Mating system and gene flow in the Lutheran communities from historical Polish territories (the Parish of Trzebosz, the second half of the 19th and early 20th century)

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ABSTRACT

The aim of this paper was to analyse the mating system and the degree of genetic isolation of the Lutheran Parish of Trzebosz situated on the borderland between Greater Poland and Silesia. Use was made of 343 records from marriage registers for 1855-1913. For exogamous marriages an analysis of distributions of marriage distances based on the order of neighbourhood for isotropic, 2-dimensional migration was carried out. The factual and theoretical mating distances distributions were compared using the chi-square test. The degree of isolation of the Lutheran Parish of Trzebosz was evaluated on the basis of the coefficient of kinship f and the intragroup coefficient of inbreeding by isonymy. Gene flow in the Lutheran Parish of Trzebosz had no bearing upon the theoretical model of isotropic, 2-dimensional migration. Low values of the coefficients of kinship and the intragroup coefficient of inbreeding by isonymy show that the parish was not isolated in terms of breeding.

Keywords: Coefficient of Kinship, Factual and Theoretical Distribution of Mating Distances, Isonymy, Gene Poles

SUBJECT CLASSIFICATION

Population Genetics, Demography

TYPE (METHOD/APPROACH)

Analysis of the mating system and the degree of genetic isolation

INTRODUCTION

The history of German settlement on Polish territory reposing under Prussian rule mentions several stages. The first influx of Germans to Greater Poland (Wielkopolska) occurred in the Middle Ages, and reached maximum intensity in the 13th and 14th centuries. This settlement had a huge impact on the national and religious structure of the region. Some areas became Polonized in the subsequent generations, while in the borderland between Silesia and Brandenburg, the regions of Leszno (German: *Lissa*), Wschowa (German: *Fraustadt*), Międzyrzecz (German: *Meseritz*) and Babimost (German: *Bomst*) experienced continuous German settlement until the 19th century [1, 2]. The next wave of settlers came to Greater Poland in the 17th century. These were Protestants from Silesia, settling mainly in urban areas of Greater Poland, while on the rural territories new villages were founded by so called Dutch settlers. These new settlers maintained their separate cultural character until the mid-19th century, after which they slowly began to integrate into Polish society. The third influx of settlers from Germany occurred after the first partition of Poland. At this time the lands of the newly formed Greater Poland and South Prussia were systematically settled by German colonists [1, 2]. After the Congress of Vienna, the Prussian authorities undertook to continue the German settlement policy in the Poznań province (German: *Provinz Posen*). Among these settlers officials, officers, landowners and intelligentsia predominated. The colonization of Silesia had begun in the late Middle Age, the main group of the German settlers coming from southern and central Germany. A massive influx of German settlers was especially observed after the Silesian Wars in the 18th century, as a result of incorporation of the main portion of Silesian territory into Prussia [3, 4]. Following peace negotiations in 1763 the King of Prussia was exempted from the duty of retaining the *status quo* of Catholicism in Silesia, which resulted in the expansion of the Lutheran Church in these areas [3].

The network of Lutheran parishes in Greater Poland at this time was very diverse. In the parishes located on the borderland between Brandenburg, Silesia and Pomerania, were groups of Catholics scattered among the Germans. Lutheran parishes in the central and eastern part of the Poznań province were mostly represented by closed rural communities, or large municipalities with a parish church within a small town surrounded by villages [5]. The new and sometimes very small Lutheran parishes, founded especially after 1850, were usually a result of division of the large communities. The rural areas of Greater Poland and Silesia were dominated by small Lutheran parishes, very remote from each other, and sometimes visited by the same pastor once every two weeks [5]. The religious structure of Greater Poland and Silesia was shaped essentially by the above-mentioned migratory movements. In the villages located on the borderland between Greater Poland and Silesia, Pomerania, and Brandenburg, Germans were predominant even before the period of Partition [5]. For central and eastern Greater Poland, in turn, the majority of the settlers had arrived during the 19th century. The Germans were mostly Lutherans, while the Poles belonged to the Catholic Church, and the synonyms Pole-Catholic and German-Lutheran therefore became widespread. This however is an oversimplification, since a small group of the Poles belonged to the Protestant church while some Germans were members of the Catholic Church. In Poznań province in the 1890s, an area roughly coinciding with the territory of 19th-century Greater Poland Lutherans represented more than 30 per cent of the population (author's calculations after [2]): in the district of Poznań – about 30 per cent, while in the district of Bydgoszcz 10 per cent more [2]. The numbers of Lutherans differed in various regions. In the Międzyrzecz county (German: *Meseritz*; district of Poznań), for example, Protestants accounted for 52 per cent of the population, with only 0.02 per cent Lutherans of Polish nationality. The same demographic was true in the Czarnków county (German: *Czarnikau*; district of Bydgoszcz). Here Lutherans constituted more than 53 per cent of the population, mostly of German nationality, while Pole-Lutherans were in the minority (only 0.01per cent). In the City of Poznań(German*: Posen*) and Leszno (German: *Lissa*) the proportion of Lutherans exceeded 30 per cent (33.18 and 36.48 per cent, respectively) [2].

It is difficult to difficult to determine the openness or closedness of the Lutheran rural populations of historical Poland, since studies on the Lutherans have been mainly the work of historians [3, 5-18] and demographers (e.g.: [19, 20]). In the light of the above, the aim of this study emerges: the aim of this study, therefore, was to analyse the mating distances and the degree of genetic isolation in the second half of the 19th and early 20th century in the Lutheran Parish of Trzebosz located on the borderland between Greater Poland and Silesia.

MATERIAL

The Lutheran parish of Trzebosz has been already a subject of anthropological studies. Earlier research focused on analysis of fertility figures [21] and marriage patterns [22]. In this study data obtained from parish marriage registers of the Lutheran Parish of Trzebosz for 1855-1913 were used. Information was gathered on names and surnames of spouses, date and place of marriage, place of origin of spouses, and their religious denomination. A total of 343 data items were collected. The Parish of Trzebosz was located on the borderland between two major regions: the agricultural Greater Poland and the agro-industrial Silesia. The 19th century Parish of Trzebosz comprised the village of Trzebosz and the landed estates. The village was inhabited by 388 people, including 33 of Catholic denomination. The landed estates accounted for 260 people, of whom 37 were Catholics [23, 24]. Over the next three centuries the landed estates were owned by various German families. This state of affairs lasted until the early 20th century, when the landed estates passed into the hands of the Polish family Czarnecki [23]. At that time an efflux of German Lutherans and decrease in the number of parishioners was noted [22, 25].

METHODS

1. Analysis of mating distances

An analysis of mating distances was carried out for exogenous marriages. For this purpose the model proposed by Henneberg [26- 29] of mating distances distribution – based on so called *'order of neighbourhood'* – was used. As claimed by its author, a distance should not be measured in geographical units alone but also take into account all expenditures on travelling between settlements, measured not only in economic efforts but also in interpersonal relations. Therefore, Henneberg's method combines information about both geographical and cultural distances. The latter includes also tradition and socio-economic factors. The following variables form the basis for estimation of the mating distances distributions: pattern of distribution of the settlements in the territory, intensity of exogamy, and so called the *order of neighbourhood*. The *order of neighbourhood* is a measure of the opportunity of contact between people from different settlements, in other words – it is a measure of ecological and cultural distances [26]. In the case of the Parish of Trzebosz it was assumed that there were neither geographical nor cultural barriers and all settlements were evenly distributed, and the spouses had migrated here evenly from all geographical directions. This situation corresponded to a model of isotropic, 2-dimensional migration (2 DIM). Probability of marriage between spouses from distance ON for the abovementioned situation is described by the following formula:

$$P_{ON} = \left(\sum_{ON=1}^{\alpha} e^{-\frac{ON}{2\pi m}} \right)^{-1} \cdot e^{-\frac{ON}{2\pi m}}.$$

In this formula ON denotes *order of neighbourhood*, and α is such *order of neighbourhood*, where the summed expression equals zero, *m* is the coefficient of exogamy calculated as a ratio of the number of spouses to places of origin that were not identical to the overall number of spouses. The distances between the places of origin of the spouses were measured on a map of scale 1: 100,000. Geographical distances were then converted into the *order of neighbourhood ON*, on the assumption that the average distance between the settlements in the studied area was 3.4 km. The number of couples corresponding to the subsequent *order of neighbourhood* value was transformed into the probability of marriage between spouses from a distance ON. Then, the factual and theoretical mating distances distributions were constructed, and their fit with each other determined by the chi-square test [30]. A single level of significance – α = 0.05 – was adopted.

2. Degree of genetic isolation

The degree of genetic isolation of the Lutheran Parish of Trzebosz was assessed by calculation of the coefficients of kinship *f*. Use was made of the equation proposed by Henneberg [29] and Malècot's classical equation [31]. Henneberg's equation uses two variables: the value of the coefficient of exogamy *m* and the effective population size N_b. In the case of isotropic, 2- dimensional migrations, Henneberg's equation is expressed by the following formula:

$$f = \frac{1}{1 + 32\pi^3 m^3 N_b \left(\frac{-1}{\ln 2b} \right)},$$

where *m* is the coefficient of exogamy, N_b is the effective population size where b is an adjustment for the operation of linear pressures stabilizing the gene pool, which in practical terms is the strength of a mutation found in men (it was assumed that b= $5\cdot10^{-6}$). The effective population size is defined as the fraction of individuals capable of reproduction. It is calculated as the product of the population density in a settlement and the individuals capable of reproduction, and the surface of a circle with a radius equal to a half the average distance between the villages. The age of individuals capable of reproduction is roughly coincident with the working age. In the case of women, this is from 18 to 50 years, and for men - between 18 and 60 years [32]. In this paper several variants of N_b were calculated according to the population density of individuals capable of reproduction. In the first case, the number of individuals capable of reproduction was determined as 49 per cent of the rural population inhabiting Greater Poland in the 19th century (data taken from Borowski [33]). The second way was to calculate the proportion of individuals potentially capable of reproduction as one-third of the harmonic mean of the living population read from the logistic curve [34, 35] (author's unpublished calculations). The next variable used in Henneberg's equation is the coefficient of exogamy *m*, which in Trzebosz in years 1855-1913 ranged between 0.78 – 0.67 [22].

Malècot's equations [31], in turn, include, apart from the population density of persons capable of mating, variance of the distance between the places of origin of the spouses. In the case of isotropic, 2-dimensional migration the model is expressed as follows:

$$f = \frac{1}{1 + 8\pi\delta\sigma^2 \left(\frac{-1}{\ln 2b} \right)}$$

where δ denotes population density of individuals capable of reproduction, estimated based on the number of the living population and its density for 19th century rural areas of Greater Poland (after: [33]), $2\sigma^2$ is the mean square marital

distance between the places of origin of the spouses, and *b* is as denoted in Henneberg's equation above [29]. Since the Malècot's equation contains $2\sigma^2$, it is sensitive to the occurrence of long mating distances in the data. Budnik [34, 36], in regard to historical Kashubian populations, tried to avoid this inconvenience and offered two approaches: estimation of the mean square marital distance between all the places of origin of the spouses, and estimation of the mean square marital distance between the places of origin of the spouses within distances of 100km or less. In the present study both of the abovementioned approaches were employed.

3. Analysis of isonymic relationships

The intragroup coefficient of relationship *f* used to analyse spouses surname data and was estimated based on the frequency of identical spouses'surnames (isonymous marriages). The isonymy analysis was proposed in the 1960s by Crow and Mange and permits estimation of the coefficient of relationship resulting from mating between individuals even when very distantly related [31]. The probability that any degree relatives have the same surname because they have inherited it from a common ancestor is always four times the coefficient of a particular type of marriages (e.g.: 36-44). The isonymy analysis is based on several assumptions. The first is the assumption of the identity of the surnames derived from a common ancestor, the second is the assumption of the monophyly of surname, third - the assumption that the shared kinship relationships are equal among the male and female ancestors, and fourthly that the breeding is patrilineal (the father's surnames) and proportional to other types of inbreeding (e.g. matrilineal, the mother's surnames). Having the same surname by the parents indicates an increase in homozygosity in their children's generation [38, 40, 45]. If we assume that all individuals have the same surnames, as had their common ancestors, the frequency of isonymous spouses divided by four gives us the value of intragroup coefficient of relationship (inbreeding) [31].

Table 1. Frequency of surnames in the Lutheran Parish of Trzebosz (≥ 1%).

Surnames	N	%
Hoffmann	20	2.8
Scholz	19	2.9
Riedel	15	2.1
Paschke	13	1.8
Schmidt	12	1.7
Weigt	12	1.7
John	10	1.4
Frontzke	8	1.1
Goldmann	8	1.1
Kobilke	8	1.1
Marx	8	1.1

In the Lutheran parish of Trzebosz in the second half of the 19th century and beginning of the 20th century a uniform and patrilineal system of surname inheritance was noted. Since in human groups there is positive or negative selective mating due to recognition according to social dependence, the intragroup coefficient of relationship *f* has two components: 1) first f_r resulting from random mating and 2), second f_n resulting from non-random mating [31]. Thus, the intragroup coefficient of relationship by isonymy is calculated according to the equation: $f = f_r + (1 - f_n)f_r$

Components f_r and f_n are expressed by formulas:

$$f_n = \frac{\left(p - \sum q_i^2\right)}{4\left(1 - \sum q_i^2\right)} \quad \text{and} \quad f_r = \frac{1}{4}\sum q_i^2 \text{ respectively.}$$

In the formula q_i^2 is the fraction of individuals having the same surname, *p* – the fraction of isonymous marriages among all observed marriages, and *f*, f_r, and f_n are the coefficients of relationship. Use was made of 715 surnames of spouses. The number of the most common surnames and their frequencies are presented in Table 1.

RESULTS AND DISCUSSION

Spatial structure of marriage

In the second half of the 19th century and the early 20th century the gene flow in Trzebosz was not consistent with the theoretical model. The chi-square test revealed a statistically significant difference between the factual and empirical mating distances distributions (see Figure 1; χ^2=1,515.8). This means that the inflow of exogamous spouses was

dependent on the particular geographical direction. In the second half of the 19th century the privileged directions were the west and the north, while in the early 20th century the west and the south. The influx of spouses from the west and the north in the 19th century resulted in the main towns of the region: Bojanowo, Góra and Gołaszyn being located to the west and the north of Trzebosz. The rural population had come here for commercial purposes, which could have facilitated the finding of a spouse from these localities. Partners from such urban centres as Leszno, Poznań and even from Berlin, were also arriving in Trzebosz. They were employed as managers or skilled workers in the Trzebosz landed estates [22]. When in the early 20th century the property was taken over by the Poles, the influx of Germans spouses from the west to the parish declined (author's unpublished calculations). At that time matrimony with a spouse from Germany (inflow from the west) was occasional, while marriages with partners from urban centres such as Rawicz (inflow from the south) were more frequent. The Figure 1 showed that 48 per cent of spouses came to Trzebosz from the shortest distances (1st and 2nd ONs) and about 15 per cent from the greatest ones.
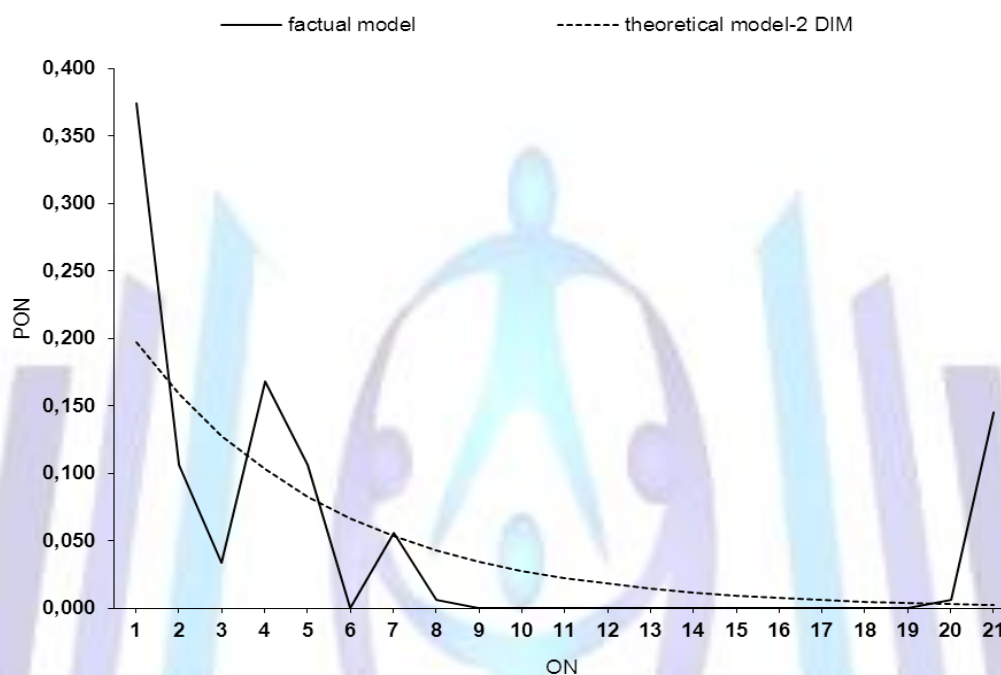

Figure 1. Comparison of factual and theoretical mating distances distributions, 1855-1913 (chi-square=1,515.8).

Coefficient of kinship

The Lutheran Parish of Trzebosz was very open to the novelties from outside and marriage partners were rapidly exchanged, as confirmed by the low values of coefficients of kinship. Migration movements and the associated intensive influx of migrants to the Lutheran Parish of Trzebosz, mainly in the 19th century, confirmed the openness of the Lutheran community. This translates into very low values for the coefficient of kinship f (Tables 2 and 3). The values of the coefficients of kinship calculated by Henneberg's method are very low in all studied sub-periods. Values of coefficient of kinship f calculated according to Malécot's method are extremely low for the 19th century, but for the beginning of the 20th century – though still very low – are more than 100 times higher than the previous period (Table 3). As is known, the Malécot's equation takes into account the mean square marital distance between the places of origin of the spouses. Since this decreased over time, a decline of the f values for the 20th century is observed. In the 20th century no distances greater than 100 km were observed here.

Despite the decline in the 20th century of migratory movements which had previously dynamized the parish, Trzebosz was not hermetic and in this context not isolated in terms of breeding. Low values of the coefficients of kinship, ranged between 0.00006 and 0.0013, were obtained for the Catholic populations from historical Poland: in the Parish of Wielkie Drogi from Silesia [46], in the parish of Dziekanowice from Greater Poland [47], and for the Kashubian populations from the Sierakowice county [34, 36] (Table 4). Higher values of the coefficient of kinship were observed in the Kashubian populations from the Hel Peninsula, characterized in the past by geographical and cultural isolation [34, 36] (Table 4)

Isonymy

The term isonymy means the same surname. Since the 1960s isonymy analysis has been used in the population studies to estimate the intragroup coefficient of inbreeding in human groups that are more or less isolated [e.g.: 28, 36-45, 47-54], this method has however been criticized [49, 50], and researchers have emphasized caution when interpreting results obtained from isonymy analysis. In this paper the values of the intragroup coefficient of relationship by isonymy f and its components f_r and f_n are presented in Table 5. As can be seen the f value is low. Low values of coefficient f estimated by this method were also obtained for the Catholic populations from historical Poland (Table 5). In the parishes from Greater

Poland: Szczepanowo and Dziekanowice – the values of intragroup coefficient of relationship were 0.0014 and 0.00123, respectively [28, 38].

Table 2. Values of the coefficient of kinship *f* in the Lutheran Parish of Trzebosz (calculated according to Henneberg's method).

Period	m*	N_b	f
1855-1913	0.73	177.00[1]	0.00015
		193.64[2]	0.00015
1855-1899	0.78	187.00[1]	0.00013
		184.39[2]	0.00013
1900-1913	0.67	121.00[1]	0.00021
		206.80[2]	0.00019

Keys:

*after: [22]

[1] – N_b estimated as a one-third of the harmonic mean of the living Lutheran population in the Parish of Trzebosz (author's unpublished data).

[2] – N_b estimated based on the number of the living populations for 19th century rural areas of Greater Poland; after: [33].

Table 3. Values of the coefficient of kinship *f* in the Lutheran Parish of Trzebosz (calculated according to Malécot's method).

Period	$2s^2$	f^a	$2s^2$	f^b
1855-1913	4846.64	0.000009	256.78	0.00016
1855-1899	4030.23	0.000011	298.25	0.00015
1900-1913	32.67	0.0012	–	–

Keys:

f^a – calculated for all distances between the places of origin of the spouses

f^b – distances greater than 100 km excluded from the material

Table 4. Coefficient by kinship *f* in the Lutheran Parish of Trzebosz compared with selected populations from Poland.

Population	Period	Religion	*f*	Source
Trzebosz	1855-1913	Lutherans	0.00015	Author
Wielkie Drogi	1850-1899	Catholics	0.00140	[46]
Płużnica Wielka	1850-1899	Catholics	0.00059	[46]
Szczepanowo	1855-1874	Catholics	0.00130	[28]
Dziekanowice	1872-1909	Catholics	0.00040	[47]
Sierakowice county	1875-1912	Catholics	0.00022	[34]
Kuźnica	1875-1919	Catholics	0.010	[34]
Jastarnia	1875-1919	Catholics	0.011	[34]

Table 5. Intragroup coefficient of relationship by isonymy method in the Lutheran Parish of Trzebosz compared with selected populations from Poland.

Population	Period	Religion	f_r	f_n	f	Source
Trzebosz	1855-1913	Lutherans	0.00141	0.00016	0.00282	Author
Szczepanowo	1825-1874	Catholics	0.00110	0.00030	0.00140	[28]
Dziekanowice	1818-1909	Catholics	0.00123	-0.00033	0.00245	[38]
Kuźnica, Jastarnia	1885-1919	Catholics	0.03100	-0.003	0.028	[36]

Higher isonymic relationships, amounting to 0.028, were noted among the Kashubians from the Hel Peninsula, who in the past were characterized by higher than elsewhere geographical and cultural isolation [36]. What is worth emphasizing is the positive value of the non-random component f_n of the intragroup coefficient of relationship, indicating a positive selective mating, meaning that those having the same surname might have decided to get married (Table 5).

SUMMING UP

1. The gene flow in the Lutheran Parish of Trzebosz was not consistent with the theoretical model of isotropic, 2-dimensional migration. This means that geographical directions were preferred. In the second half of the 19th an influx of spouses to Trzebosz was noted, mainly from the west and the north, while at the beginning of the 20th century – from the west and the south.

2. There is no evidence of breeding isolation in the parish. This is confirmed by the low values of the coefficients of kinship and the value of the intragroup coefficient of inbreeding by isonymy. Thus, the gene pool in the Lutheran parish of Trzebosz in the 19th and the early 20th century was a very diverse one.

3. In the Lutheran parish of Trzebosz, not limited by any barriers of geographical and cultural nature, migration was a strong factor in modelling the gene pool.

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