Europe: The Anthropological Laboratory at the Museum of Industry and Agriculture in Warsaw (1905). Year 2026 will record the centenary of the publication of the first volume of the Polish Anthropological Society journal "Przegląd Antropologiczny", now "Anthropological Review" (1926), and the 170th anniversary of the beginning of anthropology as a university discipline (1856), considered the year when the first anthropology lectures were given at the Jagiellonian University in Kraków by Professor Józef Majer. A number of works devoted to the history of physical/biological anthropology in Poland have been documented in the literature, especially the history of individual centers, published in the 1950s on the occasion of the 100th anniversary of the discipline in 1956, as well as studies on the history of Polish anthropology in a more comprehensive approach on other occasions. This article explores the history of biological anthropology in Poland, narrated mostly through short biographies of its founders – the professors whose work and achievements contributed to the development of the discipline, becoming part of the history of science. The biographical histories essentially cover the 19th and 20th centuries and include the professors who have either already made history or who have turned 75 on the date of publication of this article (born up to 1950).

Keywords: history of science, history of anthropology, Polish anthropologists, Polish scientists

Original article

Received: 30.11.2025; Revised: 5.12.2025; Accepted: 5.12.2025

The Dawn of Interest in Anthropology in Poland – the 19th Century

Historical Background

The origins of interest in anthropology in Poland date to the early 19th century. This was a period of political turmoil in Poland, which had ceased to exist as an independent state for over 120 years. The First Polish Republic, as a result of three successive partitions by its neighboring states, was finally dissolved at the end of the 18th century (1795). The Russian Empire annexed 62.8% of the lands of the Crown of the Kingdom of Poland and the Grand Duchy of Lithuania, the Kingdom of Prussia annexed 18.7%, and the Habsburg Monarchy, later the Austrian Empire, annexed 18.5%.

At the beginning of the 19th century, from part of the lands of the Prussian partition, the dependent on France Duchy of Warsaw was created (1807–15), with the King of Saxony as its ruler. However, shortly after Napoleon's defeat in Russia, the Duchy of Warsaw legally ceased to exist, and from its lands, pursuant to the Russo-Austrian-Prussian Treaty of May 3rd, 1815, were created: (1) the Kingdom of Poland, joined by a personal union with the Russian Empire, initially with its own constitution (1815–32) until the complete abolition of the Kingdom's autonomy in 1867 following the suppression of the January Uprising; (2) a province subordinate to Prussia – the Grand Duchy of Posen (1815–48), whose autonomy was abolished after the failure of the Greater Poland/Poznań Uprising of 1848; and (3) the Republic of Kraków with the Free City of Kraków (1815–46), annexed to the Austrian Empire after the downfall of the Kraków Uprising of 1846. In the following years, until the end of World War I (1918), Poland would no longer appear on the map of Europe.

At the beginning of the 19th century, three universities were operating in Poland: (1) the Jagiellonian University in Kraków, one of the oldest universities in the world, founded by King Casimir III the Great in 1364; (2) the University of Vilnius, founded by King Stephen Báthory in 1579; and (3) the University of Lvov, founded by King John II Casimir Vasa in 1661. In 1816, a fourth university, the University of Warsaw, was established by an edict issued by the Tsar of Russia and King of Poland Alexander I Romanov.

The development of science in Poland, including anthropology, and the activities of universities and departments/chairs, thus depended on what the partitioning powers permitted or prohibited. Polish universities existed within the Russian and Austrian partitions but were periodically closed – Russified in the Russian partition and Germanized in the Austrian partition. No higher education institution of a national character was ever established in the territory of the Prussian partition (Popiński 2018), later the German Empire.

First Publications and Emergence of a University Discipline

The pioneers of anthropological thought in Poland were naturalists, and above all, physicians, most of whom practiced medicine. The first naturalist of note here was **Jędrzej Śniadecki** (1768–1838), born in the village of Rydlewo, near Żnin (Kuyavian-Pomeranian Voivodeship), doctor of medicine and professor of chemistry at Vilnius University. Śniadecki, long-time president of the Vilnius Medical Society and full member of the Warsaw Society of Friends of Science[1], was a pioneer of physical education in Poland and a promoter of hygiene. His work, "O fizycznym wychowaniu dzieci", first published in the "Dziennik Wileński" in 1805, and as a collected work in 1840, constituted the beginning of research on human biological development and the health-promoting education of society. He is also known for his two-volume work, "Teorya jestestw organicznych", in which he defined (Śniadecki 1811: paragraph 222) and outlined the science of man, devoting Volume II to matters concerning human biology and physiology.

In 1818, also in Vilnius, the first Polish anthropology book was published, entitled "Antropologia. O własnościach człowieka fizycznych i moralnych", by **Józef Jasiński** (17??–1833), born on the outskirts of Grodno, graduate of the Faculty of Medicine at Vilnius University, member of the Vilnius Medical Society, and a proponent of the Vilnius evolutionary school (Gronkiewicz 1989).

Elements of anthropology and ethnology can also be found in the 1824 work "Śledzenie początku narodów słowiańskich" by **Wawrzyniec Surowiecki** (1769–1827), economist, educator, educational activist, and historian (Slavic scholar) born in Imielenko (Greater Poland Voivodeship). This work, apart from topics in the field of linguistics, addressed the issue of human morphological diversity and provided an outline of the ethnogenesis of European nations, including Poles. Surowiecki, a member of the Warsaw Society of Friends of Science, was one of the main pioneers of research into the history and culture of the Slavs and a co-organizer of the first Royal University of Warsaw (founded in November 1816 by the Commission of Religious Denominations and Public Enlightenment).

The rise of Polish anthropology as a university discipline is considered the year 1856, when Professor Józef Majer delivered first lectures on anthropology from a university chair in Poland, during the partition period.

Józef Majer (1808–1899) – Kraków-born physiologist, professor of medical sciences, dean of the Faculty of Medicine and rector of the Jagiellonian University, doctor *honoris causa* of the Jagiellonian University and the University of Lvov, president of the Kraków Scientific Society, founding member of the Academy of Arts and Sciences[2] and its first president, as well as an initiator of the Anthropological Commission at the Academy of Arts and Sciences, which he chaired for many years (1874–1890), from its establishment in March 1874. The Anthropological Commission became an association of Polish anthropologists, something akin to the anthropological societies that were established in the years 1859–73 in various scientific centers of Europe at that time (Czekanowski 1948b).

1 The Warsaw Society of Friends of Science (Towarzystwo Warszawskie Przyjaciół Nauk) was a scientific society uniting researchers in various fields, active from 1800 to 1832 (until it was abolished by the Tsarist authorities).

2 The Academy of Arts and Sciences (Akademia Umiejętności) was a scientific institution established in 1872 in Kraków (first meeting in 1873), which arose from the Kraków Scientific Society. In 1918, it was transformed into the Polish Academy of Arts and Sciences. In 1952, the communist authorities transferred all its assets and research facilities to the Polish Academy of Sciences. The reconstruction of the Polish Academy of Arts and Sciences was only made possible by the change of regime in 1989.

Lectures in anthropology began, one might say, fortuitously during the partitions (Austrian partition) and the ruthless germanization of the Jagiellonian University, which imposed German as the language of instruction (1853). Although Majer could have, in fact, begun lecturing in German, he declared that he did not speak it sufficiently (Wrzosek 1957). After temporarily resigning from the Chair of Physiology at the Jagiellonian University (until 1860), he went on to lecture in Polish on subjects not required for students, including anthropology (1856–73). With these lectures, Majer paved the way for the development of anthropology in Poland and, eventually, the establishment of the first Chair of Anthropology at the Jagiellonian University (1908).

Associated with Galicia and Kraków from 1871 was **Izydor Kopernicki** (1825–1891), physician, anatomist, and anthropologist born in Czyżówka (present-day Ukraine). He was the first Polish professor educated in anthropology. While in exile, Kopernicki became acquainted with the world-leading French anthropology developed by Paul Broca in Paris, ultimately establishing the final direction of his scientific passions (Godycki 1956). Having come to Poland from the University of Bucharest, and unsuccessfully applying for a chair in anatomy in Kraków, he subsequently obtained a doctorate in medicine and a habilitation in anthropology (1878). From 1874, he volunteered to organize the Anthropological Commission at the Academy of Arts and Sciences, becoming its secretary without yet being a member. Until his death, he was the editor of the Commission's publishing house "Zbiór Wiadomości do Antropologii Krajowej", the first Polish anthropological and ethnographic scientific journal, published in the years 1877–95.

Izydor Kopernicki initiated field research. Collaborating scientifically with Józef Majer together, through surveys, they collected and processed material on the physical characteristics of the population of the Austrian partition (totalling approximately 7,000 surveys), publishing the work "Charakterystyka fizyczna ludności galicyjskiej…" in Volume I of the Commission (1877), and then Part II in Volume IX (1885). He was interested in the craniology of Slavs, Bulgarians, prehistoric skulls, the Roma, and the Ainu people (the latter obtained from the zoologist and physician, an anthropology enthusiast, Benedykt Dybowski [see *The Lvov Center* section]). He created a craniograph of his own design to improve skull measurement methods. In 1876, as a private associate professor[3], Kopernicki resumed his anthropology lectures at the Jagiellonian University, which had been interrupted by Józef Majer. Towards the end of his life, in 1886, he was appointed associate professor at the Jagiellonian University, but without obtaining a chair, despite his long-standing efforts and donation of an extensive collection of skulls and books to the university (Wrzosek 1929, Godycki 1956), which would become the germination of the Jagiellonian University Anthropological Museum.

After Kopernicki's death in 1891, anthropology lectures at the Faculty of Medicine of the Jagiellonian University in Kraków were suspended and would be revived at the university's Faculty of

3 "Private associate professor" (privatdozent) – a person with a postdoctoral degree who lectured at a university, but without a full-time position, and financed not from the university budget but from student contributions.

Philosophy only after 17 years, in 1908. Meanwhile, at the turn of the 20th century, the work in the field of anthropology was led by Ludwik Krzywicki (Stołyhwo 1938).

Ludwik Krzywicki (1859–1941) – born in Płock (Masovian Voivodeship) sociologist, ethnologist, anthropologist, demographer, and participant in the labor movement. He was a professor at the Flying University[4], the Free Polish University[5] (as well as its rector), and later at the University of Warsaw, where, in 1921, the Chair of the History of Social Systems was created for him (ad personam). He was a member of the Polish Academy of Arts and Sciences, and doctor *honoris causa* of Vytautas Magnus University in Kaunas (1940), the leading authority in Polish social sciences at the turn of the 20th century.

Krzywicki, characterized by an extraordinary versatility of his scholarly interests (Krzeczkowski 1938, Hołda Róziewicz 1969, Hrynkiewicz 2012), in the field of anthropology, then being understood holistically – as a collection of all sciences concerning the humanities, published, among others: "Ludy. Zarys antropologii etnicznej" (1893), and "Kurs systematyczny antropologii. 1. Rasy fizyczne" (1897), which served on one hand, as textbooks for anthropology, and on the other, to popularize the discipline. Of interest is that Krzywicki's attitude towards "human races" diverged from the dominant views at the turn of the 20th century. He emphasized the continuity of morphological variation, calling racial types "somewhat artificial categories" (Krzywicki 1897: 9) and subject to change, and stated:

> *Pure types are abstractions, separated by analysis from the actual racial mixture.*
>
> (Krzywicki 1897: 44)

This part of Ludwik Krzywicki's work is overlooked in contemporary sociological anthropology (Kubica 2015), and in biological anthropology – once, in the era of typology, underestimated, and today – completely forgotten.

The First Anthropological Centers – the 20th Century to World War II

The Warsaw Center

Resulting from the activities of Ludwik Krzywicki, Julian Talko-Hryncewicz (see *The Kraków Center* section) and a number of provincial physicians, the interest in anthropology sparked the establishment, on the initiative of **Kazimierz Stołyhwo** (see *The Kraków Center* section) in 1905, in the then Russian partition, of the Anthropological Laboratory at the Museum of Industry and Agriculture in Warsaw – the first center in Poland and the first in Eastern Europe dealing with physical anthropology. In 1911 this center, already a well-organized scientific institution, was transferred, together with all its equipment, to an academic and research institution – the Warsaw

4 The Flying University (Uniwersytet Latający) was an informal institution of higher education operating in Warsaw from 1882 to 1905. Its name denoted the lack of a permanent location and the constant shifting of lecture venues.

5 The Free Polish University (Wolna Wszechnica Polska) was a private university established in Warsaw in 1916, conducting research and teaching until 1952.

Scientific Society[6], where it existed until 1939. In 1920, in independent Poland, the Anthropological Laboratory was converted into a department, and then (1921) into the Institute of Anthropological Sciences of the Warsaw Scientific Society (comprising two departments and a museum), which was recognized as the Polish branch of the International Institute of Anthropology, bringing together all the most preeminent Polish anthropologists and ethnologists (apart from K. Stołyhwo, also including: B. Dybowski, L. Krzywicki, J. Talko-Hryncewicz, and J. Czekanowski).

The University of Warsaw, founded in 1816, was dissolved and revived several times under various names during the first hundred years of its existence[7]. When the Russian troops left Warsaw in 1915 and were replaced by German troops, they authorized the establishment of a Polish-language university (for nearly half a century, the language of instruction at the University of Warsaw had been Russian). In 1915, Edward Loth, one of the organizers of the new University of Warsaw, took over the Chair of Human Anatomy at the Faculty of Medicine.

Edward Loth (1884–1944) – Warsaw-born anthropologist, anatomist, and orthopedic surgeon, pioneer of the "anthropomorphology of soft parts", from 1915 the chair in Human Anatomy at the University of Warsaw (professor from 1921), member of the Warsaw Scientific Society and the Polish Academy of Arts and Sciences, lecturer at the clandestine University of the Western Lands[8], and medical chief of the Polish Army Training Inspectorate (1917–18). Loth was imprisoned twice in Pawiak Prison – the largest German political prison in occupied Poland from 1939 to 1944. During the Warsaw Uprising, in which he would perish, Professor Loth, holding the rank of lieutenant colonel, served as medical chief officer of the Home Army's Mokotów District.

Educated in Zurich (where he studied anatomy and anthropology), Bonn, Göttingen, and Heidelberg (medical studies), Loth, after returning to Poland, conducted comparative research on the soft parts (primarily muscles) of humans in relation to primates. He was a continuator of Carl Gegenbaur's Heidelberg school of comparative anatomy and the founder of developmental anatomy in Poland. In 1927, he proposed the establishment of the International Committee for the Study of Soft Parts, whose chairman was the renowned British anthropologist and anatomist, Sir Arthur Keith (1866–1955) (Czekanowski 1946-47, Odrowąż-Szukiewicz 1975). In 1931, he published the world-renowned monograph "Anthropologie des parties molles", which received

6 The Warsaw Scientific Society (Towarzystwo Naukowe Warszawskie) – founded in 1907 in Warsaw with the aim of "developing and supporting research in all branches of knowledge and publishing scientific works in Polish", became a scientific institution. It was liquidated with the establishment of the Polish Academy of Sciences at the First Congress of Polish Science in 1951, in conjunction with the Stalinization of science by the communists.

7 Royal University of Warsaw (1816–31), Warsaw Main School (1862–69), Imperial University of Warsaw (1870–1915).

8 The University of the Western Lands (Uniwersytet Ziem Zachodnich) – a clandestine Polish university operating in Warsaw and its surrounding area during World War II, established in 1940, most of whose lecturers came from the University of Poznań, which had been closed by the Germans.

a prestigious award from the International Institute of Anthropology. He was also a co-organizer and participant in a Polish research expedition to Uganda (1938/39), from which he brought back a large collection of primates and osteological material (human skulls). Jan Czekanowski (1948a), in listing the leading centers of Polish anthropology in the interwar period, called the center headed by Loth the "Warsaw morphological-comparative school." Loth was considered an anatomy enthusiast (during whose time dissection rooms were "scientifically revived"), an excellent educator, and efficient organizer, and had many students who later became professors of anatomy and surgeons. However, his research area found few followers in Poland and, after his death, was not systematically continued. His most important book publication was "Człowiek przeszłości" (1938).

Meanwhile, in 1920, during the Polish-Soviet War[9], the Military Anthropology Department was established in the Ministry of Military Affairs (with the participation of Kazimierz Stołyhwo, who subsequently incorporated it into the Institute of Anthropological Sciences of the Warsaw Scientific Society under his direction). In 1924, a special department was established within the Ministry of Military Affairs – the anthropological section, entrusted to Jan Mydlarski (see *The Wrocław Center* section), who, from 1921 onwards, co-conducted mass anthropometric measurements of recruits and soldiers for the army – the so-called "military anthropological survey" (Stęślicka 1957).

In 1931, at the Central Institute of Physical Education in Warsaw, founded in 1929 on the initiative of the Head of State – Marshal Józef Piłsudski as an academic school with a sports and military character (later the Academy of Physical Education in Warsaw), the Department of Anthropology and Biometry was established, which was also headed by Jan Mydlarski until 1939 (and for two years after World War II).

The Kraków Center

Józef Majer and Izydor Kopernicki (see *First Publications and Emergence of a University Discipline* section) with their lectures on anthropology paved the way for the establishment of the first Chair of Anthropology at the Jagiellonian University in Kraków. In 1908, Julian Talko-Hryncewicz was appointed associate professor of anthropology at the Jagiellonian University (then in the Austrian partition), creating the first chair of anthropology at a university in Poland (simultaneously with the Czech University in Prague), which was the result of many years of efforts initiated by his mentor, Izydor Kopernicki (Jasicki 1957). In November 1911, at the Faculty of Philosophy in the Collegium Juridicum, Talko-Hryncewicz delivered the inaugural lecture at the opening of the new Department of Anthropology (Wrzosek 1926, 1951; Kaczanowski 2008).

Julian Talko-Hryncewicz (1850–1936) – born in Rukszany near Kaunas (present-day Lithuania) physician, ethnographer, and anthropologist who explored Siberia, professor and organizer

9 A two-year armed conflict (1919–1921) between the Republic of Poland (Second Polish Republic) and Soviet Russia, which sought to implement the idea of communist revolution throughout Europe and transform European states into Soviet republics, ending with a Polish victory (including the famous Battle of Warsaw of 1920) and stopping the expansion of Bolshevism.

of anthropology departments at the Jagiellonian University (1908–14 and 1918–30)[10] and at Stefan Batory University in Vilnius (1920), member of the Anthropological Commission of the Jagiellonian University (1887). He studied in St. Petersburg, Kiev, Paris, and Vienna. He founded a field he called "strict physical anthropology" (Jasicki 1957) and co-founded, together with Kazimierz Stolyhwo, the Kraków School of Anthropology. The first honorary member of the Polish Anthropological Society (1927) and doctor *honoris causa* from the Jagiellonian University (1926).

In the 1880s, in the Ukrainian steppes near Ryzhanivka, Talko-Hryncewicz discovered a Scythian burial mounds (kurgans). During his sojourn in Eastern Siberia (in the Transbaikal region), he organized natural, archaeological, and ethnographic expeditions, and studied graves and burial customs. After returning from Russia, as a professor at the Jagiellonian University, he began longitudinal studies of the development of children and adolescents in Kraków schools. His next important endeavors included collecting materials on Polish highlanders – publications: "Górale polscy jako grupa antropologiczna" (1916) and "Materiały do antropologii górali polskich" (1934), research on the 14th–16th-century skeletal cemetery at Łankiszki near Nacza in Lithuania, and collecting skeletal material from former Kraków residents from old cemeteries – publication: "Mieszkańcy Krakowa z X–XX wieku: studjum antropo-bio-socjologiczne" (1926) (Jasicki 1957). He also wrote the book "Człowiek na ziemiach naszych" (1913). His students included future professors Kazimierz Stołyhwo and Bronisław Jasicki.

Following Talko-Hryncewicz's retirement in 1930, Kazimierz Stołyhwo, the founder of the first Polish center for physical anthropology in Warsaw and an opponent of the Lvov School of Anthropology, was finally elected to fill the Chair of Anthropology at the Jagiellonian University after the chair had been vacant for several years[11].

Kazimierz Stolyhwo (1880–1966) – born in Brajłów (formerly Brahiłów) in Podolia (present-day Ukraine) anthropologist, founder of the Anthropological Laboratory at the Museum of Industry and Agriculture, then at the Warsaw Scientific Society (which he headed 1905–34), co-organizer of the Department of Military Anthropology (1920), lecturer at the Society for Scientific Courses[12], the Free Polish University, and the University of Warsaw (at the Faculty of Medicine), and professor at the Jagiellonian University. He studied at the Imperial University of Warsaw, then in Berlin, Munich, and Paris (at the Broca Laboratory of the École d'An-

10 During the period 1914–18, when Julian Talko-Hryncewicz was away from Kraków – in St. Petersburg and Lithuania, the department was headed by Adam Wrzosek.

11 A potential candidate, Jan Czekanowski, did not have a good reputation in Kraków circles, which considered his academic direction „one-sided and harmful" and the Lvov anthropological school „expansive and full of impertinence" (Jasicki 1957: 33, from a letter from Henryk Hoyer, professor of comparative anatomy at the Jagiellonian University, to Kazimierz Stołyhwo dated January 28, 1932). As a result, neither Czekanowski nor his students were considered for positions in Kraków.

12 The Society for Scientific Courses (Towarzystwo Kursów Naukowych) – a private higher education institution in Warsaw operating in the years 1905–18, which was established as a continuation of the previously existing illegal Flying University and transformed in 1916 into the Free Polish University.

thropologie de Paris under the supervision of Léonce Manouvrier), and received his PhD from Charles University in Prague (1926). In 1933 he was appointed head of the Chair and Department of Anthropology at the Faculty of Philosophy, Jagiellonian University in Kraków (until 1960) and was dean of the Faculty of Mathematics and Natural Sciences of the Jagiellonian University (1946–47). In November 1939, Stołyhwo, sharing the fate of many professors at the Jagiellonian University, was imprisoned (until April 1940) in the German Nazi concentration camp in Sachsenhausen near Berlin. He was a member of the Polish Academy of Arts and Sciences, an honorary member of the Polish Eugenics Society (1937) and the Polish Anthropological Society (1959), and was awarded the Officer's Cross of the Order of the Legion of Honor of the French Republic (1926) (Jasicki 1978, Musiał 2016).

Stołyhwo, while still in Warsaw, and before taking up the Chair of Anthropology in Kraków, engaged in polemics with German anthropologists – including Gustav Schwalbe – regarding the species status of Neanderthal man (so-called Homo primigenius), conducted research in Poland and abroad (including in museums in Vienna, Argentina, Padua, Bologna, and Florence), and collected anthropological materials in Siberia and among the Kashubians in Pomerania. Based on his lectures and thanks to the efforts of students of the Medical Club (Malinowski 1996), the textbook "Zarys antropologii. Podręcznik antropologii dla studentów medycyny" (1928) was published. After taking up the Chair of Anthropology in Kraków, Stołyhwo began to prepare an anthropological survey of the population of Polish Silesia, collecting material consisting of nearly 25,000 specimens in total ("Struktura antropologiczna polskiego Śląska" 1939) and in the 1930s, together with his wife – Eugenia Stołyhwo, developed an analytical method called the Stołyhwos' "cross-sectional correlation method" for distinguishing racial types (Jasicki 1957). The second set of materials he collected consisted of studies on human ontogenetic development, mainly among school youth from Kraków. This field of research would later become one of the foremost research topics of Kraków anthropologists. Among his students were future professors: Paweł Sikora, Stanisław Panek, and Napoleon Wolański.

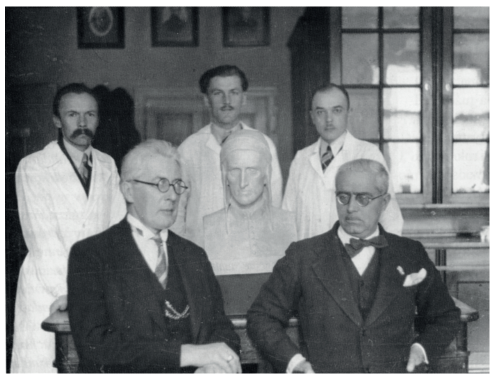

Figure 1. Kazimierz Stołyhwo with Fabio Frassetto of the University of Bologna (sitting) – the author of the facial reconstruction of Dante Alighieri (bust) – and the assistants of the Department of Anthropology, Faculty of Philosophy, the Jagiellonian University in Kraków. From the left: Bronisław Jasicki, Paweł Sikora, Włodzimierz Nielipiński (1938). (Source: Archives of the Department of Anthropology, Jagiellonian University)

The Lvov Center

The establishment of an anthropology center in Lvov (then part of the Russian partition) was at the end of the 19th century, the subject of unsuccessful efforts by Benedykt Dybowski (Czekanowski 1956, Stołyhwo 1957) after he took over the Chair of Zoology at the University of Lvov.

Benedykt Dybowski (1833–1930) – born in Adamaryn (Minsk Governorate, present-day Belarus) physician, zoologist, traveler, explorer of Siberia, lecturer at the Main School of Warsaw, professor at the University of Lvov (1884–1906), member of the Academy of Arts and Sciences, and one of the best-known figures among Polish exiles, whose death sentence for active participation in organizing the January Uprising was commuted to 12 years of exile in Siberia. Dybowski, an anthropology enthusiast (and later a proponent of "anthropotechnics" – eugenics [Dybowski 1924–28]), collected anthropometric and osteological materials from the *vanishing* Kamchadal and Ainu tribes during his expedition to Kamchatka in 1879–83. The measurements were lost, but the skulls and skeletons were donated to Izydor Kopernicki (see *First Publications and Emergence of a University Discipline* section) for the future museum of the Jagiellonian University Anthropology Department in Kraków (Stołyhwo 1957). He constructed several anthropological instruments of his own design, including a profilotractor, which were later given to Julian Talko-Hryncewicz.

Coincidentally, in 1908, a Chair of Ethnology was established at the University of Lvov, however, it was vacated two years later. In 1911, Jan Czekanowski, who was then completing the publication of the first volume on the results of an African expedition, was offered the position. He was eventually appointed to the Chair of Anthropology and Ethnology in 1913 (Czekanowski 1956).

Jan Czekanowski (1882–1965) – born in Głuchów, near Grójec (Masovian Voivodeship) anthropologist, ethnologist/ethnographer, and statistician, professor at the University of Lvov[13] (1913–41 and its rector from 1934–36), and after World War II professor at the Catholic University of Lublin (1945–49) and the University of Poznań (1946–60), later the Adam Mickiewicz University. He was the creator of the so-called Lvov School of Anthropology (called by Czekanowski himself the "Synthetic Lvov School"), which for half a century (1913–65) set the tone for almost all anthropological research in Poland – hence the later term "Polish Anthropological School". He was a member of almost all the most important ethnographic and anthropological organizations, including the Polish Ethnographic Society, the Polish Copernicus Society of Naturalists (president for many years), the Scientific Society of Lvov, the Warsaw Scientific Society, the Polish Academy of Arts and Sciences, and the Polish Academy of Sciences (in 1959–65 he chaired its Anthropological Committee). He was also honorary member of the Swiss Anthropological and Ethnological Society (1955), the Polish Anthropological Society (1959), and the Royal Anthropological Institute of Great Britain and Ireland (1961) and received honorary doctorates from the University of Wrocław (1959) and Adam Mickiewicz University in Poznań (1962).

Czekanowski studied in Zurich (doctoral degree under the Swiss anthropologist Rudolf Martin), and after completing his studies, in 1907, he obtained a position as an assistant in the African Studies Department at the Royal Muse-

13 The University of Lvov had various names throughout its history, during the time of Jan Czekanowski: the Franciscan University (1817–1918), the Jan Kazimierz University (1919–39), and the Ivan Franko State University of Lvov (1940–41).

um of Ethnology (Königliches Museum für Völkerkunde) in Berlin, under the ethnologist Professor Felix von Luschan. From there, as an ethnographer and anthropologist, he took part in the German interdisciplinary scientific expedition led by Duke Adolf Frederick of Mecklenburg, to Central Africa (1907–08, where he remained a year longer), researching, among other things, the Bantu and Pygmy peoples, and acquiring rich ethnographic collections and anthropological materials (measurements of the indigenous population and over 1,000 skulls[14] [Czekanowski 1951, Bar and Tymowski 2023]). In 1911–13 he was curator of the African Department of the Ethnographic Museum of the Imperial Academy of Sciences in St. Petersburg, from where he moved to the University of Lvov.

Figure 2. Jan Czekanowski (center) surrounded by students (1^{st} row first from the right – Jan Mydlarski) in the first year of the existence of the Department of Anthropology and Ethnology of the Faculty of Philosophy at the University of Lvov (academic year 1913/14). (Source: Czekanowski 1956)

14 The skulls were brought to Berlin, catalogued and measured by Czekanowski, and donated to the museum collection of Professor F. von Luschan (Guardian 6/10/2017). They originated primarily from the then Kingdom of Rwanda (a German-controlled territory) and were collected from indigenous people who did not bury their dead. For over 100 years, they were stored in the collections of the Charité Medical University in Berlin, from where they were donated to the Prussian Foundation for Cultural Heritage in 2011 and subsequently designated for return to Africa (DW 09/06/2023).

In the first half of the 20th century, Czekanowski elevated the meaning and importance of anthropology in Poland. He defined anthropology as a science "investigating the biological basis of social phenomena" (Czekanowski 1956: 39), and his primary goal was to transform Polish anthropology into an exact science, drawing inspiration from the English biometric school of Francis Galton and Karl Pearson. His ambition was to invent a mathematical method for classifying individuals based on multiple traits simultaneously (Bielicki 1959). Czekanowski's methodological innovations included (Bielicki et al. 1985, 1989):

- the concept of "average difference" (DD statistic), the first measure of biological distance,
- the concept of a square matrix of these distances (the so-called Czekanowski table),
- a method for ordering this matrix (Czekanowski diagram) – a method of cluster analysis.

He introduced numerical taxonomy to racial classification, developing a sophisticated framework for anthropological typology based on his diagraphic method of differences and similarities (Czekanowski 1909, 1962). Historically, this was the first method of cluster analysis in the world (Krzyśko 2010). He was convinced that his method of calculating racial composition was groundbreaking and considered it his greatest achievement. The theory of distinguishing "racial types" and the method of calculating "racial compositions" of a population (the percentage of individual "racial elements" within it) seemed simple, coherent, and elegant, but it did not stand the test of time: simplicity proved to be a simplification and, therefore, the main weakness of the theory (Bielicki et al. 1985, 1989). This line of research is now considered historical and is no longer pursued in academic research. This is what Bielicki, Krupiński and Strzałko wrote about Professor Czekanowski:

> *Czekanowski was a scholar in the old, grandiose, professorial style, a Sage, adored by some, admired by many, and intensely disliked by a few.*
>
> (Bielicki et al. 1985: 21)

His major book publications include: "Zarys metod statystycznych w zastosowaniu do antropologii" (1913) – the first textbook on mathematical statistics in Polish; "Wstęp do historii Słowian: Perspektywy antropologiczne, etnograficzne, archeologiczne i językowe" (1927, 1957); and "Człowiek w czasie i przestrzeni" (1927, 1934, 1967). Jan Czekanowski's students at various stages of their careers included later doctors and professors: Jan Mydlarski, Father Bolesław Rosiński, Karol Stojanowski, Stanisław Klimek (killed in the Battle of the Bzura River in 1939), Salomon Czortkower (died in the Lvov Ghetto in 1943), Tadeusz Henzel, Stanisław Żejmo-Żejmis (killed in Auschwitz in 1942), Adam Wanke, and Franciszek Wokroj (Czekanowski 1956).

To mark the 60th anniversary of Jan Czekanowski's scientific work, the editors of "Materiały i Prace Antropologiczne" dedicated one issue of the publishing series to a commemorative book dedicated to him (Wanke 1964). On the centenary of Jan Czekanowski's birth, a commemorative academic conference was organized at Adam Mickiewicz University in Poznań (September 9–10, 1982), titled "The Polish School of Anthropology on the 100th Anniversary of the Birth of its Founder, Jan Czekanowski", and a collective volume "Teoria i empiria w Polskiej Szkole Antropologicznej", was later published (1985).

In September 1939, resulting from the pact between Stalin's Soviet Russia and Hitler's Nazi Germany (the Molotov-Ribbentrop Pact), Lvov became part of the Soviet Empire. By late June 1941, it was under German occupation, and ultimately, following the Yalta Agreements (1945), Lvov became part of the Ukrainian Soviet Socialist Republic. Poland, therefore, lost its pre-war "capital" of anthropology.

The Vilnius Center

The pioneers of anthropological thought in the Vilnius region were the aforementioned physicians Jędrzej Śniadecki and Józef Jasiński (see *First Publications and Emergence of a University Discipline* section), whose anthropological works were published in the first two decades of the 19th century. In 1832, by decree of Tsar Nicholas I, as part of the repression following the November Uprising, Vilnius University was closed and only reactivated in the Second Polish Republic in 1919 as Stefan Batory University in Vilnius.

In 1919, the Department of Anthropology and Prehistory of the University of Vilnius was established, which took up a professor of anthropology at the Jagiellonian University – Julian Talko-Hryncewicz (1920), beginning the acquisition of collections (including those from the Vilnius Museum of Antiquities) and the organization of the department. However, the Polish-Soviet War interrupted Talko-Hryncewicz's activities, and after a few months later that same year, he returned permanently to Kraków. The lectures on anthropology at the Faculty of Medicine were then taken over by Michał Reicher.

Michał Reicher (1888–1973) – born in Sosnowiec (Silesian Voivodeship) anthropologist and anatomist trained in Zurich (PhD 1912). He held a scholarship at the Carnegie Institution in Baltimore (1914), was a member of the Department of Anatomy at the University of Warsaw (1915–20), founder of the Collegium Anatomicum in Vilnius, which remains active today, and professor of anatomy at the Stefan Batory University in Vilnius (from 1920 until its closure by the Lithuanian authorities in 1939) and at the Medical Academy in Gdańsk from 1945. He co-authored and continued work on the comprehensive human anatomy textbook "Anatomia człowieka", begun by the Kraków anatomist and anthropologist Professor Adam Bochenek (1875–1913), was an honorary Member of the Polish Anatomical Society (1964), and doctor *honoris causa* of the Medical Academy of Gdańsk (1965). Michał Reicher, like Edward Loth in Warsaw, conducted research on the intersection of anatomy and anthropology, known as "the anthropomorphology of soft parts", studies on the growth and body proportions of human fetuses, typological studies on the constitutional structure of the human body, and studies on the Lithuanian ethnic minority – the Karaites of Trakai and Vilnius (Reicher and Sylwanowicz 1956). Reicher's students included, among others, the anatomist and anthropologist Witold Sylwanowicz in Vilnius, and the anthropologist and paleopathologist Judyta Gładkowska-Rzeczycka in Gdańsk (see *The Białystok Center* section).

After World War II, Vilnius became the capital of the Lithuanian Soviet Socialist Republic, thus ending the short, barely twenty-year history of the Polish Vilnius anthropology center.

The Poznań Center

Anthropology in Poznań did not have the same long traditions as the four previously mentioned academic centers in Poland. Only after the end of World War I, in May 1919, was a university established in Poznań, thanks to the efforts of Professor Heliodor Święcicki (1854–1923) – a Poznań-born physician, social activist, philanthropist, and the university's first rector. After the opening of the University of Poznań, work began to establish a Chair of Anthropology at the Faculty of Philosophy which, following the division of the faculty in 1925, was incorporated into the Faculty of Mathematics and Natural Sciences. However, despite these efforts, the chair remained vacant.

In 1920, the organization of a second Department of Anthropology at the Faculty of Medicine of the University of Poznań was initiated, with Professor Adam Wrzosek as its head.

The third anthropological institution, also at the Faculty of Medicine of this university, was the Physical Education Center, which was established on the basis of the Chair of School Hygiene and Theory of Physical Education at the University of Poznań, and headed by Eugeniusz Piasecki (1872–1947) – a Lvov-born physician, academic teacher, theoretician of physical education and school hygiene, and later patron of the Academy/University of Physical Education in Poznań (Godycki 1958).

Adam Wrzosek (1875–1965) – born in Zagórze (near Dąbrowa Górnicza) pathologist, anthropologist, and historian of medicine, founder of an academic center for anthropology in Poznań. He studied at the universities of Kiev, Zurich, and Berlin (where he attended lectures by eminent German professors Rudolf Virchow and Robert Koch), and after obtaining his doctorate in medicine and surgery in 1898, he continued his studies in Paris (attending lectures by Léonce Manouvrier), Zurich, Kraków, and Vienna. From 1901, he worked at the Jagiellonian University: in the Chair of General and Experimental Pathology (1901–13), and in the Department of Anthropology (1913–18, first under Professor Julian Talko-Hryncewicz, and then as his replacement).

In 1920, Wrzosek – by then former professor at the Jagiellonian University in Kraków and the University of Warsaw (1918) and former head of the Department of Science and Higher Education in the Ministry of Religious Denominations and Public Enlightenment (1919–20), was appointed organizer and first dean of the newly established Faculty of Medicine at the University of Poznań (1921–23), where he headed up two departments: the Department of History and Philosophy of Medicine and the Department of Anthropology (from 1921), focusing, following the example of the French school, on physiological anthropology, including body temperature, pulse, and visual acuity (Ćwirko-Godycki 1935, Godycki 1958). He introduced anthropology into medical studies, and on his initiative the Polish Anthropological Society was founded in Poznań in 1925, of which he was the first president (1925–48). He was also founder and first editor-in-chief of the scientific journal "Przegląd Antropologiczny" (Anthropological Review) (1926–48 and 1955–56)—the official organ of the Society and, from 1938, of Polish anthropology departments.

Figure 3. Adam Wrzosek (second from the left) and Michał Ćwirko-Godycki (second from the right) surrounded by volunteer assistants of the Department of Anthropology, Faculty of Medicine, University of Poznań, in the osteological collections of its second location – Marcinkowski Collegium in Wilda (1935). (Source: Archives of the Polish Academy of Sciences, Poznań branch)

From 1935 to 1939, while working in Poznań, Adam Wrzosek commuted to Vilnius, where he lectured at the Stefan Batory University. During the war, he co-organized the Faculty of Medicine at the clandestine University of the Western Lands in Warsaw. After the defeat of the Warsaw Uprising, he settled in Grodzisk Mazowiecki (in the Chrzanów manor), where he continued his clandestine medical teaching. When, after the war, in 1945, the Department of Anthropology was reactivated and, resulting from Professor Wrzosek's efforts, a Chair at the Faculty of Medicine of the Poznań University was created, he was reappointed as its head. Soon afterwards, however (in 1947), the communist authorities of the Stalinist era removed him from his position and forcibly retired him. In the years 1947–50, Wrzosek continued to work at the university but had to agree to accept the position of "contract junior assistant," and then, renewable monthly, an "associate professor" without teaching duties (Musielak 2022). In January 1957, during the "Gomułka thaw" (a period of liberalization of the political system and limitation of communist repression in Poland), he was reinstated as professor of the Chair of the History of Medicine at the then Poznań Academy of Medicine[15], where he worked until

15 The Poznań Academy of Medicine, like other such medical universities in Poland, was established as an independent institution in 1950, when, by a decree of the Council of Ministers, the Faculties of

1959. Member of the Academy of Medical Sciences and the Polish Academy of Arts and Sciences; honorary member of the Poznań Society of Friends of Sciences (1912), distinguished member of the Polish Anthropological Society (1959), and doctor *honoris causa* of three universities: the Stefan Batory University in Vilnius (1929), the Poznań Academy of Medicine (1961), and the Jagiellonian University in Kraków (1964).

Adam Wrzosek compiled a bibliography of Polish anthropology "Bibliografia antropologii polskiej do roku 1955 włącznie" (1960), wrote numerous works on the history of anthropology (including profiles of Julian Talko-Hryncewicz and Józef Majer) and works on human physiological characteristics. Together with his student and later collaborator, Michał Ćwirko-Godycki, in the 1920s he conducted anthropological research on Kashubian school children (collecting material from 1,400 individuals), in the years 1925–29 he conducted research on the cemetery of the Lusatian culture (dated to the period from 1000 to 400 BC) in Laski (near Kępno, Poznań Voivodeship), collecting material from over 1,500 urns, and in 1932–35 conducted regular excavations at Ostrów Lednicki near Gniezno (10th–13th centuries; totalling over 1,400 skeletons), which remains the most valuable skeletal collection in Poland to this day (Godycki 1958).

Michał Ćwirko-Godycki (1901–1980) – born in Mińsk Litewski (present-day Belarus) physician and anthropologist. Participant in the Polish-Bolshevik War. He was associated with the Department of Anthropology at the Poznań University/Adam Mickiewicz University in Poznań from 1923 to 1971, initially as a volunteer assistant while still a student. After completing his medical studies, he studied at the École d'Anthropologie de Paris, a Parisian school of anthropology. In 1931, he assumed the position of school hygiene inspector at the Poznań District School Board (until 1952). During World War II, he lectured at the clandestine University of the Western Lands. He participated in organizing the Higher/University School of Physical Education in Poznań[16], established in 1950, where he organized and directed (1953–68) two departments: the Department of Biology and Anthropology, and the Department of Hygiene, while also serving as the Chair in Biological Sciences. From 1956 to 1965 he served as Rector of the Higher School of Physical Education for three terms; from 1960 to 1971 he was chairman of the Commission on Anthropometry of the Polish Academy of Sciences. Head of the Chair of Anthropology at Adam Mickiewicz University (1966–69) and of one of its two departments, the Department of General Anthropology (1967–69). President/vice-president of the Polish Anthropological Society (1948–56), editor-in-chief of "Przegląd Antropologiczny" (1957–77), distinguished member of the Polish Anthropological Society (1965). First doctor

Medicine and Pharmacy were separated from universities. In 2007, the Poznań Academy of Medicine changed its name to the Poznań University of Medical Science (Uniwersytet Medyczny im. Karola Marcinkowskiego w Poznaniu).

16 The Poznań Higher School of Physical Education was renamed the Poznań Academy of Physical Education in 1973 (now Akademia Wychowania Fizycznego im. Eugeniusza Piaseckiego w Poznaniu).

honoris causa of the Poznań Academy/University of Physical Education (1975; on the 25th anniversary of the university's independence).

Ćwirko-Godycki (who in the People's Republic of Poland usually used only the second part of his surname) contributed to the development of collaboration between anthropology and archaeology and promoted the application of anthropology to physical education and sport. He pursued multifaceted research, with a particular interest in child development. Interestingly, his first research, while still a student, was conducted on the population of Kleck in the Nieśwież district, former Nowogródek Voivodeship (Dzierżykray-Rogalski 1973, Malinowski 1981) – the birthplace of his later student and professor of anthropology at Adam Mickiewicz University in Poznań – Jan Strzałko. One of Michał Ćwirko-Godycki's most important scientific achievements (Godycki 1958) was a longitudinal study of the developmental dynamics of school children from Poznań (1930s, the results of which were lost during World War II) and children from the Poznań Voivodeship (1940s–1950s; N=180,000) – this material was summarized in Chapter I of the monograph "Dziecko poznańskie" (1976). Together with Adam Wrzosek, he also studied Kashubian children and conducted research on the Lusatian culture cemetery from the Bronze Age/Halstatt period in Laski (a cremation site) and an early medieval cemetery in Ostrów Lednicki (a skeletal site). He also participated in the 2nd Arab-Polish Anthropological Expedition to Egypt (1962). In addition to the biology of human development and historical anthropology, he was interested in the development of the skeleton under the influence of muscles (the influence of the masticatory muscles on the shape of the skull), the history of medicine, and anthropometric techniques (he published the first textbook in Polish entitled "Zarys antropometrii" [1933, 1952, 1956]). He compiled four parts of the bibliography of Polish anthropology covering the years 1956–1980 ("Bibliografia antropologii polskiej"), and was also the author of several academic textbooks, including: "Antropologia. Dla studiujących wychowanie fizyczne" (1955).

Ćwirko-Godycki's students, who later became professors (see *Poznań* section), included Andrzej Malinowski, Zbigniew Drozdowski, Jan Strzałko, and Maria Danuta Kaliszewska-Drozdowska. On the twentieth anniversary of his death – in 2000 – a study room was opened at the Museum of the First Piasts in Lednica to commemorate the participation of professors Adam Wrzosek and Michał Ćwirko-Godycki in the work related to the excavation of the Ostrów Lednicki cemetery in the 1930s.

The third active employee of the interwar Poznań center was Karol Stojanowski, a student of Jan Czekanowski, who arrived there from Lvov in 1926.

Karol Stojanowski (1895–1947) – born in Kobyłowłoki (western Ukraine) anthropologist, eugenicist[17], social activist (Scouting) and political activist

17 Eugenics (from the Greek for „well-born") – pseudoscientific ideology theoretically aimed at improving the condition of the human species (in the sphere of biology, mental characteristics and morality) through selection and control of reproduction.

(National Camp). Participant in the Polish-Bolshevik War. He began working as a teacher in 1919, moving to the university in Lvov in 1921 (PhD in 1924), simultaneously serving as an assistant at the Chair of Prehistoric Archaeology, and then on to Poznań. He was head of the Laboratory of Applied Anthropometry at the Physical Education Center at the Faculty of Medicine, University of Poznań (1926–39) headed by Eugeniusz Piasecki, and head of the anthropological branch of the Department of Prehistory, University of Poznań (1934–39). He lectured at the clandestine University of the Western Lands. After World War II, in 1945, due to political issues (as a leading activist of the National Party he was under surveillance by the Security Office), he moved to the newly established Polish University of Wrocław, where he became the first head of the Department of Anthropology at the Faculty of Mathematics and Natural Sciences (Patalas 2010).

Stojanowski undertook research on physical fitness depending on body type and racial type and addressed German racism, outlining the threat of German racism directed against Poland and Slavic countries. He attempted to demonstrate that Poland was on a par with Germany in terms of racial composition (particularly the frequency of Nordic elements). In his book "Rasowe podstawy eugeniki" (1927), he presented the thesis that "Eugenics is a science and movement aimed solely at the good of the nation as a whole" (1927: 50) and made openly anti-Semitic statements, including that about the physical "degeneration" of the Jewish population and their racial components, which were alien to the Polish population. Stojanowski concluded one section of this publication by stating:

> *To summarize my arguments, I state that the assimilation of Jews is undesirable for eugenic reasons. They must either emigrate or, having limited their birthrate, simply die out.*
>
> (Stojanowski 1927: 69)

Centers Established After World War II (in 1940s–1950s)

In the postwar years, almost all anthropology departments at Polish universities (with the exception of Kraków) were staffed by Jan Czekanowski's students (Lublin – Jan Mydlarski, later replaced by Tadeusz Henzel; Wrocław – Karol Stojanowski, later replaced by Jan Mydlarski; Warsaw – father Bolesław Rosiński; Toruń – Franciszek Wokroj) or students of his students (Łódź – Ireneusz Michalski; Białystok – Tadeusz Dzierżykray-Rogalski). After World War II, Jan Czekanowski himself found employment briefly at the Catholic University of Lublin and for longer at the University of Poznań.

The Lublin Center

Lublin was a city with a long academic tradition, dating back to the 16th and 17th centuries, when religious schools—the seeds of higher education—were established there: a Talmudic academy and a Jesuit college, followed by a *studium generale* at the Dominican monastery. During the interwar period, Lublin hosted a Catholic university, founded in 1918 under the name of the University of Lublin (renamed the Catholic University of Lublin in 1928), which resumed its activities as the first Polish university after the German occupation already in August 1944.

In October 1944, in Lublin, which for several months served as the capital of the People's Republic of Poland, by decision of the Polish Committee of National Liberation (PKWN)[18], the first secular, state university was established – the Maria Curie-Skłodowska University. It was intended to educate a new intelligentsia from among the working and peasant classes (Kruszyński 2015). Its first rector was Professor Henryk Raabe, a zoologist (and political activist of the Polish Socialist Party). This new university in Lublin, the first in liberated Poland, offered professors, particularly those from the Eastern Borderlands, the opportunity to quickly return to professional work – the first official inauguration of the academic year took place in January 1945.

Departments of Anthropology were established in early 1945 at both universities – the Catholic University of Lublin and Maria Curie-Skłodowska University (UMCS) (Czekanowski and Wiązowski 1959), employing faculty from Lvov in managerial positions. At the end of 1949, a third institution was established – the Department of Anthropology at the Faculty of Medicine at UMCS. However, none survived for long, and by 1950, many academics had abandoned Lublin and UMCS, seeing little prospect for academic development due to unfulfilled ambitions and expectations, and the marginalization of the university (Kruszyński 2015).

The first institution – the Chair of Anthropology at the Faculty of Humanities at the Catholic University of Lublin, with its Department of Ethnology and Sociology organized by ethnologist Józef Gajek, operated from 1945 to 1949. Its head was the founder of the Lvov School of Anthropology himself, Jan Czekanowski (from 1946 onwards, working concurrently at the University of Poznań, to which he eventually transferred).

The second institution, the Department of Anthropology at the Faculty of Natural Sciences of Maria Curie-Skłodowska University, was established in February 1945. Its first heads were Jan Czekanowski's students, **Jan Mydlarski** (1945–49) (see *The Wrocław Center* section) and Tadeusz Henzel (1949–55), followed by J. Mydlarski's students – Kazimierz Wiązowski (1955–63) and Krystyna Modrzewska (1964–69), who was its last head. As Mydlarski (1949) reported, the department initially had nothing – neither books, research materials, measuring instruments, nor even furniture (except for a borrowed table and chair). Over time, he acquired a series of African skulls from Uganda (previously brought over by Edward Loth), a series of skulls from devastated old cemeteries, casts of a series of skulls from Ngandong in Java (the analysis of which was entrusted to Wanda Stęślicka [see *The Wrocław Center* section]) and stuffed exhibits of monkeys and prosimians (Czekanowski and Wiązowski 1959). Wanda Stęślicka and Krystyna Modrzewska studied and later

18 The Polish Committee of National Liberation (Polski Komitet Wyzwolenia Narodowego, PKWN) – a political body established in Moscow by Stalin's decision in July 1944. Its manifesto, published on July 22nd, proclaimed, among other things, land reform and the confiscation of German property. The PKWN was the first communist center of power in Poland (based in Lublin), and its founding was a key step in the creation of the People's Republic of Poland, establishing a communist party monopoly and subordinating the country to the USSR.

worked at the Maria Curie-Skłodowska University in Lublin, while Halina Milicer (see *Warsaw* section) and Tadeusz Dzierżykray-Rogalski (see *The Białystok Center* section) worked there briefly as assistants.

Figure 4. Scientific staff of the Department of Anthropology, Faculty of Natural Sciences, Maria Curie-Skłodowska University in Lublin in the academic year 1947/48. From the left: Kazimierz Wiązowski, Krystyna Modrzewska, Jan Mydlarski, Wanda Stęślicka, Tadeusz Dzierżykray-Rogalski (Source: Multimedia Library Teatrnn.pl)

Tadeusz Henzel (1905–1955) – an anthropologist born in the village of Wygnanka near Chortkiv (present-day Ukraine). He worked at the Central Institute of Physical Education in Warsaw before World War II, and after the war, as an associate professor at Maria Curie-Skłodowska University. His works included so-called ethnic anthropology/typology, particularly of African peoples ("Pigmeje centralno-afrykańscy. Studium antropologiczne" 1934), as well as research methodology.

Krystyna Modrzewska (Mandelbaum, Frenkiel) (1919–2008) – Warsaw-born anthropologist, physician, and writer. Before the Second World War, she studied in Bologna (1937–39 under Professor Frassetto), and after the war, at Maria Curie-Skłodowska University. A student of Jan Mydlarski (PhD 1948), she was a researcher at UMCS in Lublin (1947–49 and 1956–69 – with breaks for medical practice), the University of Poznań (1949–50), the Medical Academy/University of Białystok (1950–55), and Uppsala University (1971–85). Her scientific interests focused on human genetics and demography, and she also studied PTC (phenylthiocarbamide) sensitivity. In the 1950s, she led excavations at an early medieval cemetery in the village of Czarna Wielka. After the events of March 1968, "Due to growing conflicts at the university, repression by the authorities, intrusive surveillance, and deepening anti-Semitic sentiment", K. Modrzewska decided to leave Poland in 1970 and emigrate to Sweden (Wejman and Zachariewicz 2025). She was an honorary member of the Polish Anthropological Society (1987). She co-authored the textbook "Zarys antropologii dla medyków" (1955), authored fiction under the pseudonym Adam Struś, as well as memoirs under her own name, including "Trzy razy Lublin" (1991), and "Z Bolonii do Uppsali" (2002).

The third institution, the Department of Anthropology at the Faculty of Medicine of Maria Curie-Skłodowska University, was established in 1949 under the direction of the recently promoted doctor, Tadeusz Dzierżykray-Rogalski. In 1950, the department gained autonomy, transforming itself into the Lublin Medical Academy. Owing to the removal of anthropology lectures from medical faculties, the department was renamed the Paleoanthropology Laboratory. However, this, like the Department of Anthropology at the Catholic University of Lublin, did not last for long: in 1952, after only three years in existence, it was liquidated.

The Wrocław Center

Poland lost Wrocław in 1335 and regained it only after over 600 years. With the surrender of Festung Breslau (Wrocław Fortress) in May 1945, the history of German higher education in these areas ended, and in August of that year, the former German universities in Wrocław were transformed into Polish state academic schools. Under German rule, Wrocław had a rich tradition in the field of anthropology, where renowned professors worked in the institutes of anatomy and anthropology of the University of Wrocław (then Königliche Universität Breslau): anthropologist and anatomist Hermann Klaatch (1863–1916), and anthropologist and ethnologist Egon von Eickstedt (1892–1965), author of the book "Rassenkunde und Rassengeschichte der Menschheit" (1934).

In 1946, at the Polish University of Wrocław, Karol Stojanowski (see *The Poznań Center* section) took over the Chair in Anthropology and began organizing the department and recovering the hidden collections of the German university – literature, instruments, and osteological materials, including the famous craniological collections of Klaatch brought back from his expedition to Australia in 1904–07. Stojanowski died in 1947, and two years later, in 1949, another student of Jan Czekanowski, Jan Mydlarski, was appointed head of the department, transferring here from Maria Curie-Skłodowska University in Lublin. Under Mydlarski's leadership, the Wrocław center would soon become the second "capital" of Polish anthropology, after the pre-war one in Lvov. From 1951, for several years, it also offered the only specialized master's degree program in anthropology in Poland (Bielicki 1959).

Jan Mydlarski (1892–1956) – born in Pilzno (Subcarpathian Voivodeship) anthropologist whose scientific activity encompassed the genetics of blood groups, human growth and development and standards of motor fitness, the relationship between body structure and physiological properties, human typological differentiation, anthropogenesis and evolutionism. He was a lecturer at the Higher School of Intendenture in Warsaw (1923–24), at the Jan Kazimierz University in Lvov (1926–27), at the University of Warsaw (1927–39), head of the Department of Anthropology and Biometry/Anthropobiology at the Central Institute for Physical Education in Warsaw (1931–39 and 1947–49), lecturer at the clandestine University of the Western Lands (1940–41), professor of anthropology at the Maria Curie-Skłodowska University in Lublin (1945–49) and dean of its Faculty of Natural Sciences, and later professor at the University of Wrocław, of which he was rector from 1951 to 1953. He was also the founder and first director of the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1953–56). He was a member of the Anthropological Commission of the Polish Academy of Arts and Sciences and a member of the Warsaw Scientific Society, a corresponding member of the Polish Academy of Sciences and chairman of its Anthropological Committee (1952–56), head of the Anthropometrics Commission at the Presidium of the Polish Academy of Sciences (from 1955). Upon the establishment of the Polish United Workers' Party (PZPR) in 1948, its activist (Śródka 1983).

During the First World War, Mydlarski was drafted into the army of the Austro-Hungarian Monarchy; in years 1918–21 he served in the Polish Army, where, as an officer, in 1921 he began, and for 18 years continued, anthropometric measurements of recruits and soldiers for army purposes, the so-called military anthropological photograph (Mydlarski 1925), thanks to which Poland, from an anthropological perspective, was the best-studied country (Czekanowski 1956)[19]. In 1922 he made an important discovery regarding the mode of inheritance of the ABO blood group system (one tri-allelic locus instead of two pairs of independently inherited alleles), which, however, he did not publish (Stęślicka 1957, Bielicki et al. 1985, 1989). In the 1920s, he collaborated in the field of serology with Ludwik Hirszfeld (1884–1954 – physician, immunologist, and bacteriologist whose most important scientific achievement was his work on blood groups). In the 1930s, he initiated research on physical motor fitness, developing a "motor fitness measurer" (Mydlarski 1934/35) as a tool for objectively assessing the level of motor fitness in children and adolescents.

Jan Mydlarski had unprecedented achievements in organizing post-war anthropology in Poland, occupying "the number one position in the official hierarchy of the discipline" (Bielicki et al. 1985: 13). He led the establishment (1946) of the Maria Curie-Skłodowska University's scientific journal "Rocznik Uniwersytetu Marii Curie-Skłodowskiej" (from 1949 "Annales Universitatis Mariae Curie-Skłodowska"), of which he was the first editor-in-chief. From 1951, he was chairman of the Polish Anthropological Society, editor-in-chief of "Przegląd Antropologiczny" (1953–54)[20], and editor-in-chief of the Polish Anthropological Society's publications (1955–56). He founded and edited "Materiały i Prace Antropologiczne" (Anthropological Materials and Works) – the publication of the Department of Anthropology of the Polish Academy of Sciences. He is also credited with introducing anthropology as a specialization within biological studies. He educated a large group of independent academics, including: Wojciech Kóčka, Ireneusz Michalski, Wanda Stęślicka, Krystyna Modrzewska, Halina Milicer, Adam Wanke. Mydlarski's major book publications include: "Pochodzenie człowieka" (1948), textbook "Antropologia ogólna" (1949), "Drogi i bezdroża rozwoju człowieka" (1951).

A student, colleague, and later wife of Jan Mydlarski was Wanda Stęślicka.

Wanda Stęślicka-Mydlarska (1907–2001) – born in Siemianowice Śląskie anthropologist and popularizer of science. She began her scientific career after World War II at the Department of Anthropology, Maria Curie-Skłodowska University in Lublin (1946–49). She later headed the Department of Anthropology at the Faculty of Physical Education in Wrocław (1957–61), the Chair of Anthropology, Nicolaus Copernicus University (UMK) in Toruń (1962–71), and the Department of Anthropology, University of Wrocław (1971–75); an honorary member of the Polish Anthropological Society (1975). Her scientific work focused on comparative anatomy, primatology,

19 This material was practically destroyed at the beginning of World War II in 1939.

20 After the death of Joseph Stalin (March 1953), the 1953 volume of "Przegląd Antropologiczny", of which Jan Mydlarski was the editor-in-chief at the time, published the speech of the Chairman of the Central Committee of the Polish United Workers' Party (KC PZPR), Bolesław Bierut, to the nation after the return of the Polish delegation from the funeral of the „Leader".

anthropogenesis (including "Stanowisko systematyczne człowieka z Ngandong" [1947]), evolutionism, and the application of anthropology to physical education. She corresponded with Robert Broom (1866–1951), a paleontologist at the Transvaal Museum in Pretoria, South Africa (now the Ditsong National Museum of Natural History), who sent her several casts of the Australopith fossils, including skull fragments of Paranthropus from Kromdraai. She wrote popular science books, including "O pochodzeniu człowieka" (1954) and "Rodowód człowieka uzupełniony" (1964). She also authored a textbook for grade 8 in primary schools – "Nauka o człowieku", which was in circulation for more than a decade.

After World War II, Poland found itself in the Soviet sphere of influence, and in science – of Lysenkoism (see e.g., Sigmon 1993) (a pseudoscientific interpretation of the Michurinism theory in biology, based on the thesis of inheritance of acquired characteristics and rejecting the achievements of genetics) – an ideological trend that was officially announced in Poland in 1949. At the congress of zoologists and anthropologists in Łódź in December 1950, as a result of criticism of the state of Polish anthropology (including from the then head of the Science Department of the Central Committee of the Polish United Workers' Party) and before the planned First Congress of Polish Science in 1951, which was intended to subordinate science to political and ideological goals[21], Jan Mydlarski presented the "shortcomings" of Polish anthropology and a program for reforming and ideologically restructuring the discipline (Mydlarski 1951). In his December 1950 paper, Mydlarski also conducted self-criticism, stating:

> *Bound by habits of thought to my old worldview, I announced in 1946 a phylogenetic concept based on the chromosomal theory of heredity. At that time I was not sufficiently armed to understand the ideological meaning of these assumptions. Between the old accretions and the growing new ideology arose a contradiction that I did not understand at the time. Today, after breaking the old habits of thought, I assess my work in retrospect as outdated.*
>
> (Mydlarski 1951: 24)

After World War II, the anthropology curriculum was also restructured. Contrary to the pre-war concept, in which anthropology represented a more humanistic field[22] (and anthropologists were often also ethnographers), the idea of closely linking physical anthropology with biology, particularly zoology, prevailed. From then on, Polish anthropology, from a discipline combining biological and cultural sciences, became part of the exact

21 At the First Congress of Polish Science, the decision was made to dissolve the Polish Academy of Arts and Sciences and the Warsaw Scientific Society and to establish the Polish Academy of Sciences, modeled on the Soviet model, initially as a corporation of scholars, later as a central government institution. A Coordinating Commission was also established, bringing together the heads of all anthropology departments, which was later (1952) renamed the Anthropological Committee of the Polish Academy of Sciences.

22 The first anthropology departments were established at the Faculty of Philosophy at both the Jagiellonian University in Kraków and the University of Lvov.

sciences, with an increasingly weaker connection between the two disciplines.

According to Stęślicka-Mydlarska (1985), the 1950s witnessed a true "golden age" in the history of Polish anthropology. Between 1951 and 1954, three national anthropological conferences were organized, focusing on taxonomic methods, ethnogenetic research, and anthropological typology. Chairs of anthropology operated at all universities, and departments and laboratories were being established in medical academies/universities, in higher schools/academies of physical education, and in pedagogical studies. Anthropological institutions of the Polish Academy of Sciences also began to be established (like Mydlarski's in Wrocław).

Figure 5. Polish physical anthropologists – participants in one of the national anthropological conferences of the first half of the 1950s (most likely 1952 Osieczna or 1954 Wrocław). 1st row from the left: Wojciech Kóčka, Ireneusz Michalski, Jan Czekanowski, N.N., Jan Mydlarski, 2nd row third from the left: Judyta Gładkowska, Franciszek Wokroj, Wanda Stęślicka-Mydlarska, Zbigniew Drozdowski. Behind them in the 3rd row from the right: Irena Szewko-Szwaykowska and Zdzisław Kapica

The Wrocław center, although based on the traditions of Jan Czekanowski's Lvov school, abandoned the program of transforming anthropological typology into an exact science based on mathematical statistics, rejecting the "law of cardinality of types", yet at the same time distanced itself from the "methodological primitivism" of the Łódź "morphologists," who denied the usefulness of mathematical methods in anthropology in general (Bielicki 1959; Bielicki et al. 1985, 1989). After the death of Mydlarski in 1956, the third head of the Department of Anthropology in Wrocław was another alumnus of the former Lvov school – Adam Wanke.

Adam Wanke (1906–1971) – anthropologist born in Lvov. He worked in various professions until 1946, and from

1946 onwards at the Physical Education Center[23] of the University of Wrocław as an assistant. He also directed the anthropology laboratory at the Psychiatric Hospital in Wrocław for four years. During the Stalinist repressions in Poland, he was sentenced in 1950 to three years in prison and forced to resign from the university (he was released after nine months owing to the intercession of Professor Mydlarski, then rector of the University of Wrocław). In 1954, he became an assistant professor at the Department of Anthropology of the Polish Academy of Sciences. After Mydlarski's death, he was director of the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1956–65), and head of the Department of Anthropology at the University of Wrocław (1956–71), chairman of the Committee on Anthropology of the Polish Academy of Sciences (1965–71), president of the Polish Biometric Society (from 1963), editor-in-chief of the journal "Materiały i Prace Antropologiczne" (1956–71). He also edited "Mały słownik antropologiczny" (1969).

Wanke developed new taxonomic methods for typological analyses (Bielicki 1959): the stochastic multiple correlation method (Wanke 1953a), also known as the cube method, or the surplus method (cluster analysis method), and the so-called reference point method (Wanke 1953b), also known as "Wanke approximation"—an indicator of similarity for multiple comparisons. He also studied male body types, describing them with letters resembling their silhouettes: I, A, V, H, creating a system of human somatic typology. His students included Tadeusz Krupiński, Antoni Janusz, Tadeusz Bielicki, Zygmunt Welon, Zofia Szczotkowa, and Ewa Kolasa, who later became professors at Wrocław universities and research institutions.

From the time of Wrocław's incorporation into Poland, and throughout the 20th century, Wrocław anthropology was systematically developed in three units: (1) the Department of Anthropology at the University of Wrocław (subsequent directors: Karol Stojanowski, Adam Wanke, Wanda Stęślicka-Mydlarska, Tadeusz Krupiński), (2) the Anthropology Laboratory at the Physical Education Center (subsequent directors: Adam Wanke, Wojciech Kóčka) / the Department of Anthropology at the Higher School of Physical Education (subsequent directors: Wanda Stęślicka-Mydlarska, Aleksander L. Godlewski) / the Department of Anthropology and Biometry at the University of Physical Education (director: Antoni Janusz), and (3) the Department of Anthropology at the Polish Academy of Sciences (subsequent directors: Jan Mydlarski, Adam Wanke, Halina Milicer, Tadeusz Bielicki). This third department soon became the largest anthropological research center in Poland.

Following the breakup of the school of anthropological typology and the death of its main proponents (Jan Czekanowski and Ireneusz Michalski, both in 1965), research themes in the late 1960s and early 1970s underwent significant modifications. In Wrocław, the focus shifted to various auxological studies, developmental genetics and longitudinal twin studies, the variability

23 The Wrocław Physical Education Center was established in 1946 at the University's Faculty of Medicine. In 1950, all such institutions were transformed into separate three-year schools – Higher Schools of Physical Education, and then (in 1972) renamed Academies of Physical Education.

and genetics of anthroposcopic traits, human evolution, applied anthropometry, and, above all, "large-scale research on the relationship between social stratification and anthropometric measures became a specialty of Polish anthropology" (Kopczyński 2006: 34).

Figure 6. Anthropologists gathered for the ceremony of the award of the honorary doctorate by the University of Wrocław to Professor Jan Czekanowski (1962). From the left in the foreground: Jan Czekanowski and Tadeusz Bielicki, at the back right: Tadeusz Dzierżykray-Rogalski and Wanda Stęślicka-Mydlarska (Source: Wrocław archival materials)

Leading figures in Wrocław anthropology at the Polish Academy of Sciences in the second half of the 20th century were:

Tadeusz Bielicki (1932–2022) – Warsaw-born anthropologist, founder of a scientific school combining human biology and social sciences—factorial analyses of social stratification. He was a researcher at the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1956–2014) and its long-time director (1970–2001). He was deputy chairman of the Department of Biological Sciences of the Polish Academy of Sciences (1990–97), then its chairman (1999–2002), a corresponding member (1983), and then a full member of the Polish Academy of Sciences (1996), a corresponding member of the Polish Academy of Arts and Sciences (1997), and a member of the Presidium of the Polish Academy of Sciences (1999–2006). He was an honorary member of the Polish Anthropological Society (1999); and doctor *honoris causa* of the Józef Piłsudski University of Physical Education in Warsaw (2002).

As a 21-year-old student, in 1953, Bielicki was expelled from the University of Warsaw and spent six months in detention/in prison on Rakowiecka Street in Warsaw's Mokotów district on political charges. Barred from returning to the University of Warsaw, his academic career was linked to Wrocław. A student of Adam Wanke (PhD 1959), he began his scientific career by addressing a controversial issue in Polish anthropology at the time: the justification of the racial typology system formulated by the Lvov School of Anthropology, conducting a thorough critique of the typological concept of race (Bielicki 1961). A year-long Rockefeller Foundation postdoctoral fellowship (1959/60) at the University of California, Los Angeles (UCLA) with Professor Joseph B. Birdsell focused Bielicki's interests on population genetics (action of natural selection on head shape). The next direction of his research interests were issues related to human evolution ("Niektóre związki zwrotne w procesie ewolucji Hominidae" 1969), but he is best known for his anthropological studies of social stratification (biological effects of social stratification, secular changes depending on the standard of living of given social groups and indicators of biological well-being of the contemporary Polish population) (Kaszycka et al. 2022).

Tadeusz Bielicki was one of the co-authors of the UNESCO Statement on Race and Racial Prejudice (Moscow, 1964). He taught as a visiting professor at Washington State University (1967–68), at the Free University of Brussels (1989), and at the University of Texas at Austin (1991). He was an undisputed academic authority. He initiated and participated in numerous research programs, including longitudinal studies of Wrocław schoolchildren, longitudinal studies of Wrocław twins, genetic studies of families, studies of conscripts, cohort studies of child and youth development (the so-called anthropological photographs of the Polish population), and studies assessing the biological condition of the Wrocław population of working age. He was also founder and editor-in-chief of the Polish journal published in English "Studies in Physical Anthropology" (1975–90).

Zygmunt Welon (1924–2005) – born in Chita, Siberia, mathematician and anthropologist who worked at the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1957–2003). He was a student of Adam Wanke (PhD 1964). As a soldier in the Home Army, at the age of 20 (1944) he was arrested by the NKVD[24] and, after a year in prison, sent to work in Soviet and Georgian labor camps, from where he returned in 1948. He researched anthropometrics and ergonomics, the application of mathematics in anthropology, and the relationship between body type constitution and physical development. He is the author of the monograph: "Normy do oceny rozwoju fizycznego dziecka" (1984).

Barbara Hulanicka (1936–2022) – Vilnius-born anthropologist, researcher at the Department of Anthropology of the Polish Academy of Sciences in Wrocław (since 1961, acting director in 2005–06), and academic staff member at the Institute of Sociology of the University of Wrocław. She spent her childhood in Siberia and then, with other refugees, in Tehran. Honorary member of the Polish Anthropological Society (2013). Her research focused on the relationship between environmental factors and the course of ontogenetic development. Her research included the influence of upbringing in dysfunctional families on the age of menarche and the process of puberty in girls depending on different urban environments. She was also a pioneer of Polish knemometric[25] research. She co-authored the monograph: "Dziewczęta z Górnego Śląska: społeczne i ekologiczne uwarunkowania dojrzewania" (1994).

Paweł Bergman – born in Łódź in 1936, retired professor of anthropology. He was a researcher at the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1959–2005, and its director from 2002 to 2005) and at the Faculty of Physiotherapy at the Academy/University School of Physical Education in Wrocław (head of the Department of Human Biology from 1995 to 2003). He served as chairman of the Polish Anthropological Society (1987–99) and its honorary member (1999). He focused on clinical anthropology, the biology of human populations, and the genetics of human morphological traits. He

24 NKVD – Narodny Komissariat Vnutrennikh Del (People's Commissariat of Internal Affairs) – the political police of the USSR.

25 Knemometry – measuring the distance between the knee and heel of a sitting child/teenager using a special device – a knemometer.

conducted longitudinal studies of twins, anthropometric studies of rural and urban populations, and sports groups. He was co-author and editor of the monograph "Bliźnięta wrocławskie" (Vol. I, 1988 and Vol. II, 1995).

Leading figures in Wrocław anthropology at the Academy of Physical Education and the University of Wrocław in the second half of the 20th century were:

Antoni Janusz (1929–2019) – born in the village of Ptaszkowa (near Nowy Sącz, Lesser Poland Voivodeship), sports anthropologist. A student of Adam Wanke (PhD 1962). An academic at the Higher School/Academy of Physical Education in Wrocław (1954–2002), from 1969 to 2002 he headed the Department of Functional Morphology and then the Department of Anthropology and Biometry. Rector of the Academy of Physical Education (1981–82; removed from office by decision of the state authorities during martial law). From 2004–10 he was associated with the Polish-Czech College of Business and Sport "Collegium Glacense" in Nowa Ruda. Honorary member of the Polish Anthropological Society (2003). He explored the relationships between the anthropomorphology of the muscular system and body composition, the ontogenetic development of adolescents, and the morphological, physiological, and motor determinants of children's and adolescents' selection for sports. The editor and co-author of the monograph: "Populacja dzieci wiejskich w badaniach longitudinalnych" (three parts).

Tadeusz Krupiński (1930–2007) – anthropologist born in Łańcut (Subcarpathian Voivodeship). A student of Adam Wanke (PhD 1962). Academic teacher at the University of Wrocław (1956–2000), long-time head of the Department of Anthropology, University of Wrocław (1971–99) and Dean of the Faculty of Natural Sciences, University of Wrocław (four terms), member of the Primate's Social Council, chairman of the Committee on Anthropology, Polish Academy of Sciences (1990–93), head of the Department of Human Biology, University of Opole (1999–2002). Honorary member of the Polish Anthropological Society (2001). His research interests included morphology and human genetics (including racial differentiation in the Younger Paleolithic, and the variability and inheritance of auricle characteristics), the biology of prehistoric populations, ontogeny, and ergonomics. Along with an anatomist Zbigniew Rajchel, he was also a co-founder of the Wrocław school of reconstruction (Rajchel 1990), endeavoring to create anatomical reconstructions of the skulls of extinct hominids and primates (*Paranthropus*, *Oreopithecus*, and *Gigantopithecus*) based on fragments of skulls. He continued this work many years later with his daughter, Barbara Kwiatkowska, also an anthropologist, reconstructing, based on preserved skulls, the appearance during life of famous figures, including Duchess St. Hedwig of Silesia and Blessed Czesław. He was scientific editor of the University of Wrocław's publication, "Studia antropologiczne" (Antropological Studies) (1994–2001). His students who later became professors were Ewa Nowak and Bogusław Pawłowski.

Ewa Kolasa – born in Warsaw in 1937, retired professor of anthropology. A student of Adam Wanke (PhD 1966). She was an academic at the Department of Anthropology at the University of Wrocław (1963–2002). She researched human ontogenetic development and somatotypology. She is the author/co-author of the monographs: "Wiek menarchy a budowa fizyczna studentek wrocławskich w zależności od warunków środowiskowych" (1980) and "Dziewczęta z Górnego Śląska: społeczne i ekologiczne uwarunkowania dojrzewania" (1994).

Danuta Kornafel – born in Wrocław in 1949 anthropologist, and retired university professor. A student of Tadeusz Krupiński (PhD 1978). Academic staff member at: the Department of Anthropology, University of Wrocław (1972–2014), the Faculty of Physiotherapy, Academy of Physical Education in Wrocław (Head of the Department of Human Biology and Ecology 2000–05), and the University of Lower Silesia in Wrocław (2010–19). Chairperson of the Polish Anthropological Society (1999–2007) and its honorary member (2017). Her research interests included early human ontogeny – assessing the influence of factors modifying and stimulating the course of human development in the prenatal period and the role of parental, sociocultural, ecological, and ethnic factors differentiating the biological state (health) of newborns, as well as clinical anthropology – characterizing the psychophysical health of adults in terms of birth characteristics.

Krzysztof Borysławski – born in 1949 in Ostrowiec Świętokrzyski (Lesser Poland) anthropologist and retired professor at the University of Environmental and Life Sciences in Wrocław. A student at Tadeusz Krupiński (PhD 1978). An academic at the Department of Anthropology, University of Wrocław (1972–2009 and its head from 1999–2009), the Department of Anthropology, Wrocław University of Environmental and Life Sciences (2009–19 and its head from 2009–17), and since 2019 a lecturer at the Angelus Silesius Academy of Applied Sciences in Wałbrzych. His main scientific interests include human ontogenetic development (from the fetal period to late old age), the physiological basis of physical activity, issues of physical attractiveness, the demography of historical populations, and forensic anthropology.

The Łódź Center

The University of Łódź was established in May 1945, and in September of that year, the Department of Anthropology was established at the then Faculty of Mathematics and Natural Sciences, with Dr. Ireneusz Michalski, a student of Jan Mydlarski, appointed as its head. For a year, the department did not have its own premises, being then housed in the head's private apartment until 1950, when it obtained university facilities (Michalski 1959). Between 1945 and 1949, the newly established university saw rapid growth in its teaching and research staff and students, until the communists took over full power and the Ministry of Education's plan to divide the then Polish universities into three groups (1949). The Universities of Łódź, Lublin (UMCS), and Toruń (UMK) were included in the last, third group, the so-called small universities, which were to run only basic fields of study. As a result, the University of Łódź entered a period of deep crisis in the years 1949–52 – with the liquidation of faculties and the exodus of the cardinal; in addition, the ministry introduced strict limits on student admissions. The university's crisis lasted until 1956, when its scientific and teaching status was restored (Puś 2015).

In 1951, the Faculty of Biology and Earth Sciences was established at the University of Łódź, and in 1953, the Department of Anthropology was established within the faculty, with Professor Michalski appointed as its head. In 1957, the department was granted the right to specialize in anthropology within the biology program.

Ireneusz Michalski (1908–1965) – anthropologist born in Sosnowiec (Silesia), professor at the University of Łódź, specializing in human racial typology. He participated in work on the military anthropological photograph under the supervision of Jan Mydlarski. During World War II, he informally headed the anthropology unit at the State Archaeological Museum in Warsaw (1941–44) and lectured at the clandestine University of the Western Lands (1943–44). He organized and headed the Department of Anthropology at the University of Łódź (1945–65) and the Łódź Anthropological Expedition to Mongolia (1959). He compiled a table for determining eye color, consisting of 80 shades—several times more than the classic Martin scale. He founded the school of Łódź "morphologists," who opposed the "anthropostatisticians" (the school of Jan Czekanowski), with both sides of the dispute being contested by the "populationists" (Bielicki 1961, Bielicki et al. 1985, 1989). He authored the monograph "Struktura antropologiczna Polski" (1949). Michalski's students included the future professors Andrzej Wierciński and Zdzisław Kapica.

Figure 7. Employees of the Department of Anthropology, Faculty of Biology and Earth Sciences, University of Łódź (1958). From the left: ŁucjaRóżbicka, Zdzisław Kapica, Ireneusz Michalski, Henryk Stolarczyk, and the department secretary. (Source: Michalski 1959)

Following the death of Ireneusz Michalski (1965–67), Franciszek Wokroj – a professor at Adam Mickiewicz University in Poznań and a student of Jan Czekanowski (see *Poznań* section) – was the curator of the Department of Anthropology at the University of Łódź for two years. After a few years of discontinuation of the department's activities, and following Zdzisław Kapica's habilitation, he subsequently assumed the position of it head.

Zdzisław Kapica (1928–2013) – born in Łódź anthropologist specializing in human typological/racial diversity, head of the Department of Anthropology at the University of Łódź (1974–86 and 1987–89), organizer and participant in excavations of cemeteries in the Brześć Kujawski region and Przeczyce. Co-author of the monograph "Cmentarzysko kultury łużyckiej w Przeczycach, pow. Zawiercie, w świetle badań antropologicznych" (1971).

In 1990, the Łódź department was headed by another professor from Poznań University – Andrzej Malinowski (1990–98) (see *Poznań* section) – a student of Michał Ćwirko-Godycki and Franciszek Wokroj (preventing the closure of the Łódź center), and later a student of Ireneusz Michalski and Paweł Sikora – Henryk Stolarczyk.

Henryk Stolarczyk – born in 1935 in Widawa (Łódź Voivodeship) anthropologist, retired professor at the University of Łódź. An employee of the Department of Anthropology (1958–2005), participant of scientific expeditions of the University of Łódź to Equatorial Africa (1975, 1989), supervisor and participant of the Student Scientific Expedition to Peru (1978), head of the Chair of Anthropology at the University of Łódź (1998–2005), author of the monograph "Społeczne uwarunkowania rozwoju fizycznego dzieci i młodzieży szkolnej Łodzi" (1995).

The Białystok Center

Until 1949, Białystok had no scientific or academic traditions. The first university to be established there was the Private Evening Engineering School, followed shortly thereafter by the Medical Academy, established in February 1950. Anthropology in Białystok was established in 1950 at the Chair and Department of Human Anatomy of the Medical Academy, whose organization and management were entrusted to Tadeusz Dzierżykray-Rogalski from the Lublin center. Already in the 1950s, the department's team organized excavations related to the Białystok region, including an early medieval cemetery in the village of Czarna Wielka (director: Krystyna Modrzewska [see *The Lublin Center* section]) and a barrow burial ground of the Yotvingian people in the Suwałki region. The center's second research focus was anthropological and serological studies of the Kashubian population. At that time, Judyta Gładkowska and Irena Szewko (Dzierżykray-Rogalski 1959), later academics, worked as assistants in the department.

Tadeusz Dzierżykray-Rogalski (1918–1998) – Warsaw-born anthropologist, physician, and paleopathologist, associated with universities and research institutions in Lublin, Białystok, and Warsaw. He was a member of the Grey Ranks and the Union of Armed Struggle/Home Army. During the war, he was involved in helping the Jewish population, and was awarded the Righteous Among the Nations medal. He was the chairman of the Polish Anthropological Society (1956–84), initiator and editor of the society's quarterly "Człowiek w Czasie i Przestrzeni" (Man in Time and Space) (published 1958–64), editor-in-chief of "Przegląd Antropologiczny" (1978–84), and honorary member of the Société ďAnthropologie de Paris and the Polish Anthropological Society (1968).

He began his academic career at the Faculty of Natural Sciences, Maria Curie-Skłodowska University, in the department headed by Jan Mydlarski (1947–49). He then headed the Paleoanthropology Laboratory at the Medical Academy/University of Lublin (1949–52). From 1950–62, he organized and headed the Department of Human Anatomy at the Medical Academy/University of Białystok. From the 1950s, he was closely associated with the Polish archaeological community. He co-organized the excavations of Neolithic cemeteries in Stok and Las Stocki (Lublin Voivodeship, 1951) and the Comprehensive Yotvingian Expedition, whose work contributed to understanding the prehistory of the Balts (the Baltic Yotvingian tribe). He was also a member of the leadership of both Arab-Polish Anthropological Expeditions to Egypt (January 1958/59 and February 1962), researching the contemporary population of Egypt (over 2,000 people were measured) and skeletons from the cemetery on the Mountain of the Dead – Jebel el-Mauta, dated to ca. 1100–400 BC.

After leaving the Białystok University, Dzierżykray-Rogalski headed the Human Ecology Laboratory at the Department of Mediterranean Archaeology of the Polish Academy of Sciences (1962–82) and the Department of Anthropology at the Academy of Physical Education in Warsaw (1963–71). In 1982, he moved to the Department of Non-European Countries of the Polish Academy of Sciences. On behalf of the Polish Academy of Sciences, he undertook research on skeletal materials from a cemetery in Alexandria, Egypt, and, in collaboration with archaeologists (under Professor Kazimierz Michałowski), participated in an excavation expedition in Sudan. He identified the bones of medieval bishops from Faras, the present-day Pachoras (6^{th}–14^{th} centuries, Sudan, former kingdom of Nubia), which he brought to Poland in the 1960s for anthropological research (Dzierżykray-Rogalski 1985)[26], with their images from paintings that were removed from the cathedral walls as part of the International Campaign to Save the Monuments of Nubia (due to the construction of the Aswan Dam). His major publications: "Polska antropologia w Afryce" (1981), "The Bishops of Faras" (1985), co-author of the textbook "Zarys antropologii dla medyków" (1955). His students, later professors: Tamara Jelisiejew and Janusz Charzewski.

Judyta Gładkowska-Rzeczycka – born in Toruń in 1928 anthropologist and paleopathologist, and professor emeritus at the Academy/University of Physical Education and Sport in Gdańsk. A student of Jan Czekanowski (MA 1952) and Michał Reicher (MD 1964). She began her academic career at the Medical University of Białystok (1950s) and then moved to the Academy of Physical Education in Gdańsk, where she headed the Chair/Department of Anatomy and Anthropology. For years, she collaborated with archaeologists from the Archaeological Museum in Gdańsk. She organized

26 The bones of thirteen bishops/metropolitans from Faras, the Christian bishopric of Nobadia, brought to Warsaw (including Paulos, Mathaios, Ignatios, Kollouthos, Stephanos, Aaron, and Petros I) were buried quietly in 1994 at St. Vincent's Church in the Bródnowski Cemetery in Warsaw and described with the enigmatic inscription „Priestly Tomb" (Teler 2024). Some of the archaeological finds from Faras, including the cathedral wall paintings, can be seen in the Professor Kazimierz Michałowski Faras Gallery at the National Museum in Warsaw.

the paleopathological exhibition at the Medical Academy of Białystok (1978) and at the Archaeological Museum in Gdańsk (1989). An honorary member of the Polish Anthropological Society (1999), and author of the monograph "Schorzenia ludności prahistorycznej na ziemiach polskich" (1988).

The Toruń Center

In August 1945, a decree was issued establishing Nicolaus Copernicus University in Toruń, ending over 500 years of efforts to establish a university in the Pomeranian region. Its staff was largely composed of professors and academics from Stefan Batory University in Vilnius and Jan Kazimierz University in Lvov, who had come to Toruń after the resettlements. Initially, Nicolaus Copernicus University in Toruń had three faculties: the Faculty of Humanities, the Faculty of Mathematics and Natural Sciences, and the Faculty of Law and Economics. The period 1949–56 was a period of crisis for the Toruń university, as well as for the universities in Łódź and Lublin (UMCS), due to the imposition of the Soviet model on higher education institutions in Poland, but subsequent periods brought the university development.

The beginnings of anthropology in Toruń were associated with the Department of Human Anatomy and School Hygiene of the Faculty of Mathematics and Natural Sciences, whose head (1945–47) was Michał Reicher's student (see *The Vilinus Center* section) – anatomist and anthropologist Witold Sylwanowicz (1901–1975). However, Sylwanowicz soon left Toruń, being appointed head of the Department of Anatomy at the Medical Academy in Gdańsk.

In 1952, the Department of Human Anatomy was renamed the Department of Anthropology – for a period of several years (1951–55), upon request, Bronisław Jasicki from Kraków (see *Kraków* section) lectured there, and after his resignation in 1955, **Franciszek Wokroj** (Wokroj 1959) (see *Poznań* section), a student of Jan Czekanowski from the University of Poznań/Adam Mickiewicz University, was invited to organize the department, and who became the head of the Department of Anthropology at the Nicolaus Copernicus University in Toruń in the years 1956–61. For the following year, the Toruń department remained vacant until **Wanda Stęślicka-Mydlarska** from Wrocław (see *The Wrocław Center* section) was appointed to this position, heading the department in the years 1962–71, until Dr. Guido Kriesel completed his habilitation (Stęślicka-Mydlarska 1972).

Guido Kriesel – born in 1937 in Ugoszcz (a Kashubian village in the Pomeranian Voivodeship), retired professor of anthropology. An academic at the Nicolaus Copernicus University in Toruń since 1960, he served as head of the Department of Anthropology for over 35 years (1972–2007). Student of Jan Czekanowski at the University of Poznań (MA 1960) and of Wanda Stęślicka-Mydlarska at the Nicolaus Copernicus University (PhD 1965). He participated in and directed excavations at numerous cemeteries in Pomerania, Kuyavia, and Greater Poland, including the early medieval skeletal cemetery in Gruczno (Eastern Pomerania). He is an honorary member of the Polish Anthropological Society (2007). His primary interests were studies on skeletal series of prehistoric and historical populations, as well as on living populations, including children and adolescents from Toruń.

Professor Kriesel's successor at the Department of Anthropology at Nicolaus

Copernicus University was **Wiesław Buchwald**, an anthropologist born in 1948 in Ząbkowice Śląskie, a student of Kriesel (PhD 1980), and department head from 2007–14. He focused on morphological anthropology, human genetics, and living humans, particularly dermatoglyph studies. He is co-author of the monograph "Tablice asocjacji cech dermatoskopijnych rąk" (2013).

Postwar Activities of Pre-War Centers

Warsaw

The University of Warsaw reopened in December 1945, with a staff decimated by World War II and in a capital devastated by the Germans. The Chair of Anthropology was established at the then Faculty of Mathematics and Natural Sciences (later the Faculty of Biology and Earth Sciences). Initially vacant, with guest lectures by Jan Mydlarski, it would last only a dozen or so years. In 1946, Jan Czekanowski's student, Father Professor Bolesław Rosiński, was appointed assistant professor at the University of Warsaw and began its work.

Bolesław Rosiński (1884–1964) – priest and anthropologist born in Warsaw. He studied at the Universities of Munich and Lvov. He collaborated with Kazimierz Stołyhwo in the Society for Scientific Courses (from 1911), served as a lecturer at the University of Lvov (1921–39), and during World War II (1939–46) at the State Medical Institute in Lvov. He was a professor at the University of Warsaw (1946–53, and between 1948–53, head of the Chair of Anthropology), and, after retirement by the authorities, a professor at the Academy of Catholic Theology in Warsaw (1954–64), where he headed the Chair of Anthropology. His main research areas were human racial differentiation and population genetics—the influence of morphological traits on marital selection and research on Polish emigration in Texas.

In 1950, Dr. Aleksander Lech Godlewski and a student, Andrzej Wierciński, were employed at the Chair of Anthropology at the University of Warsaw. Following the retirement of Father Rosiński, Godlewski served as an associate professor at the Chair of Anthropology at the University of Warsaw from 1954 to 1958, and then as its acting head. However, when Godlewski moved to Wrocław in 1961, the authorities of the then Faculty of Biology and Earth Sciences dissolved the department, and its two-member young staff moved to the Chair of Prehistoric and Early Medieval Archaeology in the Faculty of History (Sołtysiak and Jaskulski 2000).

Aleksander Lech Godlewski (1905–1975) – Warsaw-born anthropologist and ethnographer. He began his career as a biology teacher, joined the Institute of Anthropological and Ethnological Sciences of the Warsaw Scientific Society in 1931, and embarked on an expedition to the Pacific Islands in 1938. During World War II, he lectured to clandestine classes. From 1950–61 he was an academic at the Department of Anthropology, University of Warsaw, and simultaneously (1955–61) at the Department of Anthropology, Academy of Physical Education in Warsaw, afterwards at the Chair of Ethnography, University of Wrocław (1961–75, its head from 1965), and at the Chair of Biological Sciences, Higher School/University of Physical Education in Wrocław (1961–69). He also lectured at the Academy of Catholic Theology in Warsaw, and in 1962–68, at the invitation of Adam Mickiewicz University in Poznań, he lectured on regional and ethnic anthropology. Honorary member of the Polish Anthropological Society (1975). His research focused on human racial diversity, the anthropological structure of Polynesians, the ethnogenesis of the peoples of Australia and Oceania, and the ethnography of religion. He authored several popular science books about his travels through the Polynesian islands.

Andrzej Wierciński (1930–2003) – born in Chorzów anthropologist, religious scholar, and cabalist. An employee and later professor at the University of Warsaw (he was employed as a student in 1950–52). Student of Father Bolesław Rosiński (MA 1951) and Ireneusz Michalski (PhD 1957). From 1976 to 2000, he headed the Department of Historical Anthropology at the Institute of Archaeology, University of Warsaw. He lectured (and from 1993, headed the Chair of General Anthropology) at the Jan Kochanowski Pedagogical University in Kielce, at the Institute of Religious Studies of the Jagiellonian University in Kraków (from 1983), and, as a visiting professor, at many universities abroad, including Turin, Paris, and the United States. Honorary member of the Polish Anthropological Society (1999).

While on a scholarship at Cairo University (1957–59), Wierciński co-organized the First Arab-Polish Anthropological Expedition to Egypt, and conducted fieldwork in Mexico (craniological studies of pre-Columbian Olemek people) and Poland, including at the medieval cemetery in Wiślica. In search of the "essence of humanity", in 1983 he established (together with his wife, Professor Alina Wiercińska [1931–2019]) the Multidisciplinary Team at the University of Warsaw and the State Archaeological Museum for the Study of the Peculiarities of the Human Species. For 20 years, this team's papers and discussion meetings, held as half-day conferences, brought together scientists from various disciplines. In 1996, he founded the annual "The Peculiarity of Man" (Kielce). Andrzej Wierciński was a colorful, exceptional man, with broad interests—from the exact sciences to the humanities. He focused on human racial diversity (PhD and habilitation), microevolutionary changes in Poland from the Neolithic to the Middle Ages, the ethnogenesis of the Slavs, predynastic Egypt, and pre-Columbian Mexico, the anthropology of religion, the theory of symbolization, and the theory of culture. His most important publications include "Magia i religia. Szkice z antropologii religii" (1994). His student, later professor was Mariusz Ziółkowski.

The second post-war anthropology department in Warsaw was the Department of Anthropobiology at the Academy/University of Physical Education (in 1954 divided into two independent departments), which was headed in 1947–49 by Jan Mydlarski (see *The Wrocław Center* section), and then by biologist Stanisław Bilewicz. Assistants in this department included: in the 1940s – Halina Milicer, a graduate of the Central Institute of Physical Education and the University of Warsaw and a student of Jan Mydlarski, and in the 1950s – Napoleon Wolański, a graduate of the University of Warsaw and a student of Father Rosiński (Pastuszak and Charzewska 2010).

Halina Milicer/ Milicerowa (1907–1995) – born in Szwarszowice (Kielce-Sandomierz region) anthropologist. She worked in various scientific institutions: at the Central Institute of Physical Education/Academy of Physical Education in Warsaw (employed four times for several years between 1931 and 1976; during the period of political repression in 1951 she had to leave the university), the State Office of Physical

Education and Military Training (1935–37), at the Maria Curie-Skłodowska University in Lublin (1945–47), at an institution operating under the auspices of the Ministry of Culture and Art called the Directorate for Research on the Origins of the Polish State (1951–53), at the Scientific Institute of Physical Culture in Warsaw (1953–71) – later incorporated into the Department of Anthropology of the Academy of Physical Education, and, as director, at the Department of Anthropology of the Polish Academy of Sciences in Wrocław (1965–68). Editor-in-chief of "Materiały i Prace Antropologiczne", honorary member of the Polish Anthropological Society (1975), doctor *honoris causa* of the Józef Piłsudski University of Physical Education in Warsaw (1992).

Her passion was working for the benefit of sport (Strojna 2023). Her research interests included the human body's response to physical exertion, the relationship between body composition and athletic performance, developmental norms, the genetic basis of physical fitness, and the impact of training on the human body. While working at the Polish Academy of Sciences, she conducted pioneering anthropological research on the social stratification of the Wrocław population (including studies on the relationship between the age of puberty in girls and sociocultural factors). In 1967, she initiated a longitudinal genetic study of Wrocław twins (the "Wrocław Twin Study"). She was also a pioneer of long-term research in sport and a proponent of interdisciplinary research, advocating for close collaboration between anthropologists and archaeologists. Her major publications include: "Crania Australica" (1955), a study of a series of early 20th-century skulls and skeletons from the collection of Herman Klaatch, and "Wiek menarchy dziewcząt wrocławskich w 1966 r. w świetle czynników środowiska zewnętrznego" (1968). Her students, later professors included: Anna Skibińska, Maciej Skład, Teresa Łaska-Mierzejewska, and Elżbieta Rogucka.

Teresa Łaska-Mierzejewska (1931–2016) – born in Łódź sports anthropologist, associated with the Academy/University of Physical Education in Warsaw from 1958 to 2001, where she started working in the Department of Anthropology of Biology and Medicine Chair. Student of Halina Milicer (PhD 1966). From 1962 to 1964, she conducted anthropological research on children and adolescents in Cuba (descendants of European settlers and African slaves). She lectured at the University of Havana (1962–64), at the Universities of Alcalá de Henares and Complutense in Madrid (1983–89), and at Mexican universities (1992). She focused on sports anthropology, examining somatic predispositions to the practicing of various sports, as well as the biological effects (particularly at menarche) of diverse living environments. Honorary member of the Polish Anthropological Society (2003). Author of the monographs: "Antropologia w sporcie i wychowaniu fizycznym" (1999) and "Antropologiczna ocena zmian rozwarstwienia społecznego populacji wiejskiej w Polsce, w okresie 1967–2001: badania dziewcząt" (2003).

Janusz Charzewski (1938–2003) – born in Rejowiec (Lublin Voivodeship, Chełm Land) anthropologist professionally associated with the Academy/University of Physical Education in Warsaw (1963–2003), serving as Head of the Department of Anthropology (1981–2003), as well as Director of the Institute of Biological Sciences (1983–91) and Chair of Biology and Medicine (1991–2003). Student of Tadeusz Dzierżykray-Rogalski (PhD 1967). Chairman of the Committee on Anthropology at the Polish Academy of Sciences (1993–2003), and corresponding member of the Warsaw Scientific Society (since 1994). He worked on topics of human development and the anthropology of sport, including aspects of social differentiation in the physical activity of children and adults. Author of the monograph "Społeczne uwarunkowania rozwoju fizycznego dzieci warszawskich" (1981), and co-author of textbooks: "Zarys antropologii dla studiujących wychowanie fizyczne" (1986), "Aktywność sportowa Polaków" (1997), and "Antropologia" (ed. 1999). Since 1998, as chairman of Committee of Anthropology of the Polish Academy of Sciences, he organized annual, cyclical workshop meetings at the Academy/University of Physical Education in Warsaw, which, after his death, were reconstituted as Anthropological Workshops named after him.

Anthropology in Warsaw was also developed in scientific and research institutes belonging to the Ministry of Health, such as the Institute of Mother and Child (IMD) (with which later professors – Napoleon Wolański and Jadwiga Charzewska – were associated), the Children's Health Centre (CZD), the Institute of Food and Nutrition (IŻŻ), and units of the Polish Academy of Sciences.

Napoleon Wolański (1929–2022) – born in Zapusta (Sandomierz Region) anthropologist, auxologist, and human ecologist. An employee of the Department of Anthropobiology at the Academy/University of Physical Education in Warsaw (1951–54) and then Head of the Department of Anthropology at this university for a year. He then headed the Department of Developmental Morphophysiology at the Institute of Mother and Child in Warsaw (1958–68), the Department of Human Ecology at the Institute of Ecology of the Polish Academy of Sciences (1969–99), and the Section/Department of Human Ecology at the governmental Center for Scientific Research and Postgraduate Studies CINVESTAV in Mérida, Mexico (1992–2005) (Wolański and Siniarska 2003). He was also associated with the Cardinal Stefan Wyszyński University in Warsaw, where, together with Anna Siniarska-Wolańska, he co-organized the establishment of the Institute of Ecology and Bioethics (2002).

Operating somewhat outside the mainstream of anthropology, Wolański was founder of Polish auxology. The author of the first post-war standards for the physical development of children and adolescents (1960–62), co-author of a method for assessing the psychomotor development of infants and a method for assessing nutritional status. He patented a device for measuring infants (liberometer) and developed two devices for spatial measurements of the spine. Honorary member of the Slovak (1965), Croatian (1978), and Polish (2001) Anthropological Societies, as well as the American Society for Human Ecology (1987). Full member of the Mexican Academy of Sciences (1994), President of the International Commission on Human Ecology of the IUAES and UNESCO (1985–2004). Organizer (since 1967) of the national seminars on morphology and developmental physiology in relation to motor activity and environmental influence. Founder and editor-in-chief of "Prace i Materiały Naukowe IMD" (Works and Scientific Materials of the Institute of Mother and Child) (1963–68) and "Studies in Human Ecology" (1973–99). Author/co-author of numerous books and monographs, including: "Metody kontroli i normy rozwoju dzieci i młodzieży" (1965, 1975), "Rozwój biologiczny człowieka" (8 editions, 1970–2012), "Czynniki rozwoju człowieka" (1972, 1981, 1987), "Biomedyczne podstawy rozwoju i wychowania" (1979, 1983), "Metody badań w biologii człowieka" (1988), "Ekologia człowieka"– 2 volumes (2006–2013).

A student, colleague, and later wife of Napoleon Wolański was **Anna Siniarska** (1952–2022), anthropologist and human ecologist born in Wolbórz (Łódź Voivodeship). She worked at the Institute of Ecology of the Polish Academy of Sciences (since 1980), the Center for Scientific Research and Postgraduate Studies in Mérida, Mexico (1992–2003), and the Cardinal Stefan Wyszyński University in Warsaw (2002–2022), serving as head of the Department of Human Ecology at the Faculty of Christian Philosophy, and then (from 2009) as head of the Department of Human Biology at the Faculty of Biology and Environmental Sciences at that university. Her research interests include assessment of changes in body size in the context of secular trends and socioeconomic inequalities, the relationships between neonatal birth parameters and maternal and environmental factors, and changes in the biological status and dynamics of the inhabitants of the Yucatan Peninsula.

Jadwiga Charzewska – born in 1937 in Warsaw, retired professor of anthropology at the Institute of Food and Nutrition. She began her scientific career as an employee of the Department of Developmental Morphophysiology at the Institute of Mother and Child (1960–68), and was then head of the Department of Epidemiology and Nutritional Standards at the Institute of Food and Nutrition (1968–2020). She also served as head of the Chair of Biology and Medicine and the Department of Anthropology at the Academy/University of Physical Education in Warsaw (2003–08), working at that university until 2017. Student of Bronisław Jasicki (PhD 1967). Recipient of a WHO scholarship at Cornell University, USA (1972). Expert in nutritional anthropology, focusing on the relationships between nutrition and physical activity on health and physical development, and has implemented grants from the European Commission and the National Institutes of Health, USA. Honorary member of the Polish Anthropological Society (2019). Author of the monograph "Społeczne uwarunkowania nadwagi i otyłości u mężczyzn zawodowo czynnych z Warszawy" (1985), co-author of book publications, including: "Społeczne uwarunkowania żywienia młodzieży w latach 1982–1991" and "Normy żywienia dla populacji Polski i ich zastosowanie" (ed. 2020).

Kraków

The liberation of Kraków from German occupation, as part of the Vistula-Oder Operation, took place in January 1945, and shortly thereafter, the staff of the Department of Anthropology Jagiellonian University reported to the university to take up their pre-war positions. The composition of the department's staff remained essentially unchanged: Kazimierz Stołyhwo remained head of the department and chair (see *The Kraków Center* section), Eugenia Stołyhwo became a full-time associate professor, Bronisław Jasicki became an adjunct professor, and Paweł Sikora became an assistant professor. One of the leading topics studied at the department became human ontogenetic development, and another was the methodology of material analysis.

Eugenia Stołyhwo/ Stołyhwowa (1894–1965) – Warsaw-born anthropologist, professor at the Jagiellonian University and the Higher/University School of Physical Education in Kraków (its first rector from 1950 to 1955). She began working in 1921 at the Institute of Anthropological Sciences of the Warsaw Scientific Society, collected data at the Musée d'Histoire Naturelle in Paris (in 1930) and at the United States National Museum in Washington[27] with Aleš Hrdlička, the famous Czech-American anthropologist (in 1933), and was the director of anthropological research on the First Arab-Polish Anthropological Expedition to Egypt (1958/59). In the postwar period, she worked at the Jagiellonian University and the Higher School of Physical Education in Kraków, and after Kazimierz Stołyhwo's retirement, she headed the Department of Anthropology at the Jagiellonian University (1960–64). She was an activist in the Polish Socialist Party (PPS), then the Polish United Workers' Party (PZPR), from which she left in 1956.

She researched anatomical and morphological topics (including hyoid bone dimorphism), racial issues (including facial prognathism in the context of racial differentiation), the relationship between constitution, racial characteristics, and the location of cancer processes, the impact of sport on the human body, the influence of maternal age on the development of daughters, and the influence of environmental factors on the personal development of children and adolescents. In the 1930s, together with her husband – Professor Kazimierz Stołyhwo, she developed the "correlation cross-section method" for distinguishing racial types (Jasicki 1957). Author of the book "Nasi prarodzice" (1948), initiator, co-author and scientific editor of the textbook "Zarys antropologii" (1962).

Figure 8. In Professor Stołyhwo's office at the Department of Anthropology, Faculty of Biology and Earth Sciences, Jagiellonian University in Kraków (1959). From the left: Bronisław Jasicki, Eugenia Stołyhwo, Kazimierz Stołyhwo, Paweł Sikora) (Source: Archives of the Department of Anthropology, Jagiellonian University)

27 Now the Smithsonian National Museum of Natural History.

Bronisław Jasicki (1907–1992) – born in Sporysz (now a district of Żywiec) anthropologist, professor at the Jagiellonian University and the Higher/University School of Physical Education in Kraków (WSWF). From 1951 to 1955 he lectured at the Nicolaus Copernicus University in Toruń. Student of Julian Talko-Hryncewicz (PhD 1931). He began his academic career at the Jagiellonian University in Kraków, from 1954 to 1965 was the first head of the Chair of Biology and Anthropology at the Higher School of Physical Education in Kraków, and in 1959, was elected rector of the university. After the death of Eugenia Stołyhwo, he resigned from the WSWF and took up the headship of the Department of Anthropology at the Jagiellonian University (1965–76). Honorary member of the Slovenian and Polish Anthropological Societies (1971).

Most of Jasicki's scientific work was devoted to human ontogenetic research – primarily on Kraków youth, as well as the morphological diversity of modern humans. He was particularly interested in changes in body proportions and weight associated with the pre-pubertal period and the phenomenon of secular trend. He participated in two Arab-Polish Anthropological Expeditions to Egypt (1958/59 and 1962), where he studied Egyptian youth and adults. He directed the anthropological survey of Silesia and organized (from 1962) periodic – every 10 years – studies of children and youth in the Żywiec region, which later led to the publication of a monograph dedicated to him, "Dziecko żywieckie" (2005), presenting the results of 40 years of research at the institute. His achievements also include works on the dynamics of boys' growth, and he co-authored the textbook "Zarys antropologii" (1962). Students, later professors, included Jadwiga Charzewska.

Paweł Sikora (1912–2002) – born in the village of Nawsie in Cieszyn Silesia (known as Zaolzie, now the Czech Republic) anthropologist and professor at the Jagiellonian University. Student of Kazimierz Stołyhwo (PhD 1949). After graduating from the Jagiellonian University, during World War II and the occupation he worked in the serum and vaccine production plant of the Polish bacteriologist, Professor Odo Bujwid in Kraków. From 1946 he was an academic teacher at the Jagiellonian University, and from 1976–82 was head of the Chair of Anthropology at the Jagiellonian University. Honorary member of the Polish Anthropological Society (1975). He researched human ontogeny, including the variation of head size with age and the age of menarche in girls depending on the socioeconomic situation, as well as historical anthropology. Based on his research conducted in 1957–58 in the village of Żmiąca in the Beskid Wyspowy Mountains, he was the first to draw attention to social stratification (Kaczanowski 2008). Participant of the 2nd Arab-Polish Anthropological Expedition to Egypt, author of the publication "Zdjęcie antropologiczne Śląska. Powiat Tarnowskie Góry" (1956), co-author of the textbook "Zarys antropologii" (1962). His students, later professors, included Jan Szopa and Henryk Stolarczyk.

In addition to the Department of Anthropology at the Jagiellonian University, the second anthropological institution in Kraków was the aforementioned Department of Anthropology of the Chair of Biology and Anthropology at the Higher School of Physical Education (now the Academy/University of Physical Culture in Kraków), established in the 1953/54 academic year. The first head of that chair was Bronisław Jasicki of the Jagiellonian University (1954–65), followed by Stanisław Panek. Following structural changes in the 1970s and the establishment of institutes, Zofia Bocheńska was entrusted with the management of the Department of Human Morphology, and subsequently of the Department of Anthropology and Anatomy.

Stanisław Panek (1916–1999) – born in the village of Lutcza in the Rzeszów Region, sports anthropologist and professor at the Kraków Academy/University of Physical Education. Student of Eugenia Stołyhwo (PhD 1965). An officer of the Home Army, he was arrested by the NKVD and imprisoned in Siberian labor camps (1944–47). From 1949, he was an academic teacher at the Physical Education Center at the Faculty of Medicine of the Jagiellonian University, which in 1950 was transformed into an independent Higher/University School of Physical Education. Head of the Chair of Biology and Anthropology at this university (1965–71), dean of the Faculty of Physical Education (1960–61), rector of the Kraków Academy/University of Physical Education (1968–79). Honorary member of the Polish Anthropological Society (1990), and doctor *honoris causa* of the Academy of Physical Education in Kraków (1996). Co-founder of the science of physical culture. His primary research interests were human development, taking into account the influence of socio-economic factors, and the biological foundations of physical education and sport. He co-authored the textbook "Zarys antropologii" (1962) and the monograph "Nowa Huta. Integracja ludności w świetle badań antropologicznych" (1971). His students, who later became professors, included Stanisław Gołąb and Maria Chrzanowska.

Zofia Bocheńska (1922–1994) – born in Krzemieniec, Volhynia (present-day Ukraine) anthropologist, professor at the Academy/University of Physical Education in Kraków. Student of Adam Wanke (PhD 1963). In the years 1948–51 she was an assistant at the Kraków Physical Education Center at the Jagiellonian University, and then an academic teacher at the Academy of Physical Education in Kraków (1954–92), head of the Department of Anthropology and Anatomy (1971–81), and director of the Institute of Biological Sciences (1981–84). She researched human ontogeny, the inheritance and differentiation of dermatoglyphic features of the hand, and the influence of athletic activity on body build (Budkiewicz and Chrzanowska 1995). Author of the monograph: "Zmiany w rozwoju osobniczym człowieka w świetle trendów sekularnych i różnic społecznych" (1972).

Following the retirement of the founders of the Kraków School of Anthropology: Julian Talko-Hryncewicz, Kazimierz Stołyhwo, and then their students and successors: Eugenia Stołyhwo, Bronisław Jasicki, and Paweł Sikora – from generations born before Poland regained independence, in 1982 the Chair of Anthropology at the Jagiellonian University was taken up by Krzysztof Kaczanowski, a student of Bronisław Jasicki and Paweł Sikora. Stanisław Panek's successors at the Kraków Academy/University of Physical Education were Stanisław Gołąb and Maria Chrzanowska.

Krzysztof Kaczanowski (1938–2016) – Warsaw-born anthropologist, academic teacher at the Jagiellonian University in Kraków (since 1962), long-time head of the Department of Anthropology at the Jagiellonian University (1982–2008), head of the Department of Anthropology and Anatomy at the Academy of Physical Education in Katowice (1992–2001), chairman of the Committee on Anthropology of the Polish Academy of Sciences (2004–10) and of the Anthropological Commission of the Polish Academy of Arts and Sciences (2011–16). Honorary member of the Polish Anthropological Society (2007).

He studied contemporary and historical populations. His research focused on paleodemography and the anthropological structure of historical populations in Kraków and southern Poland. He conducted research on cremation and skeletal cemeteries, including: The Upper Paleolithic Baczo Kiro Cave, the Bronze Age necropolis (Iwanowice) to 17th-century necropolises, as well as the anthropological structure of Greek settlers from the 6th–4th centuries BC on the Black Sea in Ukraine. He also dealt with ontogeny, taking into account environmental factors, conducting research on children, adolescents and adults from Żywiec and the Żywiec region, and the population of the Polish Spiš (a small ethnographic and geographical region located in the Western Carpathians). He also initiated and organized research on children and adolescents in the vicinity of the Katowice Steelworks. Major works include: "Dziecko żywieckie" (ed. 2005), "Ludność polskiego Spiszu w świetle badań antropologicznych" (2015). His student, later professor, was Krzysztof Szostek.

Stanisław Gołąb (1936–2019) – Kraków-born anthropologist, academic teacher at the Higher School of Physical Education/Academy of Physical Education in Kraków (since 1958). Student of Stanisław Panek (PhD 1965). Head of the Department of Anthropology (1981–99) and head of the Chair of Anthropology and Anatomy at the Academy/University of Physical Education (1985–2006). Between 1981 and 1984 he was dean of the Faculty of Physical Education, and between 1984 and 1987 and 1993–96 he was vice-rector for science. He focused on the biological and social determinants of the physical development of children, adolescents, and adults. Co-author of the monographs: "Dziecko krakowskie" (1988), "Biologiczne i społeczne uwarunkowania zmienności przebiegu rozwoju fizycznego dzieci i młodzieży z Nowej Huty (wyniki badań ciągłych)" (1993), and "Dziecko krakowskie 2000" (2007).

Maria Chrzanowska (1938–2021) – born in Lipusz (a Kashubian village in the Pomeranian Voivodeship) anthropologist, since 1966 an academic teacher at the Higher School/Academy of Physical Education in Kraków. From 1999 to 2008, she headed the Department of Anthropology at the Academy of Physical Education in Kraków, and was professor and head of the Department of Biomedical Sciences at the Institute of Physical Culture at the State Higher Vocational School in Nowy Sącz (2004–2021). She researched body posture, the biological consequences of urbanization and industrialization on individual development, and the biological development of children and adolescents with varying levels of physical fitness, and developmental changes and determinants of body fat levels. Author of the monograph "Biologiczne i społeczno-ekonomiczne determinanty rozwoju podskórnej tkanki tłuszczowej u dzieci i młodzieży" (1992), and co-author of: "Dziecko krakowskie" (1988), "Dziecko krakowskie 2000" (2007).

Poznań

The University of Poznań resumed its activities in April 1945, immediately after the city's liberation. Later that same year, the Chair of Anthropology was established at the Faculty of Medicine (at Professor Adam Wrzosek's reactivated Department of Anthropology), with Professor Jan Czekanowski appointed as its head in 1946, and Franciszek Wokroj, a student of Czekanowski, as an assistant professor in 1945. In 1947, after Wrzosek's forced retirement, Czekanowski transferred the Chair (along with its staff and assets) from the Faculty of Medicine to the Faculty of Mathematics and Natural Sciences. The founders of the Poznań Chair of Anthropology deeply regretted the decision to transfer the department from one faculty to another. As Professor Michał Ćwirko-Godycki (1958) wrote:

> *In 1947, the Faculty of Medicine lost its chair and its wonderfully organized department, while the Faculty of Mathematics and Natural Sciences, without any effort, gained a chair and a department that it had never been able to organize on its own.*
>
> (Godycki 1958: 18)[28]

Jan Czekanowski (1948a), in turn, spoke rather harshly of the Poznań center in the interwar period, accusing it of having a very broad, and, in his opinion, uncrystallized, scope of interest, which, in his opinion, did not deserve to be called a separate school. On another occasion, however, Czekanowski (1948b) praised the Poznań center for its strong organization and focus on research on children and work at the intersection of anthropology and medicine. In 1960 Professor Czekanowski retired, and from that year, at Czekanowski's request, Franciszek Wokroj became the head of the chair.

Franciszek Wokroj (1906–1991) – Lvov-born anthropologist, student of Jan Czekanowski (PhD 1946), and follower of the Lvov school of anthropology. He worked briefly at the University of Lvov (1937–41), and was associated with the Department of Anthropology of the Poznań University/Adam Mickiewicz University from 1945 to 1972. In 1956, he was promoted to the rank of associate professor without having completed the habilitation procedure[29]. He participated in the First Arab-Polish Anthropological Expedition to Egypt (1958/59). He served as head of the Chair of Anthropology at Adam Mickiewicz University (1960–66), and subsequently as head of one of its two departments – the Department of Regional and Ethnic Anthropology (1967–69). He organized the Department of Anthropology at the Nicolaus Copernicus University in Toruń (1956–61), and for two years after the death of Ireneusz Michalski (1965–67) he served as curator of the Department of Anthropology at the University of Łódź. A life and honorary member of the Polish Anthropological Society (1984).

In 1946, Wokroj became a delegate of the Ministry of Education, representing the Department of Restitution and Compensation, and transported the collections of the University of Lvov, including most

28 Jan Czekanowski in the 1920s did not want to accept the Chair of Anthropology at the Faculty of Mathematics and Natural Sciences of the University of Poznań that was offered to him at that time.

29 In the years 1952–56, the Act of 15 December 1951 on Higher Education and Research Workers was in force, in connection with which habilitation was not required when applying for the degree of associate professor, and the appointment to the position of independent research worker was decided by the appropriate bodies in the Ministry of Higher Education.

of Professor Czekanowski's book collection, from the then Ukrainian city of Lvov to Poznań. Collaborating with archaeologists, he participated in excavations in Kruszwica, Gniezno, and Biskupin. He subsequently organized numerous excavations himself: Młynówka, Góra Chełmska, Łowyń, Kołobrzeg–collegiate church, and Cedynia (Malinowski 1993, 2008). He analyzed early medieval craniological materials from Ostrów Lednicki (Wokroj 1953), including those from the excavations of Adam Wrzosek and Michał Ćwirko-Godycki. His students, later professors were: Andrzej Malinowski, Janusz Piontek, and Czesław Grzeszyk.

The 1920s to the 1970s saw a time of "ups and downs" for Poznań's university anthropology. Over its 50 years of operation, it changed headquarters four times, from a department to a chair, then to a section, only to return to department status (in 1987, it would become an institute). In 1965, professors emeritus Adam Wrzosek and Jan Czekanowski died—two outstanding figures in the world of anthropology. In 1969, the Adam Mickiewicz University faculty authorities did not extend Michał Ćwirko-Godycki's right to continue to head the chair due to his age (he was over 65), and they did not want to rehire Wokroj in that position. Therefore, the Chair of Anthropology and both departments were dissolved, and the Section of Anthropology was established in their place, even though Professor Ćwirko-Godycki retired only in 1971 (remaining at the faculty as a private employee).

Figure 9. Professor Ćwirko-Godycki surrounded by his students and other young anthropologists of the Department of Anthropology, Faculty of Biology and Earth Sciences, Adam Mickiewicz University in Poznań (1972). From the left, sitting: Andrzej Malinowski, Maria Danuta Kaliszewska-Drozdowska, Michał Ćwirko-Godycki, and Jan Strzałko; standing: Joachim Cieślik and Janusz Piontek (Source: Przegląd Antropologiczny vol. 47)

Despite these turmoils, beginning in the 1970s, anthropology in Poznań entered a period of very dynamic development. Its energetic, enthusiastic, and innovative young graduates undertook research on various aspects of the so-called New Physical Anthropology or continued the work initiated by Professor Michał Ćwirko-Godycki. These included: (1) Research on skeletal populations, including paleodemography and microevolution (Jan Strzałko, Janusz Piontek, Maciej Henneberg); (2) Research on human ontogeny (children's growth and physical development), including the construction of "developmental norms" (Andrzej Malinowski, Maria Danuta Kaliszewska-Drozdowska, Joachim Cieślik [Maria Kaczmarek would later join the team of "ontogeneticists"]); (3) Applications of anthropology in forensic medicine (A. Malinowski, J. Strzałko, J. Piontek) and (4) Studies on the morphogenesis of the skull and the influence of the masticatory muscles on its shape (A. Malinowski, J. Strzałko) (Malinowski 1973).

Soon, the Department of Anthropology at Adam Mickiewicz University in Poznań would become the largest anthropological academic center in Poland – the next "capital" of anthropology, after Wrocław. Professor Ćwirko-Godycki's work at the Poznań University of Physical Education was continued by Zbigniew Drozdowski.

Zbigniew Drozdowski (1930–2004) – born in Sieraków (Greater Poland Voivodeship) anthropologist, academic teacher at the Higher School/Academy of Physical Education in Poznań (1952–2001) and the University of Szczecin (1985–93). As a student of both Jan Czekanowski (MA 1952) and Michał Ćwirko-Godycki (PhD 1960), he attempted to combine the concepts of Czekanowski's Lvov School with the assumptions of the Poznań center presented by Wrzosek and Ćwirko-Godycki (Drozdowski 1985), linking anthropology with physical culture. He focused on the anthropology of sport, including physical culture methodology, the theory of athletic performance, human motor skills and their measurement, the chronobiological foundations of physical activity, and the determinants and effects of human athletic and professional activity. From 1953, he was a member/activist of the Polish United Workers' Party.

For 34 years (from 1967) he was head of the Department of Anthropology/Sport Anthropology, then (from 1991) head of the Chair of Anthropology and Biometry at the Faculty of Physical Education, Academy/University of Physical Education in Poznań; vice-dean, dean, vice-rector, and rector of the Academy of Physical Education in Poznań (1975–98). Organizer and head of the Laboratory of Anthropology and Biometry at the Faculty of Physical Education in Gorzów Wielkopolski, head of the Department of Anthropology at the Faculty of Natural Sciences, University of Szczecin. Member of: the Committee on Anthropology of the Polish Academy of Sciences (its chairman from 1975 to 1987), the Main Council for Science and Higher Education (including its vice-chairman), the Committee on Physical Culture Sciences of the Polish Academy of Sciences (including its chairman), and the Central Commission for Academic Titles and Academic Degrees. Honorary member of the Polish Anthropological Society (1979), and doctor *honoris causa* of the Academy/University of Physical Education in Wrocław (1998) and the Academy/University of Physical Education in Poznań (2003). He published numerous monographs and textbooks for students, including: “Antropologia sportowa” (1984), “Antropologia a kultura fizyczna” (1996), and “Antropometria w wychowaniu fizycznym” (1998).

Leading figures in the Poznań University Department / Institute of Anthropology were:

Andrzej Malinowski (1934–2023) – Poznań-born anthropologist, academic teacher at the Adam Mickiewicz University in Poznań (1962–65 and 1972–92), the Department of Anatomy at the Poznań Medical Academy (1965–72), the Independent Laboratory of Anthropology at the Academy of Physical Education in Gdańsk (1985–87), the University of Łódź (1990–98), the Chair of Physical Education at the Higher Pedagogical School/University of Zielona Góra (1998–2005), and the Chair of Physical Culture at the Radom University of Technology (2009–11). Student of Michał Ćwirko-Godycki (MA 1962) and Franciszek Wokroj (PhD 1967). Head of departments of: Anthropology at Adam Mickiewicz University and the University of Łódź, Ergonomics and Applied Anthropology at Adam Mickiewicz University, and Physical and Health Education at the University of Łódź. Dean of the Faculty of Biology and Earth Sciences at Adam Mickiewicz University (1981–84), Director of the Institute of Anthropology at Adam Mickiewicz University (1987–89). Chairman of the Polish Anthropological Society (1984–87), and its honorary member (2003), honorary member of the Yugoslav Anthropological Society (1996).

His research interests included human ontogeny (prenatal development, child and adolescent development, and developmental norms), morphological and historical anthropology (including studies of bones from cremation graves), anatomy, applied anthropology in medicine, ergonomics (standardized foot and hand measurements), and physical education, as well as the history of anthropology in Poland. He participated in excavations (Góra Chełmska, Kołobrzeg Collegiate Church, Posada Rybotycka) and in exhumation and identification studies of victims of German crimes from World War II in the Palędzie forests near Poznań. He held research internships and conducted research and lectures in Bulgaria, the republics of the then USSR (Russian, Ukrainian, Lithuanian and Belarusian), and in Yugoslavia, and Czechoslovakia. He strived to establish the position of Polish biological anthropology among the academic scientific disciplines. Author/co-author/scientific editor of numerous books, monographs, and textbooks, including: “Antropologia fizyczna” (1980), “Antropologia” (1985, 1989), “Metody badań w biologii człowieka” (1988), “Wstęp do antropologii i ekologii człowieka” (1994, 1999), “Auksologia: Rozwój osobniczy człowieka w ujęciu biomedycznym” (2004, 2007, 2009), and the series of monographs: “Dziecko poznańskie” (1976), “Dziecko wielkopolskie” (1978), “Dziecko konińskie” (1989), “Dziecko łódzkie” (1998), “Dziecko lubuskie” (2005). His students, later professors included Joachim Cieślik, Maria Kaczmarek, and Elżbieta Żądzińska.

Jan Strzałko (1943–2016) – born in the Eastern Borderlands in Kleck, Nieśwież County (now Belarus) anthropologist and human ecologist, academic teacher at Adam Mickiewicz University in Poznań (1965–2016). A student of Michał Ćwirko-Godycki (PhD 1968). Participant in the Poznań scientific expedition to the Rwenzori Mountains and Mt. Kenya (1974). First dean of the newly established Faculty of Biology at Adam Mickiewicz University (1984–85; his term of office was interrupted due to the political vetting of academic staff), head of the Department of Anthropology at the Faculty of Biology at Adam Mickiewicz University (1984–87), creator and head of the Department of Human Population Ecology at the Institute of Anthropology (1987–2012), vice-rector for research at Adam Mickiewicz University (1990–96). Editor-in-chief of "Przegląd Antropologiczny – Anthropological Review" (1987–2011). An award granted by the Polish Society for Human and Evolution Studies is named after him (the Professor Jan Strzałko Award for an outstanding young scientist).

In the early years of his scientific career, Jan Strzałko was primarily interested in the morphology and morphogenesis of the human skeleton, including factors influencing skeletal variability, and muscle function. His second research focus (primarily in the 1970s and 1980s) was the methodology of research on so-called prehistoric populations—bone materials from excavations at various anthropological and archaeological sites in Poland (both cremated and skeletal). His third research interest was human population ecology, focused on determining the influence of natural and social factors on human populations and the relationships between biological and cultural evolution. His fourth research project (1980s and 1990s) was focused on the biological foundations of human social behavior—physical attractiveness and sexual selection, demonstrating that the most beautiful is the "average". Finally, his last research topic (starting from the 2000s) was the problem of human "races", racial stereotypes and xenophobia (Kaszycka 2016a, 2016b).

Professor Strzałko had a wide range of interests (from biology and statistics to literature) and vast knowledge. His scientific accomplishments include authorships of manuals, textbooks, dictionaries, and encyclopedias, of which he was a co-author and often an editor, including: "Wstęp do ekologii populacyjnej człowieka" (1976), "Antropologia fizyczna" (1980), "Populacje ludzkie jako systemy biologiczne" (1980), "Antropologia" (1985, 1989), "Ekologia populacji pradziejowych" (1990), "Ekologia populacji ludzkich. Środowisko człowieka w pradziejach" (1995), "Kompendium wiedzy o ekologii" (1999, 2005), "Słownik terminów biologicznych" (2006). He was also the managing and scientific editor of the first Polish translation of the American textbook "Campbell's Biology" (2012).

Maria Danuta Kaliszewska-Drozdowska (1941–2003) – born in the village of Lipa (on the border of the Lublin and Subcarpathian Voivodeships, where her family was relocated from Września) anthropologist, academic teacher at Adam Mickiewicz University in Poznań (1964–2001). Student of Michał Ćwirko-Godycki (PhD 1970). Deputy director of the Institute of Anthropology at Adam Mickiewicz University (1987–93). She specialized in human ontogeny, with particular emphasis on the prenatal, perinatal, and neonatal periods. She compiled "developmental norms" for newborns and small children based on Polish material and was a co-author of several monographs in this field: "Dziecko poznańskie" (1976 and 1994) and "Dziecko wielkopolskie" (1978), author of "Stan biologiczny i akceleracja rozwoju noworodków" (1980), and co-author of the textbooks "Antropologia fizyczna" (1980) and "Antropologia" (1985, 1989).

Janusz Piontek – born in 1945 in Dąbrowa (near Poznań), professor emeritus of anthropology at Adam Mickiewicz University in Poznań (1967–2019), lecturer in the Department of Human Biology at the University of Wrocław (2009–12), visiting professor at the Universidade de Santiago de Compostela, Spain (1987–89). Student of Franciszek Wokroj (PhD 1970). Founder and head of the Department of Human Evolutionary Biology (1987–2017), long-time director of the Institute of Anthropology at Adam Mickiewicz University (1990–2016), dean of the Faculty of Biology at Adam Mickiewicz University (1992–96). Honorary member of the Croatian Anthropological Society (2016) and the Polish Anthropological Society (2019). He has studied microevolutionary processes, the biology and ecology of prehistoric and early historical populations, changes in the human skeletal system following the transition to agricultural farming, morphological responses to living conditions in populations from archaeological sites, and the methodology of research on human skeletal remains. He is co-author of monographs and textbooks: "Wstęp do ekologii populacyjnej człowieka" (1976), "Procesy mikroewolucyjne w europejskich populacjach ludzkich" (1979), "Antropologia fizyczna" (1980), "Populacje ludzkie jako systemy biologiczne" (1980), "Antropologia" (1985, 1989), and "Biologia populacji pradziejowych" (1996).

Joachim Cieślik – born in 1942 in Piekary Śląskie, professor emeritus of anthropology at Adam Mickiewicz University in Poznań (1969–2016), lecturer at the Academy/University of Physical Education and Sport in Gdańsk (1987–97), visiting professor at the Université de Batna, Algeria (1982) and the Université de Renes, France (1990). Student of Andrzej Malinowski (PhD 1973). He completed a postdoctoral fellowship at the University of Paris VII (1974/75). Founder and head of the Department of Human Biological Development (1987–2012), vice-dean of the Faculty of Biology, vice-rector of Adam Mickiewicz University for student affairs (1996–2002). Chairman of the Committee on Anthropology of the Polish Academy of Sciences (2012–15). Honorary member of the Polish Anthropological Society (2019). He has studied human ontogenetic development, norms and normality as a "biological frame of reference", and auxology in its broadest sense. Author of the monograph "Wielopoziomowy rozwój fenotypowy populacji i osobnika w ontogenezie" (1980), co-author of the monographs "Dziecko poznańskie" (1976 and 1994) and "Dziecko wielkopolskie" (1978), as well as the textbooks "Antropologia fizyczna" (1980) and "Antropologia" (1985, 1989).

Maciej Henneberg – born in Poznań in 1949 anthropologist, academic teacher at Adam Mickiewicz University in Poznań (1973–84), professor emeritus at the University of Adelaide. He received his doctorate (1976) under Jan Strzałko. Chairman of the NSZZ "Solidarność" of Adam Mickiewicz University Trade Union Committee (1980–81). On December 13th, 1981, following the imposition of martial law in Poland, the aim of which was to suppress the Solidarity movement, he was placed in an internment center for opposition activists. In 1984 he emigrated from Poland, traveling successively across three continents: from North America (University of Texas at Austin, USA, 1984–86), through Africa (University of Cape Town, 1986–90, and the University of the Witwatersrand in Johannesburg, 1990–95), to Australia (University of Adelaide, 1996–2021).

Honorary member of the Polish Anthropological Society (2001), doctor *honoris causa* of the University of Łódź (2023).

Expert in paleodemography, paleopathology, auxology, forensic science, and human anatomy and evolution, science popularizer. He has conducted excavations in Poland, Texas, South Africa, and Italy (Metaponto), as well as longitudinal studies of child development in South Africa and Australia. Formerly, editor of the journal "Homo–Journal of Comparative Human Biology." He is the co-author of numerous books and monographs, including "Wstęp do ekologii populacyjnej człowieka" (1976), "Populacje ludzkie jako systemy biologiczne" (1980), "Antropologia" (1985 [under his wife's maiden name] and 1989), and the popular science book "The Hobbit trap" (2008, 2012).

Polish Anthropological Society and Przegląd Antropologiczny/ Anthropological Review

Professor Adam Wrzosek, recognizing the enormous importance of scientific publishing for the development of every scientific discipline, in the early 1920s raised the issue of publishing an anthropological periodical and creating an organization that could both coordinate the work of existing anthropological institutions and promote and disseminate knowledge in the field of anthropology among specialists in other scientific fields and broader segments of society in Poland. After the initial failure (owing to financial reasons) to publish only a single issue of "Wiadomości Antropologiczne" (Anthropological News), Professor Wrzosek decided to establish the Anthropological Society, whose primary statutory goal would be to "contribute to the development of anthropology" by, among other things, "supporting anthropological publications." He put his resolve into action, and the Polish Anthropological Society was thus established (Dzierżykray-Rogalski 1973, Godycki 1976).

The Polish Anthropological Society (PAS) was founded at a meeting on November 12, 1925, in the presence of a dozen or so founding members, all academics from the University of Poznań. A statute (modeled on the statute of the Polish Prehistoric Society) was adopted and a board elected, consisting of Professor Adam Wrzosek (chairman), Professor Adam Wodziczko (vice-chairman), Doctor Włodzimierz Missiuro (secretary and treasurer), and Doctor Michał Ćwirko-Godycki (deputy secretary and treasurer). In the following years, the Society's membership grew quite rapidly: by the end of 1926, it numbered 42, in 1929 – 73, and in 1931 – 131 (Wrzosek 1951); all Polish anthropologists and those interested in anthropology became members of the Society. Annual general meetings of the Society were held in Poznań (with reporting and scientific parts), the scientific part of which (lectures, papers) largely reflecting the activities of the Department of Anthropology of the University of Poznań.

As Professor Ćwirko-Godycki emphasized (Godycki 1958), the Poznań center's major achievement was the establishment of the journal "Przegląd Antropologiczny", which, as a body of the Polish Anthropological Society, was published by Professor Wrzosek starting in 1926. However, "Przegląd Antropologiczny", from its inception until 1937, struggled with financial difficulties and was published largely thanks to the private initiative of the Society's president and editor-in-chief. With the establishment of the Anthropological Committee of the Council of Natural and Applied Sciences in 1936, a reform of the journal's content, and a resolution to make "Przegląd Antropologiczny" the main body of all anthropological centers in Poland, in 1938 it received a significant subsidy from the National Culture Fund, and volume 12 of the journal, with its four issues, was impressive in terms of the page count. However, World War II interrupted its further publication for several years.

In December 1948, a year after Professor Adam Wrzosek was retired by the communist authorities, at the general meeting of the Polish Anthropological Society, its first president resigned from the office he had held since 1925, and Michał Ćwirko-Godycki was elected as the new president of the PAS. The next significant date in the history of the Society (which then consisted of 135 members) came two years later – the general meeting of December 10, 1950 (the so-called "Łódź Coup") and the election of a new board on February 3, 1951. Jan Mydlarski became the new president of the Society (Wrzosek 1951). In 1953 (from volume 19), Professor Mydlarski also assumed the position of editor-in-chief of "Przegląd Antropologiczny" (although A. Wrzosek remained as the scientific and technical editor), and in 1955 he took over the position of Editor of the PAS Publishing House (Professor Wrzosek subsequently returned to the journal as its editor-in-chief for two years). In 1957 (from volume 23), Michał Ćwirko-Godycki became editor--in-chief of "Przegląd Antropologiczny." At that time, Polish anthropology already had two other scientific publishing houses: "Materiały i Prace Antropologiczne" (1953–90, edited by Jan Mydlarski, and then by Adam Wanke, Halina Milicer and Edmund Piasecki), and the second organ of the Polish Antropological Society – the quarterly "Człowiek w Czasie i Przestrzeni" (1956–64, edited by Tadeusz Dzierżykray-Rogalski).

The first Congress of Polish Anthropologists, organized by Professor Adam Wrzosek, took place in Poznań in September 1933, as part of the then 14th Congress of Polish Physicians and Naturalists. Thirty-three speakers registered to participate, representing all of the academic anthropological centers in Poland at the time (Warsaw, Kraków, Lvov, Vilnius, and Poznań) (Musielak 2022). Another important congress was the joint congress of the Polish Zoological Society and the Polish Anthropological Society (the so-called Łódź Congress) in December 1950, featuring Jan Mydlarski's famous paper on the shortcomings and need for a retooling and ideological reconstruction of Polish anthropology (Mydlarski 1951). As a result, in the first half of the 1950s three national anthropological conferences were organized: two in Wrocław (December 1951 and February 1954) – concerning taxonomic methods and anthropological typology, and one in Osieczna (December 1952) – pertaining to ethnogenetic research.

In November 1956, the celebratory Jubilee Congress of the 100th Anniversary of Polish Anthropology took place at the Jagiellonian University in Kraków, marking the centenary of Professor Józef Majer's beginning of anthropology lectures at the Jagiellonian University. The congress was attended by the French anthropologist and paleontologist Professor Henri Victor Vallois (later an honorary member of the Polish Anthropological Society) and delegations from the then

Eastern Bloc countries (the so-called people's democracies): East Germany, Yugoslavia, and Czechoslovakia (see Przegląd Antropologiczny, vol. 24, 1958).

In October 1975, the Poznań Academy/University of Physical Education hosted the Jubilee Congress, which began with a ceremonial gathering to celebrate the 50th anniversary of the Polish Anthropological Society and the 100th birthday of its founder, Professor Adam Wrzosek. The Society was formally acknowledged by being awarded the Medal of the Commission of National Education (see Przegląd Antropologiczny, vol. 42, 1976). Beginning with the Society's 50th anniversary, the Poznań center has organized PAS jubilee conferences every ten years, thus celebrating subsequent 10-year anniversaries of the Society's founding: the 60th anniversary of the PAS (1985), the 70th anniversary (1995), the 80th anniversary (2005), the 90th anniversary (2015), and the 100th anniversary (2025) – this year.

Presently, the Polish Anthropological Society has approximately 120 active (due-paying) members, organized in 10 branches (Poznań, Kraków, Warsaw, Wrocław, Łódź, Gdańsk, Szczecin, Bydgoszcz, Świętokrzyskie, and Rzeszów), as well as 10 honorary members (out of a total of 67 appointed between 1927 and 2023: 39 from Poland and 28 from abroad).

The history of the Society, including its organ – "Przegląd Anthropologiczny" (currently "Anthropological Review"), was addressed by the presidents/chairpersons of the PAS and/or editors-in-chief of the journal on the occasion of subsequent anniversaries: on the quarter-century of the PAS – Adam Wrzosek (1951), on the half-century of the PAS – Tadeusz Dzierżykray-Rogalski (1976), on the 60th anniversary of the PAS – Andrzej Malinowski (1986), on the 75th anniversary of "Przegląd Anthropologiczny" – Jan Strzałko (2001) and on the 90th anniversary of the PAS and "Anthropological Review" – Maria Kaczmarek (2016).

The PAS chairpersons (1925–2025) were as follows:

1. Adam Wrzosek	(1925–1948) – 7 terms
2. Michał Ćwirko-Godycki	(1948–1951) – 1 term
3. Jan Mydlarski	(1951–1956) – 2 terms
4. Tadeusz Dzierżykray-Rogalski	(1956–1984) – 8 terms
5. Andrzej Malinowski	(1984–1987) – 1 term
6. Paweł Bergman	(1987–1999) – 4 terms
7. Danuta Kornafel	(1999–2007) – 2 terms
8. Maria Kaczmarek	(2007–2015) – 2 terms
9. Krzysztof Szostek	(2015–2019) – 1 term
10. Jacek Tomczyk	(2019–) – currently serving his second term

The list of editors-in-chief of "Przegląd Antropologiczny"/"Anthropological Review" and the volumes of the journal published during their tenure (1926–2025) is as follows:

1. Adam Wrzosek	(1926–1948 and 1955–1956) – vol. 1–15 & 21–22
– Editorial Board	(1949–1952) – vol. 16–18 (volumes editor A. Wrzosek)

2. Jan Mydlarski	(1953–1954) – vol. 19–20
3. Michał Ćwirko-Godycki	(1957–1977) – vol. 23–43
4. Tadeusz Dzierżykray-Rogalski	(1978–1984) – vol. 44–50
5. Zbigniew Drozdowski	(1985–1986) – vol. 51 (volume editor J. Strzałko)
6. Jan Strzałko	(1987–2011) – vol. 52–74
– Board of Editors	(2012) – vol. 75
7. Maria Kaczmarek	(2013–2019) – vol. 76–82
8. Sławomir Kozieł	(2020–2024) – vol. 83–87
9. Justyna Miszkiewicz	(2025–) – vol. 88

Anthropological Institutions in Poland – Current Status

In the 21st century, the traditional departments/chairs of physical/biological anthropology, both at universities and other institutions of higher education, began to undergo transformations to their structure (partly as a result of the 2018 "Constitution for Science – Act 2.0" reform of the higher education and science system in Poland), and to their nomenclature, often replacing the word "anthropology" with "human biology." Some anthropological departments from centers established after World War II have not survived to this day, some have been reorganized, and still others were established at universities where biological anthropology had not previously existed – some of which remain operational, and others have failed, becoming departments under a single head, such as the Chair and Department of Anthropology at the L. Rydygier Collegium Medium of Nicolaus Copernicus University in Bydgoszcz.

Three historical departments were liquidated: (1) the Department of Human Ecology at the Institute of Ecology of the Polish Academy of Sciences in Warsaw (in 2002), founded and long-time headed (1969–99) until his retirement by Napoleon Wolański. (2) the Department of Anthropology at the Faculty of Biology and Environmental Protection, Nicolaus Copernicus University in Toruń (in 2018), for years (1972–2007) headed by Guido Kriesel (most recently: 2014–18 by Tomasz Kozłowski). (3) the Department of Physical Anthropology at the Academy/University of Physical Education in Wrocław, originating from the Chair of Anthropology and Biometry (in 2020), for years (1969–2002) headed by Antoni Janusz (and between 2002–19 by Anna Burdukiewicz) – the department was subsequently merged with other departments and transformed into the Department of Biological Basis of Physical Activity.

In 2016, the Department of Anthropology in Wrocław, an independent scientific unit of the Polish Academy of Sciences, underwent transformation. It was established by Jan Mydlarski in 1952 and for years (1970–2001) was headed by Tadeusz Bielicki (most recently: 2010–16 by Sławomir Kozieł). The Department of Anthropology has been incorporated into the Ludwik Hirszfeld Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences in Wrocław, subordinate to the Faculty of Medical Sciences V.

In 1999, the Academy of Catholic Theology in Warsaw was transformed into Cardinal Stefan Wyszyński University. In

2002, the Institute of Ecology and Bioethics of the Faculty of Christian Philosophy at that university (currently the Center for Ecology and Ecophilosophy) established the Department of Human Ecology (headed by Anna Siniarska-Wolańska), which later was transformed into the Chair of Anthropology (headed by Father Bernard Hałaczek). In 2009, a second department dedicated to anthropological matters was established at the newly founded Faculty of Biology and Environmental Sciences at Cardinal Stefan Wyszyński University, namely the Department of Human Biology (first head: Anna Siniarska-Wolańska). In 2019, owing to the reform, the Institute of Biological Sciences was established, which presently includes two departments whose staff conduct research in biological anthropology (the director of the institute and the head of the center: Jacek Tomczyk).

In 2020, the Institute of Anthropology at the Faculty of Biology of Adam Mickiewicz University in Poznań underwent a structural reorganization, changing its name to the Institute of Human Biology and Evolution. Three departments that were established in 1987 within the institute: the Department of Human Evolutionary Biology (first head: Janusz Piontek, then Marta Krenz-Niedbała), the Department of Human Biological Development (first head: Joachim Cieślik, then Maria Kaczmarek), and the Department of Human Population/ Evolutionary Ecology (first head: Jan Strzałko, then Katarzyna A. Kaszycka) ceased to exist, and the institute now comprises of research teams. In addition to anthropological topics, the unit's core research focus has also shifted to bioinformatics, genomics, and molecular research.

In 2009, at the Wrocław University of Environmental and Life Sciences, which in 1951, as the Higher Agricultural School was established as an independent university, a department, then a Chair of Anthropology, was established, currently located within the Faculty of Biology and Animal Science (first headed by Krzysztof Borysławski).

Currently, units of biological anthropology exist at seven Polish universities: the Jagiellonian University in Kraków, Adam Mickiewicz University in Poznań, the University of Wrocław, the University of Environmental and Life Sciences in Wrocław, the University of Łódź, Cardinal Stefan Wyszyński University in Warsaw, and the University of Szczecin (a combined department of ecology and anthropology); at four academies/ universities of physical education in: Kraków, Poznań, Warsaw, and Gdańsk (a combined department of anatomy and anthropology); and at three research institutions unrelated to higher education: the Polish Academy of Sciences in Wrocław, the Children's Memorial Health Institute in Warsaw, and the Archaeological Museum in Gdańsk[30].

<u>Universities</u>:

1. Jagiellonian University in Kraków:
   - Laboratory of Anthropology, Institute of Zoology and Biomedical Research, Faculty of Biology (head: Iwona Wronka).
   - Department of Health and Environment, Faculty of Health Sciences, Medical College (head: Grażyna Jasieńska).

30 A previous report containing information on teaching and research institutions where anthropology was the primary focus, and on scientific institutions where anthropologists were employed, can be found in Drozdowski et al. (1983). Of historical value today is also information on persons who worked

2. Adam Mickiewicz University in Poznań – Institute of Biology and Human Evolution, Faculty of Biology (head: Izabela Makałowska – anthropologist and bioinformatician).
3. University of Wrocław – Department of Human Biology, Faculty of Biological Sciences (head: Bogusław Pawłowski).
4. Wrocław University of Environmental and Life Sciences – Chair of Anthropology, Faculty of Biology and Animal Breeding (head: Anna Lipowicz).
5. University of Łódź – Chair of Anthropology, Institute of Ecology and Environmental Protection, Faculty of Biology and Environmental Protection (head: Elżbieta Żądzińska).
6. Cardinal Stefan Wyszyński University in Warsaw:
   - Department of Human Biology, Chair of Biology, Institute of Biological Sciences, Faculty of Biology and Environmental Sciences (last head: Alicja Budnik, currently vacant).
   - Department of Environmental Anthropology and Toxicology, Chair of Environmental Protection, Institute of Biological Sciences (head: Krzysztof Szostek).
7. University of Szczecin – Chair of Ecology and Anthropology, Institute of Biology, Faculty of Exact and Natural Sciences (head: bird ecologist).

<u>Academies/Universities of Physical Education</u>:

1. Bronisław Czech Academy of Physical Culture in Kraków – Department of Anthropology, Institute of Biomedical Sciences, Faculty of Physical Education and Sport (head: Łukasz Kryst).
2. Eugeniusz Piasecki Academy of Physical Education in Poznań – Department of Biological Human Development, Chair of Sports Kinesiology, Faculty of Physical Culture Sciences (head: Dariusz Wieliński).
3. Józef Piłsudski Academy of Physical Education in Warsaw – Chair of Human Biology, Faculty of Physical Education (head: Monika Łopuszańska-Dawid).
4. Jędrzej Śniadecki Academy of Physical Education and Sport in Gdańsk – Department of Anatomy and Anthropology, Faculty of Physical Education (head: Ewa Wójtowicz – biologist, M.D.).

<u>Research institutions of the Polish Academy of Sciences</u>:

1. Ludwik Hirszfeld Institute of Immunology and Experimental Therapy of the Polish Academy of Sciences in Wrocław – Department of Anthropology (head: Sławomir Kozieł).

<u>Other research institutions</u>:

1. Children's Memorial Health Institute in Warsaw (a research institute under the Ministry of Health) – Anthropology Laboratory (head: Agnieszka Różdżyńska-Świątkowska).
2. Archaeological Museum in Gdańsk – Anthropology Laboratory (head: Aleksandra Pudło).

Acknowledgements

The author is grateful to Marta Krenz-Niedbała, Kazimierz Dopierała, Tomasz Kozłowski, and Anna Burdukiewicz for their comments on previous versions of the manuscript. Thanks are also due to Monika Łopuszańska-Dawid, Janusz Piontek, Henryk Głąb, Barbara Kwiatkowska, Jadwiga Charzewska, Ewa Wójtowicz, and Anna Pankowska for providing information and/or archival pho-

as anthropologists in Poland in the 1980s (Krupiński 1988).

tographs. Finally, I am indebted to David Chorn and the editor-in-chief Justyna Miszkiewicz for their assistance.

Author contributions

KAK is the sole author responsible for conceptualization, research, writing and editing of the manuscript, and its translation from a version in Polish available on the Polish Anthropological Society website: https://ptantropologiczne.pl/historia-antropologii/

Conflict of interest

The author has no conflicts of interest to declare.

Ethics statement

Not applicable.

Data availability statement

Not applicable.

Financial disclosure

The author received no financial support for the research, authorship, and/or publication of this article.

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ABSTRAKT

W 2025 roku mija dokładnie sto lat od założenia w Poznaniu Polskiego Towarzystwa Antropologicznego (12.11.1925), zainicjowanego przez profesora Adama Wrzoska z Uniwersytetu Poznańskiego, który został pierwszym jego przewodniczącym, oraz 150-lecie urodzin Adama Wrzoska. W tym roku mija też 120-lecie utworzenia, z inicjatywy Kazimierza Stołyhwy, pierwszej na ziemiach polskich, i pierwszej w Europie Wschodniej, placówki zajmującej się antropologią fizyczną, jaką była Pracownia Antropologiczna przy Muzeum Przemysłu i Rolnictwa w Warszawie (1905). W 2026 roku minie setna rocznica wydania drukiem pierwszego tomu czasopisma PTA "Przegląd Antropologiczny", obecnie "Anthropological Review" (1926), oraz 170-lecie początku antropologii jako dyscypliny uniwersyteckiej (1856), za który uznaje się rok wprowadzenia pierwszych wykładów z antropologii na Uniwersytecie Jagiellońskim w Krakowie przez profesora Józefa Majera. W literaturze można spotkać pewną liczbę prac poświęconych historii antropologii fizycznej/biologicznej na ziemiach polskich – szczególnie dziejom poszczególnych ośrodków, opublikowanych w latach 50. XX wieku z okazji jubileuszu 100-lecia dyscypliny przypadającej na rok 1956, jak również opracowań historii polskiej antropologii w ujęciu bardziej całościowym z innych okazji. Ten artykuł ujmuje historię antropologii biologicznej w Polsce, opowiedzianą między innymi za pomocą krótkich biogramów naukowych jej twórców – profesorów, których praca i dorobek przyczyniły się do rozwoju dyscypliny, stając się częścią historii nauki. Historie biograficzne obejmują zasadniczo wiek XIX i XX, a wśród nich tych profesorów, którzy albo już przeszli do historii, albo w dniu publikacji tego artykułu ukończyli 75 lat (urodzili się do 1950 roku).

Słowa kluczowe: historia nauki, historia antropologii, polscy antropolodzy, polscy naukowcy

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