THE EVOLUTION OF POPULATION
IN
CANADA'S METROPOLITAN SYSTEM:

Changes in the Rank-Size Distribution

BY

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ABSTRACT

The purpose of this research paper is to empirically examine the evolution of the Canadian urban system throughout the past century. This task is completed with the use of the rank-size rule and the parameters that emanate from its logarithmic distribution. This process entails the creation of a historical data set from the inception of the urban areas of each one of the twenty-four CMAs that are used in this study. The collection of the evolving slope and y-intercept parameters during the study's fourteen rank-size distribution periods, shows how policy decisions are manifested in the empirical changes of the rank-size rule's slope. Confederation and expansion of the railroad into the prairie frontier are distictly evident in the evolving parameters. It was also found that Canada's geographical distribution of CMAs apparently limits the rank-size rule constant to a value of -1.1 . This distribution is steeper than the optimal market efficiency slope of -1.0 as presented in Zipf's explanation of the forces of attraction and dispersion of economic activity. The statistical results of this paper can be used to compare different national systems or take a more regional approach in comparing Canadian CMA sub-systems.

ACKNOWLEDGEMENTS

First and foremost I would like to express my gratitude to Dr. Y. Papageorgiou whose suggestion of this managable and very interesting topic was the first in a series of long steps in the creation of this paper. His questions, comments and guidance throughout the research and writing of this paper are much appreciated. In addition, special thanks are owed to Eugenio Perri for his study advice and the supporting confidence to complete this paper.

To Ioannis

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1. INTRODUCTION

1.1. Overview

The system of Canadian cities has evolved from the sixteenth century staple-based settlements to the present political and economic union of very diverse urban areas. The metropolitan populations in particular are indicative of the relative importance of the corresponding metropolitan areas. Subsequently, this is an accurate and relatively easily attainable means of denoting the changes of the Canadian urban system. Historically, Canadian growth has proceeded regionally from east to west and central Canada has dominated the political, economic and population aspects of the national urban system. It would be interesting to empirically explore this evolution by using this population characteristic.

This thesis will use the changes in the rank-size distribution over time to view the evolution of the system of Canadian Census Metropolitan Areas (CMAs). Existing literature has shown that the 1971 Census of Canada ranking of the CMAs have populations that closely approximate G.K. Zipf's (1949) special form of the rank-size rule. This states that the population of the n^{th} largest city in an urban system is $1/n^{th}$ the population of the largest city.

For example, using the 1981 Census CMA data, the fourth most populous CMA (Ottawa-Hull) should have approximately one-fourth the population of the largest CMA which is Toronto with a metropolitan population of 2,998,947. In accordance to the rank-size rule, Ottawa-Hull should have an actual population of 2,998,947 ÷ 4 = 749,738. This is a fairly good approximation of the actual 717,978 population of Ottawa-Hull in the 1981 census.

What the existing literature lacks and this thesis fulfills is how the Canadian rank-size distribution and its parameters of logarithmic slope and logarithmic Y-intercept have evolved over the past century with the larger and more encompassing economic areas of the system of Canadian Census Metropolitan Areas.

In order to complete this task, this paper will build upon existing data. George Nader's Cities of Canada Vol.II (1975) is a large base of city population information which will be combined with other publications pertaining specifically to the history and development of each one of Canada's twenty-five Census Metropolitan Areas. Unfortunately, the Canadian Census Statistics of 1986 will not supplement the data set with the most up to date information for reasons to be explained later. Errors, like omissions in the data set to 1982, will be filled by extrapolating trends based on assumptions that are necessary to offset the spatial expansion of CMAs. Changes in the definition of Census Metropolitan Areas will also be corrected in this manner. This will give a historic record of growth in the twenty-four CMAs, which will not include Sherbrooke, Quebec because of its designation as a CMA in 1986.

The parameters of the rank-size distribution will then be estimated at ten year intervals with the completed records as was done with the regional analysis of Quebec and Ontario by Davies and Bourne (1968). The compiling of logarithmic population versus logarithmic rank will allow a visual interpretation of the regression analysis and will establish the parameters of the particular rank-size distribution. The Y-intercept will show the overall pattern of growth. Flatter lines of regression will indicate greater dispersion of metropolitan populations and conversely larger negative values of the regression slope will indicate greater centralization and the tendency toward primacy. The changes in these parameters over the period of this study will then be examined as indicators of the evolution of the Canadian system of metropolitan areas.

1.2. Definition of Census Metropolitan Area (CMA)

Central to this study is the evolving definition of the CMA. This classification of larger than city economic areas was first manifested as Greater City Areas in the 1931 Census, when the government came to the realization that larger, more encompassing and influential areas had evolved in the Canadian system of cities. At this time, there were ten of these "Greater Cities" which included: Montreal, Toronto, Vancouver, Winnipeg, Ottawa, Hamilton, Windsor, Halifax, Quebec and Saint John. Larger cities like London, Ontario and Edmonton, Alberta did exist but they did not have economically linked smaller communities in their periphery commuting area.

The term Census Metropolitan Area was officially coined by Statistics Canada when the areas were officially designated CMAs in 1951 Census. The definition in the 1961 Census was one with very strict regulations that had to be met before CMA status was obtained. A CMA had to consist of at least one incorporated central city of at least 50,000 residents. The surrounding population must increase the total population to at least 100,000. In addition, this periphery population must also be comprised of at least seventy percent non-agricultural workers with a density of at least 1000 persons per square mile, forty percent of which must commute into the central city. In subsequent censuses, these strict regulations were slackened with the implications of a more general definition.

This paper will utilize the definition found in the 1981 Census Dictionary for the obvious reason that this year's CMA boundary definitions will be the ones to which all historical CMA populations of this study will be standardized. The definition as found in the 1981 Census Dictionary reads:

> "Census Metropolitan Area (CMA) ... refers to the main labour market area of an urbanized core (or continuously built up area) having 100,000 or more population. CMAs are created by Statistics Canada and are usually known by the name of the urban area forming their urbanized core. They contain whole municipalities (or census subdivisions). CMAs are comprised of (1) municipalities completely or partly inside the urbanized core; and (2) other municipalities if (a) at least 40 % of the employed labour force living in the municipality works in the urbanized core, or (b) at least 25 % of the employed labour force working in the municipality lives in the urbanized core.
>
> Since a CMA must contain whole census subdivisions, its limits may fall within, or extend beyond, the actual labour market area. The differences may be significant in those parts of Canada where census subdivisions cover particularly large areas of land. Census metropolitan areas may also differ from Metropolitan Areas designated by local authorities for planning or other purposes."
>
> (1981 Census Dictionary, pg.97)

2. LITERATURE REVIEW

The underlying premise of this research paper is the appropriateness of the rank-size rule of city distribution in a system to describe the maturation of that system of cities or in the present case, census metropolitan areas. The questioning of its legitimacy as a theoretically viable method of analysis has been well documented with papers both for and against. Although the theory behind the rank-size rule is not completely developed, the concept has been shown to be empirically relevant time and time again. The following is a review of the development of this theory, its criticism and the supportive articles that make its use appropriate for the present study.

2.1. Theoretical Studies

The rank-size rule was popularized by G.K.Zipf (1949) in his book of human behaviour and discussion of the principles of least effort. He expanded the 1913 postulation of F.Auerbach that for any system of cities, the city rank multiplied by the city population will result in a constant for the system. Zipf stated that the reason that the special case of a negative-one constant of the rank-size rule was closely adhered to by economically developed countries was the economic principle of cost minimization by the forces of unification and dispersion. He explained that transport costs are minimized to consumers of products if they live in a few large cities. Similarly, the forces of diversification operate to disperse a large number of smaller settlements near the widely distributed natural resources in order to limit the cost of transportation to a manufacturing location.

The rank-size relationship can be algebraically described in the form:

$$r^q P_r = P_1 \qquad (1)$$

where, P_1 is the population of the largest city
and, P_r is the population of city ranked r
and, r is the rank of the city in order of size
and, q is an empirically derived constant for the system.

This regularity of distribution was later transformed by Lotka (1924) into its logarithmic form by taking the logarithm of each term and rearranging. The resulting form is of a straight line equation:

$$\text{Log } P_r = \text{Log } P_1 - q \text{ Log } r \qquad (2)$$

It is from equation (2) that the parameters of this study can be algebraically obtained. The slope [-q] is equal to the slope of the regression line and the Y-intercept is the [Log P_1] value. An empirical description of the gradual evolution of the slope parameter is the principle purpose of this study. Both of these parameters will be described in greater detail in the Analysis section.

Support for the rank-size rule as observed by Zipf is given by Beckmann (1958,pg.247) in showing how it is compatible with the ideas of hierarchies of market areas of August Losch, Walter Christaller and other location theorists. Berry and Garrison (1958) on the other hand set out to show alternative explanations of the urban rank-size generalization. They also discussed the similarity between Zipf and Walter Christaller with respect to location behaviour which is similar to Beckmann's work. This concludes that the rank-size rule (RSR) has a similar distribution of cities to that of Central Place Theory (CPT) of urban hierarchies. The principle difference is that CPT predicts levels of the same city populations in an order, whereas the RSR allows for a continuous distribution of population sizes. H.A.Simon's work of a probability explanation to the rank-size regularity is also relevant to supporting this inductive generalization of city-size distributions.

Berry and Garrison (1958,pg.90) also bring forth the alternative explanation that the rank-size regularities of systems of cities can be equated to a living system which attempts to attain a steady-state known as entropy. This association of natural science principles to social science reasoning allows cities to lose or gain population within the system or to enter or exit the system.

Ettinger (1981,pg.1390) also confirms this by maintaining that the rank-size distribution can evolve towards the specific case of a negative-one regression slope in logarithmic form or it can evolve towards a primal distribution of a strongly negative slope.

Berry and Garrison concluded that the rank-size rule is not a particularly good indicator of economic development or the process of nation building. Nevertheless, they resolved that it is a useful tool for describing a system of cities.

John Parr (1976) acknowledges the weakness of the theoretical underpinnings of rank-size distributions but notes that it is more important to look at the temporal alterations in the shape of the rank-size distribution curves and to consider the changes in the parameters of the regression in equation (2). These parameters are the theoretical largest city population [y-intercept] and the slope of the regression line [-q] assuming that the rank-size rule is followed by the CMA system.

2.2 Empirical Studies

The particular form of equation (2) that has a slope equivalent to minus-one is believed by Zipf (1949) to be the most efficient distribution of cities within a system because of the economic forces of attraction and dispersion. A minimum population of 2,500 was set by Zipf for consideration into the urban system to be studied. The result is that the very small uninfluential centres in an urbanized system are ignored to allow a clearer and less confusing analysis. This minimum population is extended to 100,000 in the present study.

Yeates and Garner (1980,pg.66-67) have already documented that the Canadian urban system is a very good example of the rank-size rule, based on the 1971 Census data. The current paper will therefore consider only the upper level of the Canadian urban system despite the truncation of the lesser populated urban areas and subsequently the bottom part of the logarithmic graph of population versus city rank. This position is more extreme than that taken by Davies and Bourne (1968) in the study of the central Canadian sub-system. They evaluated the rank-size distribution of Ontario and Quebec separately and then of the two regions together. Among other results, they found that both systems showed an approximately equal negative sloping logarithmic distribution whose straight line more closely approximated minus-one when the two systems were combined. It is expected that CMAs will follow this generalization of Canadian sub-systems and produce even better approximations of the rank-size rule.

Other foreign studies of rank-size distribution have taken place in Greece by A.F.Lagopoulos (1971) and P.Petsimeris (1986), on Turkey by V.Dokmeci (1986) and on Israel by G.Bell (1962). These offer examples of this type of study and will be used as additional sources of interpreting evolutions of logarithmic graphs.

P.Petsimeris (1986,pg.54) uses, "... the approach proposed by Parr (1986) which considers the rank-size distribution as a methodological point of reference with study and classification of the deviations observed". He also delineates the interpretation of the parameter q as the indication of the pattern of urbanization and shows its evolution in Greece from 1870 to 1981. Petsimeris also looks into the particular details of the significant historical, economic, political and migratory events that shaped his study's urban system. These interestingly show up in the changes of the parameters of the logarithmic rank-size distribution.

The study of Turkey occurs from 1945 to 1975 and concentrates on the changes of the shapes of the size distribution. Dokmeci offers historical reasons of why the cities of Constantinople (Istanbul) and Ankara have large populations and this leads to a description of the rank-size distribution within nine different regions. Another consideration in this study is that of the level of entry and exit of cities into the system. This consideration has no effect on the Canadian CMA system because no CMA to date has lost it CMA designation and entrance into the system occurs upon the inception of the urban area and not when the CMA status was attained.

As a result of the existing literature, this paper will consider only a sub-system of the upper portion of the Canadian urban system which truncates the logarithmic plot of the entire Canadian system of cities. This should create a greater adherence to the special case of minus-one slope of the rank-size rule than using the entire urban system. A complete record of the population growth for each Census Metropolitan Area will permit rankings to be converted into logarithmic graphs at decade intervals like the Dokmeci paper. A regression of each logarithmic distribution will show the rank-size rule and its parameters will be charted to assist in interpretation. Finally a time series of these distributions will show the evolution of the Canadian Census Metropolitan Area system as P.Petsimeris did for approximately the same period in Greece.

3. RESEARCH METHODOLOGY

3.1 Data Collection

The collection of precise historical population data for the Canadian Census Metropolitan Areas is a difficult task. Since the compilation of CMA populations is basic to this research paper, estimations of the population of these areas must be calculated. This study will cover the period from the founding of each city to 1982. Since Sherbrooke, Quebec gained its CMA designated in the most recent Census of 1986, it is the only CMA not to be included in the current study. The research considers only the CMAs of 1981 and works backward through time to interpolate the CMA population to the inception of each city.

3.1.1. Data Sources

In collecting the population data, the entire set of Canadian Census Statistics and George Nader's book "Cities of Canada, Vol.II" were used to collect the raw population. These were populations that considered the prevailing boundaries definitions at the time that the data was collected. The actual CMA statistics date back to 1951 when that Census of Canada created the designation from the former Greater City areas. The component parts of the CMAs for the censuses predating 1951 were also collected. In particular, the 1931 Census has a good partial summary of city populations back to 1871 but the other statistics were not at all tabled.

From 1981 back to 1951 the census population data for all CMAs exists for every census year. Before this period, the Prairie Provinces were enumerated every ten years that ended in a six. Since Newfoundland entered the Canadian federation in 1949 the 1941 Census of Canada does not include St.John's in its statistics. Instead, the British Colony held its own decennial census on years ending with five. Subsequently, 1945 and 1935 census population data exist for St.John's instead of the years of the regular Canadian census which decennially end in one. The slope method of calculating the 1941 population, which assumes a constant growth rate for the period, was used to estimate the ranking year population.

Example: St. John's, Newfoundland

$$\frac{(1945\ \text{Pop.} - 1935\ \text{Pop.})}{1945 - 1935} \times (1941-1935) + 1935\ \text{Pop.} = 1941\ \text{Pop.}$$

$$\frac{65.256 - 54.886}{10} \times 6 + 54.886 = 61.108$$

Similarly, this method was used to augment any data that was missing for CMAs that existed during ranking years. In this manner a complete ranking is obtained for the existing cities in the Canadian CMA system.

The gathered data for each CMA was then organized in chronological columns separating city and CMA population growth. These columns denote critical points in the CMAs history which include: the CMA population in the censuses since 1951; the original area city population; the points where large areas of land and surrounding communities are annexed; and the amalgamation of two large cities to form one CMA. This amalgamation has occurred in Ottawa-Hull, St.Catherines-Niagara Falls, Chicoutimi-Jonquiere and Fort William's merger with Port Arthur to form Thunder Bay. Once these critical points of each CMA were identified and separated, it was possible to calibrate this data by working backwards, in the aforementioned steps, to create a historical record of CMA populations based on the boundaries of the 1981 Census.

3.1.2. Standardization of CMA Populations

All of the various CMA populations that were calculated using the particular data collection year's boundary limits had to use the same limits in order to avoid incorrect increases in CMA populations because of annexations or ammalgamations. The chosen year was 1981 and this task was completed by utilising a factor of two different area definitions for the a CMA at one common time. For example, the first step of interpolation was to take the 1966 population, which had been previously standardized to the 1981 CMA boundary definition and divide it by the 1966 Census CMA population, which has its own slightly different CMA boundary limit. The derived factor is then multiplied by the preceding CMA Census populations to obtain a 1981 standardized CMA area population. This process continues all the way back to 1951 when the CMAs were first created by the census.

Example: St.John's, Newfoundland

$$\frac{\text{1966 (1981 Limits)}}{\text{1966 Census Pop.}} = \frac{119.181}{101.181} = 1.17790$$

FACTOR x 1961 Census Pop. = 1961 (1981 Limits)

1.17790 x 90.838 = 106.988

From this point a further factor of each particular city population against the standardized 1951 population was obtained in order to calibrate historical city populations into 1981 based CMA populations. This assumes that urban populations grow smoothly as in reality. A new factor is calculated for every critical point of annexation or amalgamation. For the amalgamated CMAs, the population of each component part was added together and then the factor calculated and interpolated with the previous period.

This procedure continued until the historical record of each CMA to the inception of each urban area had been obtained. Figures #1, #2 and #3 are examples of the evolution of population in the Canadian CMAs.

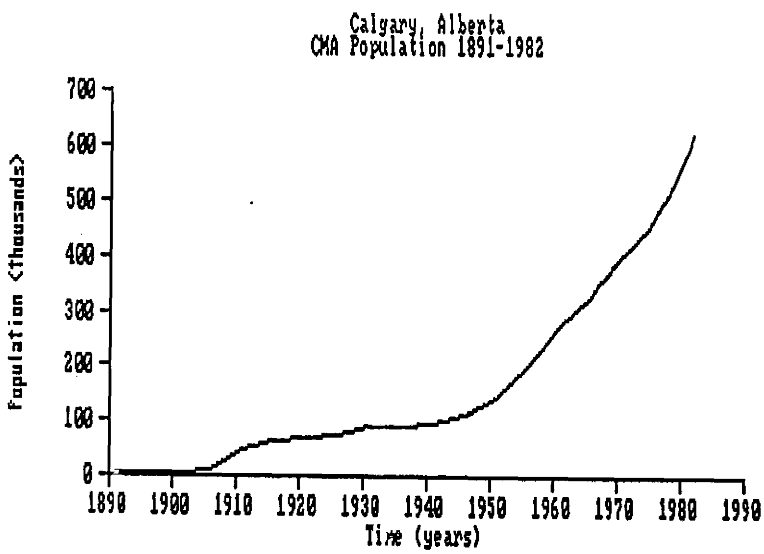

Figure # 1

Appendix A contains the complete set of the tables and graphs for the historical record of each of the twenty-four CMAs studied.

3.1.3 CMA Population Growth Characteristics

Within the first Appendix of census metropolitan area population growth there exist essentially three patterns or types of CMAs. These patterns of growth are easily distinguished by the interpretations of the graphing of their population versus a horizontal time axis, as seen in figures #1, #2 and #3 and throughout Appendix A.

The first pattern of growth is typified by population increasing at an increasing rate. The graph of Calgary's growth (Figure #1) shows that the CMA continues to grow at a very fast and even alarming pace. The general trend of this pattern is that the very large CMAs are getting much larger. Victoria, Vancouver, Edmonton, Calgary, London, Toronto, Oshawa, Quebec City, Halifax and St.John's are growing in this accelerated manner.

The second pattern of growth is an evolved form of the first because the previously increasing rate of growth is now shown to have levelled off and growth is increasing at a decreasing rate. These types of CMAs tend to be those of the middle-size like Saskatoon, Kitchener, St.Catherines, Hamilton, Ottawa-Hull (Figure #2), Chicoutimi-Jonquiere and St.John.

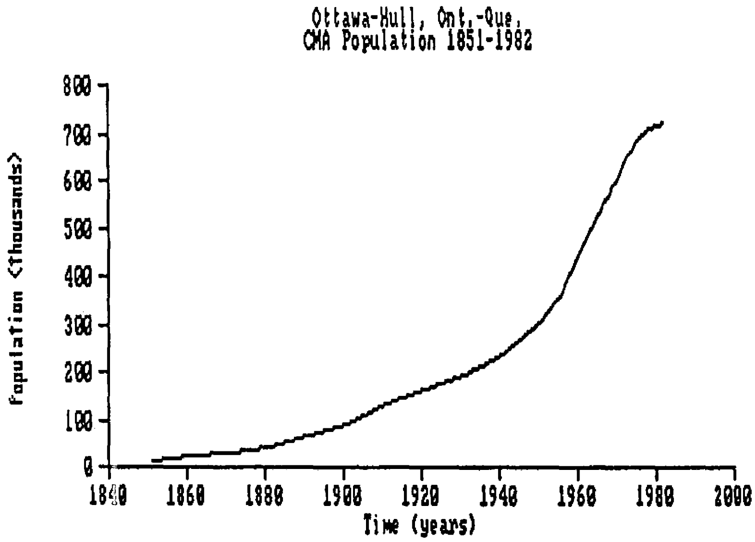

Figure # 2

The last pattern of growth that is found in the evolution of the CMAs in Canada shows eventual decline. Figure #3 shows that it has passed through accelerated and decelerated population increases and now shows a stop or decline in the absolute CMA population. These are primarily the small CMAs of Northern Ontario which are resource based and have seen a decline in the importance of their commodities. Montreal, the second largest CMA, has experienced a sudden stop in growth because of its political choice of supporting the Partie-Quebecoise (PQ) seperatists which has driven much of the anglophone population away to English Canada. Winnipeg, Thunder Bay, Sudbury (Figure #3), Windsor and Trois-Rivieres are the other examples of the more typical resource and manufacturing based CMAs that have experienced decline.

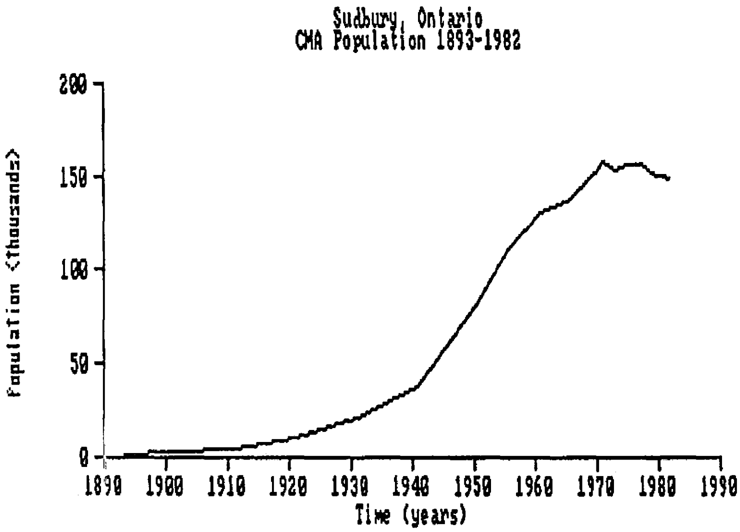

Figure # 3

This section of the chapter briefly acknowledges the various patterns of growth in a very simple manner because the reasons for these patterns are complex and quite specific to each particular area.

3.2 Analysis

3.2.1 Rankings

When the historical record for each metropolitan area was collected, they were combined and ranked at decade intervals in the census years from 1851 to 1981. The previously discussed slope method of extrapolating population growth trends was used to fill missing data for CMAs in the decennial ranking years. These coincided with the years of the national census in order to minimize these approximations. Problems occurred primarily for the nineteenth century when population statistics were not as prevalent or well kept as they are in the twentieth century.

These rankings are indications of the decade by decade changes within the Canadian urban system. The 1851 and 1861 rankings give us two periods before confederation to consider the Canadian metropolitan system before formal political ties were established. The system was dominated by only a few urban places in the pre-confederation era and that the rank-size distribution would change very little, so the 1851 cutoff point was established. Besides, Nader (1975,pg.201) suggests that no national urban system was evident at the time of Confederation. If any trend needs to draw on earlier rankings, the study can easily include the rankings of 1841, 1831, 1821, 1811 and 1801.

The CMAs are considered within the rankings from the time that the particular urban area was established in order to view the entire effect of its growth on the urban system in Canada. Very small populations like Saskatoon's in 1901, have a minuscule effect on the Canadian urban system and this is reflected by its last place ranking in 1901. This decision avoids subsequent problems of when to include an urban area within the system of CMAs because its presence most certainly affects the system before any designation as an official CMA. Table #1 is a brief synopsis of the changes in rankings since 1851 at approximately half-century intervals.

1851	1901	1951	1981
Montreal	Montreal	Montreal	Toronto
Toronto	Toronto	Toronto	Montreal
Quebec City	Quebec City	Vancouver	Vancouver
St. John	Ottawa-Hull	Winnipeg	Ottawa-Hull
Halifax	Halifax	Ottawa-Hull	Edmonton
St.John's	Hamilton	Quebec City	Calgary
Hamilton	St. John	Hamilton	Winnipeg
Ottawa-Hull	London	Edmonton	Quebec City
St.Catherines	Winnipeg	Windsor	Hamilton
London	Victoria	Halifax	St.Catherines
Trois-Riviers	Vancouver	Calgary	Kitchener
	St.John's	London	London
	St.Caherines	Victoria	Halifax
	Windsor	St.Catherines	Windsor
	Trois-Riviers	Chicoutimi-	Victoria
	Kitchener	Kitchener	Regina
	Chicoutimi-	Sudbury	St.John's
	Thunder Bay	St. John	Oshawa
	Oshawa	St.John's	Saskatoon
	Calgary	Thunder Bay	Sudbury
	Edmonton	Trois-Riviers	Chicoutimi-
	Sudbury	Regina	Thunder Bay
	Regina	Saskatoon	St. John
		Oshawa	Trois-Riviers

Table # 1

The tables of Appendix B show these rankings with their respective populations for each one of the fourteen periods that this study encompasses. It should be noted that the population rankings for CMAs have been by far dominated by Montreal and Toronto. Increasingly, Vancouver is joining these two as the three most dominant urban areas in Canada. Each one of these CMAs socially, economically and politically dominates its respective part of the country which are Quebec, Ontario and the West. It is no coincidence that these are the only CMAs with more than one million people and that no other CMA comes close.

3.2.2 Rank-Size Distribution

Once these rankings are completed for the fourteen periods from 1851 to 1981, the rank verus CMA population will be plotted to see if indeed the Canadian CMA system follows the rank-size rule of distribution as first described by Zipf (1949). As previously observed in both Davies and Bourne (1968) and Yeates and Garner (1980), it is expected that the Canadian CMA system will approximately adhere to the rank-size rule throughout its evolution.

The distribution of city sizes with respect to their rank does produce a graph similar to that of central place theory with a large number of smaller sized centres and progressively fewer large cities. (Figure #4)

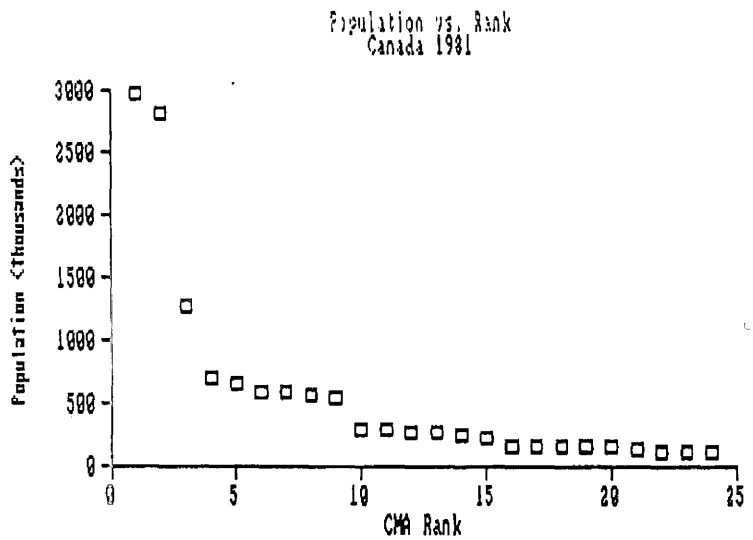

Figure # 4

This trend is upheld throughout the fourteen ranking periods of the Canadian CMA system's history. (Appendix B)

3.2.3 Logarithmic Form

The logarithmic plot of the rank-size distribution allows a more convenient quantitative description and analysis of the slope and Y-intercept parameters. By simply taking the logarithm of both axis, the plotted points permit the fitting of a regression line. This straight line can then be described by an algebraic equation and subsequently the delineation of the set of parameters which have been described as the Y-intercept and the slope.

For the sake of simplicity and because of the technical limitation of computer spreadsheet in calculating logarithmic functions, all of the populations in this research are described in thousands with the decimal place moved three places to the left of the actual population number.

The Y-intercept crosses the Y-axis at the point where the theoretical largest CMA should be in the event that the rank-size rule is perfectly followed. The evolution of this parameter will show to what extent the overall population of the system is growing. It can increase or just as easily decrease with the adherence to the rank-size rule. For example, in the case of a primal distribution of one totally dominant city population, this city could lose some its people to the surrounding smaller cities which would cause a lower value of the Y-intercept as the system maintained its rank-size rule distribution.

The principle criterion for a rank-size rule relationship is the close adherence to the constant slope value of the regression line. However, the case of the real world would almost never produce a system of cities that follows this rule to the exact number because of the dynamic nature of urban areas. The relative change in the system's constant (slope) indicates some change in the CMA system toward or away from a more organized and economically efficient system of a negative-one slope. This value obviously does describe a system of city distribution in some logical and reasonable manner.

The regression of eleven to twenty-four points, corresponding to the number of CMAs as their urban areas were added to the system, will be undertaken for each ranking period to establish the parameters of the regression line of the plotted points of log(rank) versus log(population). The 1981 example of this distribution is shown in figure #5. The fourteen Y-intercept and slope parameters will then be collected for the analysis of the evolution of the system.

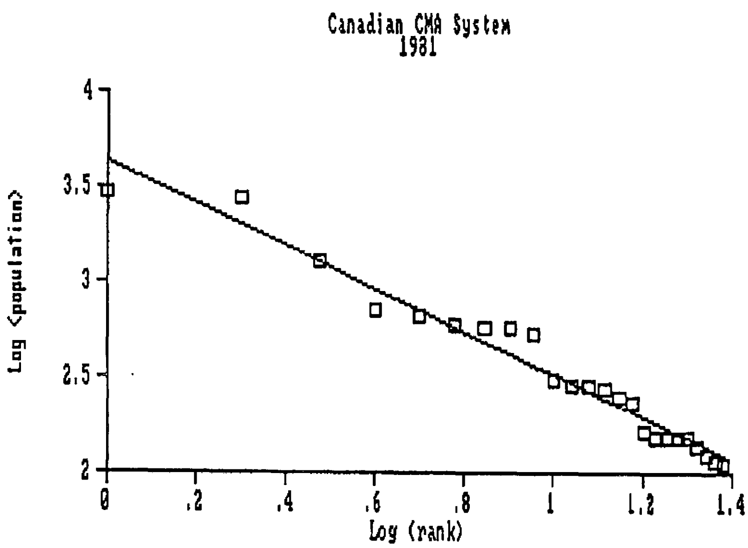

Figure # 5

In this research paper the logarithmic form of the rank-size distribution curve for Statistics Canada's twenty-four Census Metropolitan Areas will be interpreted as an aggregate indicator of the evolving importance of each CMA within the Canadian system. The analysis of this data is based in particular on the article by Berry (1961,pg.582-585) which gives the basic interpretations of geometric changes of evolving graphs. The translation of the geometric lines and curves of the logarithmic distribution are critical in the proper interpretation of the results. It must be made clear that it is the system as a whole that is being studied and the analysis of the stability of each CMA is a topic for another paper.

4. RESULTS

The results of the final stage of the analysis are numerically the twenty-eight values of both the Y-intercept and slope that correspond to each one of the fourteen periods that a regression line for the logarithmic rank-size distribution had occurred. This was an involved process of creating standardized CMA populations and then ranking them in order to get a rank-size distribution which was subsequently converted to its logarithmic form. Only then was it possible to calculate the regression line of these points and obtain the fourteen period time-series set of the two parameters. Table #2 lists these results which indicate that a relatively consistent compliance to the rank-size rule by the CMA rank-size distribution of cities occurs.

Year	Slope	Y-Intercept
1851	-1.182	2.238
1861	-1.188	2.385
1871	-1.603	2.665
1881	-1.548	2.732
1891	-1.473	2.816
1901	-1.638	3.006
1911	-1.337	3.040
1921	-1.239	3.107
1931	-1.172	3.177
1941	-1.138	3.214
1951	-1.091	3.283
1961	-1.089	3.448
1971	-1.114	3.576
1981	-1.124	3.640

Table # 2

No great fluctuations occur in the Y-intercept's gradual increase to higher largest city populations but the values of the slope are not nearly as consistent. The periods ending in 1871 and 1901 display a distinct increase in the slope of the rank-size rule which must have been caused by distinct government policy actions. In general, there is an adherence to the fundamental principles of rank-size rule and parameter evolution that pervades the period of this study.

4.1 Y-Intercept

The evolution of the Y-intercept parameter is to no surprise increasing at a approximately constant rate from about 2.2 log(population) in 1851 to about 3.7 log(population) in 1981. (Figure #6)

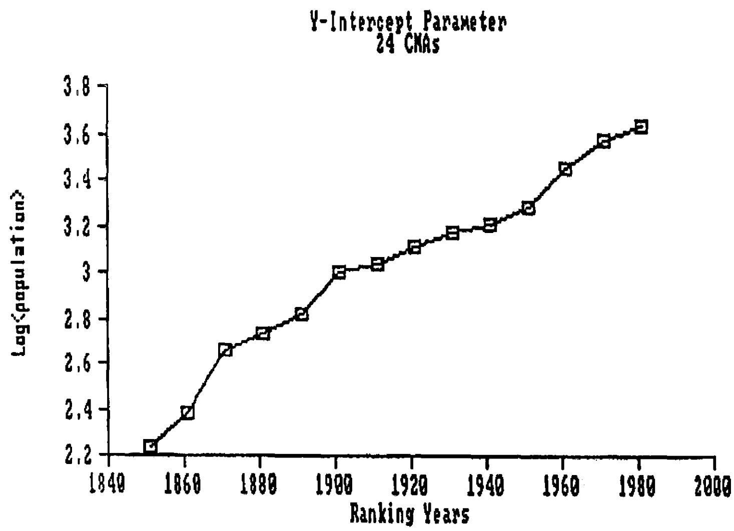

Figure # 6

This suggests that the overall magnitude of the Canadian Census Metropolitan System has increased at a steady rate throughout Canadian history. Since logarithmic increases are translated into base ten exponential, the absolute magnitudes of the Y-intercepts' theoretical largest city populations increase from approximately 158,000 to about 5 million for the latest period. This last value appears to be quite high. It is definitely affected by the very large Toronto and Montreal populations which are approximately equal and far above all other CMAs. This tandem has a profound effect on the Y-intercept and the slope of the regression because they are so removed from the other points of distribution. The magnitude of the Y-intercept value would obviously be much smaller if these two areas were not included because of the elimination of the top portion of the distribution. Their elimination would also decrease the slope of the rank-size rule because of the existence of more medium and small CMAs which have more equal population sizes. Nevertheless, they are part of the CMA system and omitting them would examine only part of the Canadian CMA system.

4.2 Slope

The evolving slope parameter (Figure #7) displays a much more interesting pattern which shows distictly two breaks in the trend; one in the 1861 to 1871 period and the other in the 1891 to 1901 period. These interruptions coincide with two political policy actions which changed the size of the Canadian urban system with the inclusion of more urban areas into the system. These actions occurred firstly upon Confederation in 1867 and secondly, with the inclusion of the western frontier provinces which were incorporated before the official joining into the Union in 1905.

This divides the graph into three significant periods: (1) Pre-Confederation; (2) Immediate Post-Confederation; and (3) After 1901 when the frontiers Manitoba, Saskatchewan and Alberta were opened to settlement by the railway infrastructure (Nader,1975,pg.244-255).

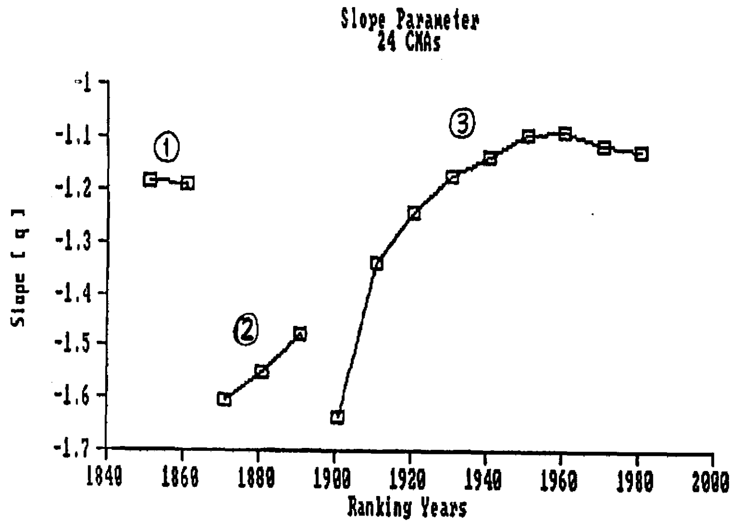

Figure # 7

Before confederation there exists a level of the rank-size rule that is close to the optimal distribution of a negative-one slope that Zipf suggested. The slope parameter maintains this level for the two pre-1867 rankings. The reason for this close adherence to the economically efficient state is believed to be the imperial dominance of trade by Britian. Raw materials from Canada were shipped overseas to the United Kingdom in return for manufactured products. The result was that an economically efficient distribution network was created by market forces and consequently, the minus-one value of the slope is closely approximated.

In the 1871 distribution, the efficiency of the colonial urban system is interupted by the political event of Cofederation. A high degree of adherence to the negative-one slope of economic efficiency is interrupted by a relatively low reading of a disorganized system in the next distribution period. The reset Canadian urban system in the immediate post-confederation period also shows an evolution of maturing market system with two consecutive periods of the lessening of the rank-size rule slope. Once again the evolution of the country is interrupted by the settling of the western provinces.

This decrease in the slope parameter value is caused by the inclusion of many small western Canadian cities into the system which increases the steepness of the lograthmic distribution log(population) versus log(rank).

Since 1901, the Canadian Urban system has been gradually developing into a more efficient and ideal system of city distribution (Figure #7). The slope parameter has evolved toward a rank-size distribution of negative-one slope at a decreasing rate of increase up to 1961 where a gradual decline and levelling off has occurred. This suggests that the CMA system has evolved to its maximum level of efficiency. The sheer size and longitudinal distribution of Canada may limit the urban system constant to -1.1 instead of the -1.0 that Zipf believed to be he most efficient and ideal system.

The critical difference among the three is the number of cities that are included in the CMA system. The period up to confederation includes eleven metropolitan areas which are:

1. Montreal
2. Toronto
3. Quebec City
4. St. John
5. Halifax
6. St.John's
7. Hamilton
8. Ottawa-Hull
9. St.Catherines
10. London
11. Trois-Rivieres

These increase to seventeen before the next critical point in 1901. In addition to the first subsystem the second includes the cities of:

12. Victoria
13. Windsor
14. Oshawa
15. Kitchener
16. Chicoutimi-Jonquiere
17. Winnipeg

In the third stage and final stage of Canadian CMA slope parameter distribution, the entire system of twenty-four CMAs is included. Since this difference exists, a further analysis is needed to view the evolution of these particular sub-systems of the CMA.

4.3 Further Analysis

The procedure followed for the entire CMA system in this study was repeated twice; once with the eleven sub-system of metropolitan areas and then with a seventeen CMA sub-system.

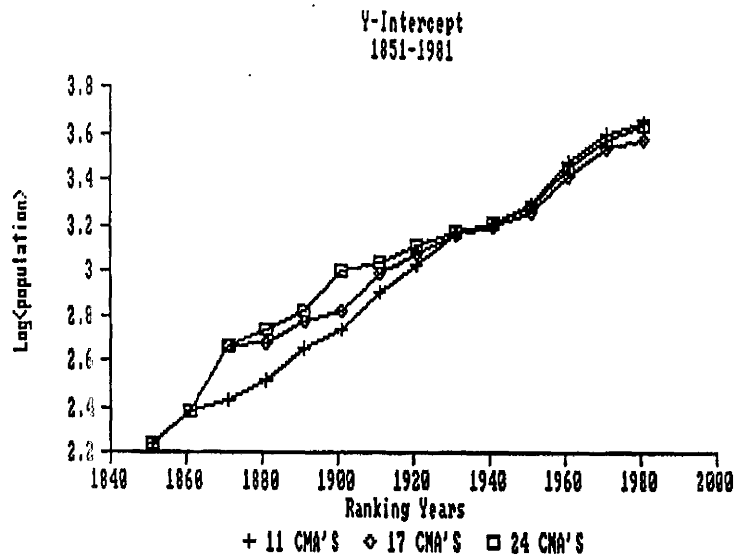

Figure # 8

Figure #8 shows the resultant analysis of the three periods together with respect to the Y-intercept. Once again, no significant change is visually observed by using these two particular sub-systems. The reasoning behind this is tht the largest CMAs, which are also most influential to the rank-size distribution, exist in each part.

The change in the slope parameter (Figure #9) is once again the more interesting variable. The later and larger sub-set does exhibit the trends of the entire system although at a slightly less efficient and more disorganized level. The smaller and more removed sub-system exhibits quite a different result.

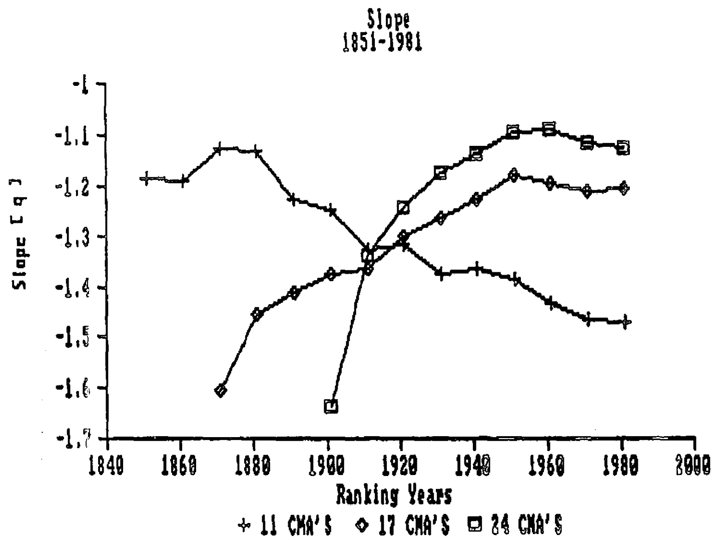

Figure # 9

The reason for this result has to do with the fact that this sub-system consists mostly of the older and more influential CMAs to the rank-size distribution. The increasing disparity between the older more populated CMAs like Toronto, Montreal, Quebec City and Ottawa-Hull and the smaller St.Catherines, London and Trois-Riviers creates a condition of an increasing Y-intercept and a more negative slope of distribution. The rank of the large CMAs is essentially the same as in the twenty-four CMA system so the Y-intercept should be the closely approximate the entire system. The increased steepness (lower slope [q] value) of the logarithmic rank-size distribution occurs when the higher ranking points are extended upward at a greater rate than the small centres further down the ranking order.

5. CONCLUSIONS

From the results of this research, it can be concluded that changes in the rank-size distribution can be logical indicators of the evolution of the urban system in Canada. This is proven by the three part division of the slope parameter's evolution which indicates two distinct political events that affected the CMA system (Figure #6). Although the value of this slope is a little steeper than minus-one, it consistently approximates the rank-size rule of an efficiently ordered system. The CMAs of Toronto and Montreal are the two dominant points in this distribution that steepen the slope line. If the present trends of Toronto's increase and Montreal's decrease in population continue, a greater adherence to the minus-one value of the slope should be observed.

The creation of the data set uncovered the previously mentioned three patterns of growth of CMAs: (1) accelerating; (2) decelerating; and (3) declining. In addition, the 1981 distribution of CMAs is particularly interesting with its apparently similar distribution as central place theory. It appears that urban hierarchies with levels of similar city population exits as seen in Figure #4. This is obviously an avenue for further study.

The findings in this paper must also contradict Nader's statement that an urban system did not exist prior to confederation. (Nader, 1976,pg.201) It was found that for the two periods preceding confederation that the level of the slope of rank-size distribution was similar to that found in the later half of the twentieth century. The case may have been that the Province of Canada was a sub-system of Imperial Britain and that the situation was similar to that found by Davies and Bourne(1968) in studying the Canadian sub-systems of Ontario and Quebec. Nevertheless, a definite order to the pre-confederate urban system in Canada was observed.

In only a limited sense, it was also found that a seventeen CMA sub-system closely assimilated the entire Canadian CMA system, but the assumption that all sub-systems follow this pattern cannot be accepted because of the results of the eleven CMA subsection. The smaller system's slope evolution did not conform to the expected pattern of a gradual adherence at a decreasing rate to the rank-size rule slope value. This may have been because of the exclusion of smaller Canadian urban centres like Kingston, Queenston and

Brockville which played major roles in colonial Canada.

5.1 Limitations of the Study

This study was limited in design because it did not include the aforementioned old principle urban areas of the mid-nineteenth century because it is biased toward CMAs existing in 1981. No allowance is made to include these smaller urban areas because their period of influence was short and have not persisted throughout Canada's evolution.

The ten year interval was selected because it was long enough to describe these trends. A shorter interval would provide a more detailed description, it would however not make a drastic difference.

This study takes the more macro view of the system and subsequently does not delve into the individual histories of CMAs which may explain many of the reasons for a CMA's growth in detail. This scrutiny was done for fifteen Canadian cities by George Nader's second volume of <u>Cities of Canada</u>.

5.2 Areas for Further Study

This paper provides the CMA evolution that can be used in further studies such as the comparison of the relative parameter's evolution among other urban industrialized nations or with Lesser developed countries. There are numerous possible groupings for such a study showing the extent of work that can be done.

The study can also be repeated using a more liberal limit of considered urban areas than the CMA. This may include all incorporated cities in Canada with more than fifty-thousand people. It would also be interesting to examine the stability of both CMAs and the new larger urban system as was done in the stability research of Greek cities by Lagopoulos (1971).

APPENDIX A

Historical Census Metropolitan Area Populations

Tables and Figures for the Twenty-Four CMAs

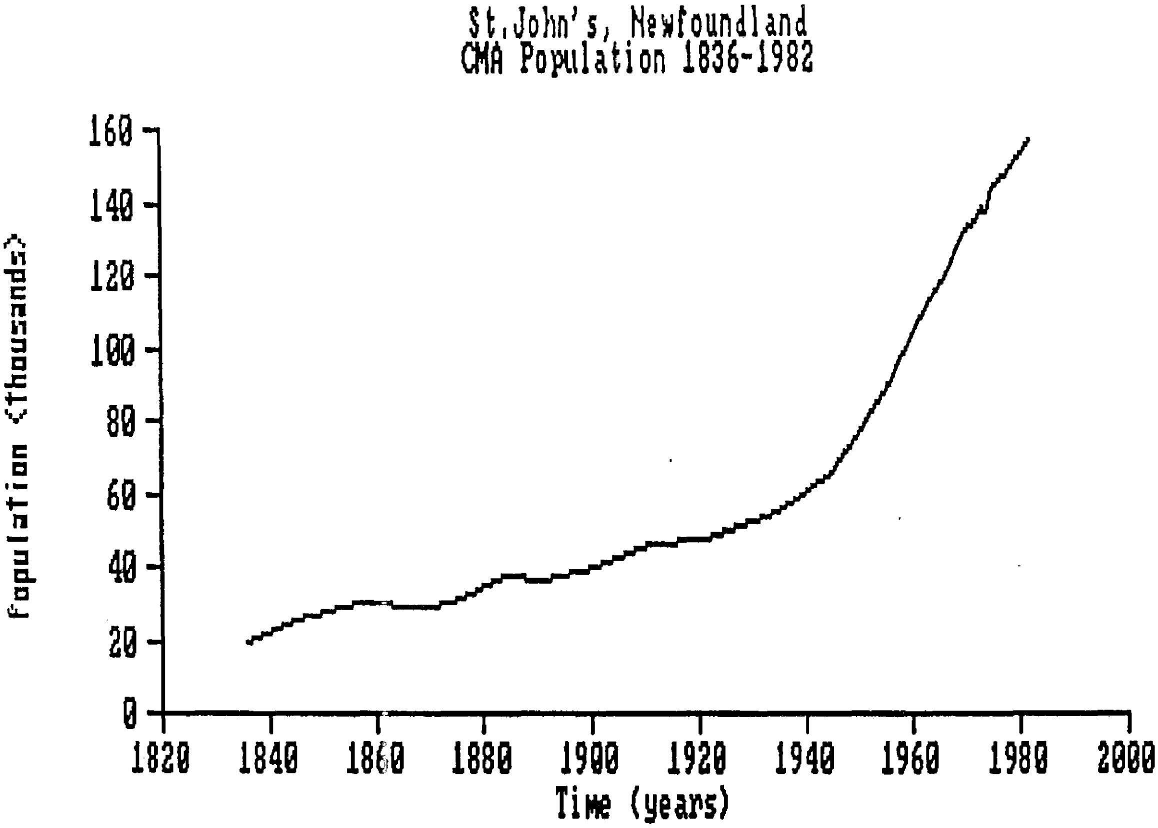

Figure # A.1

YEAR	ST.JOHN'S		
1836	18.926	1967	122.984
1845	25.196	1968	125.985
1857	30.476	1969	129.578
1869	28.850	1970	132.351
1874	30.574	1971	133.662
1884	38.145	1972	135.599
1891	36.027	1973	138.180
1901	39.995	1974	137.938
1911	45.685	1975	143.779
1921	47.801	1976	145.400
1935	54.886	1977	147.008
1945	65.256	1978	148.945
1951	79.562	1979	150.957
1956	91.403	1980	152.657
1961	106.666	1981	154.820
1966	119.181	1982	157.013

Table # A.1

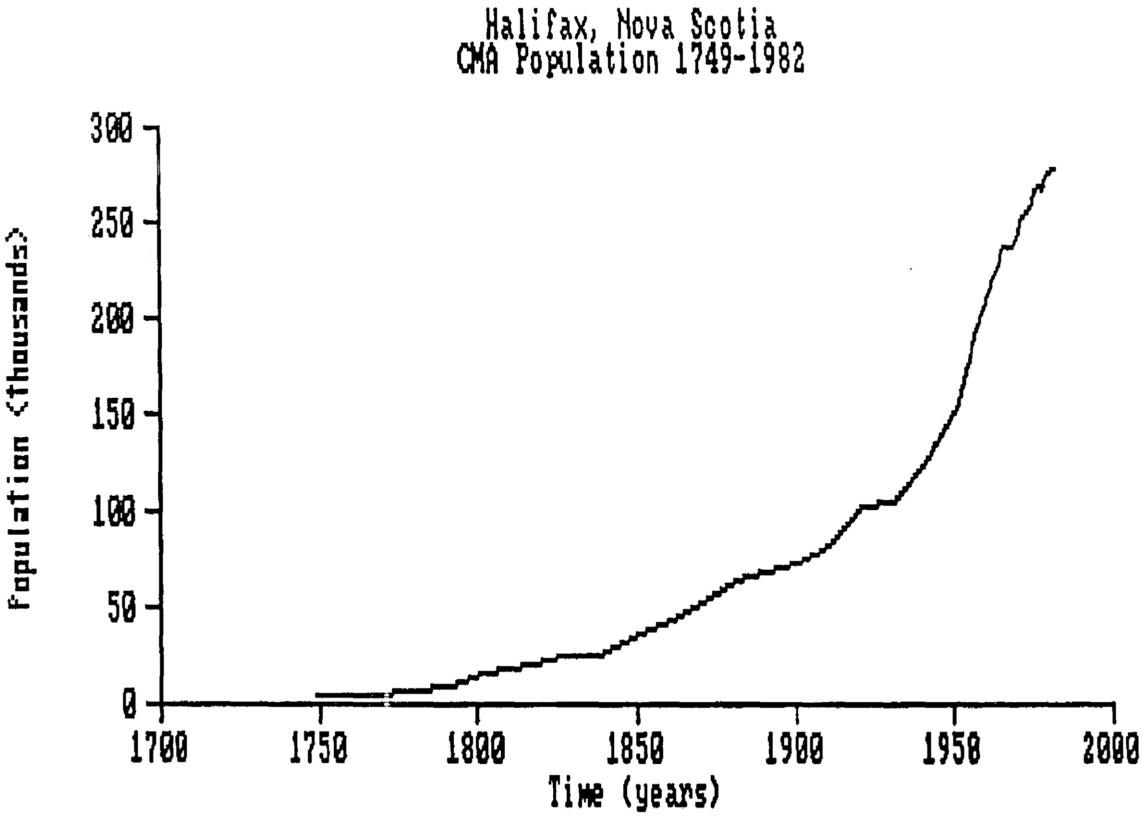

Figure # A.2

YEAR	HALIFAX
1749	4.559
1767	5.348
1791	8.667
1802	15.101
1817	19.746
1827	25.557
1838	25.523
1851	36.725
1861	44.296
1871	52.360
1881	63.897
1891	68.033
1901	72.272
1911	82.515
1921	103.318
1931	104.916
1941	124.763
1951	152.269
1956	187.529
1961	212.688
1966	236.246
1967	236.798
1968	237.829
1969	237.704
1970	242.088
1971	250.581
1972	253.860
1973	256.280
1974	258.320
1975	260.075
1976	267.991
1977	269.146
1978	266.450
1979	274.156
1980	276.278
1981	277.727
1982	279.183

Table # A.2

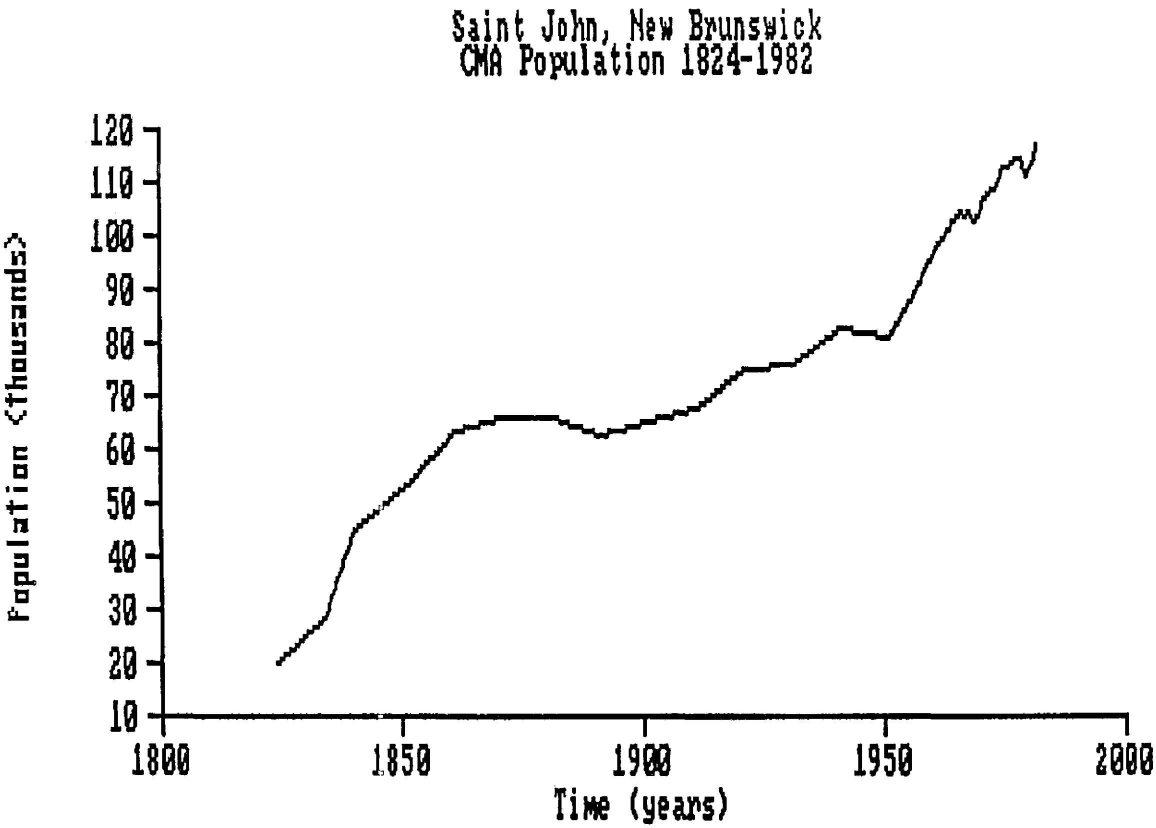

Figure # A.3

YEAR	ST.JOHN	YEAR	ST.JOHN
1824	19.886	1966	104.195
1834	28.250	1967	103.730
1840	45.117	1968	104.390
1851	53.223	1969	103.226
1861	63.921	1970	103.998
1871	66.120	1971	106.744
1881	66.164	1972	108.108
1891	62.686	1973	108.890
1901	65.137	1974	109.791
1911	68.017	1975	112.543
1921	75.465	1976	112.974
1931	76.022	1977	113.840
1941	82.785	1978	114.199
1951	80.689	1979	114.293
1956	88.375	1980	111.100
1961	98.083	1981	114.048
		1982	117.074

Table # A.3

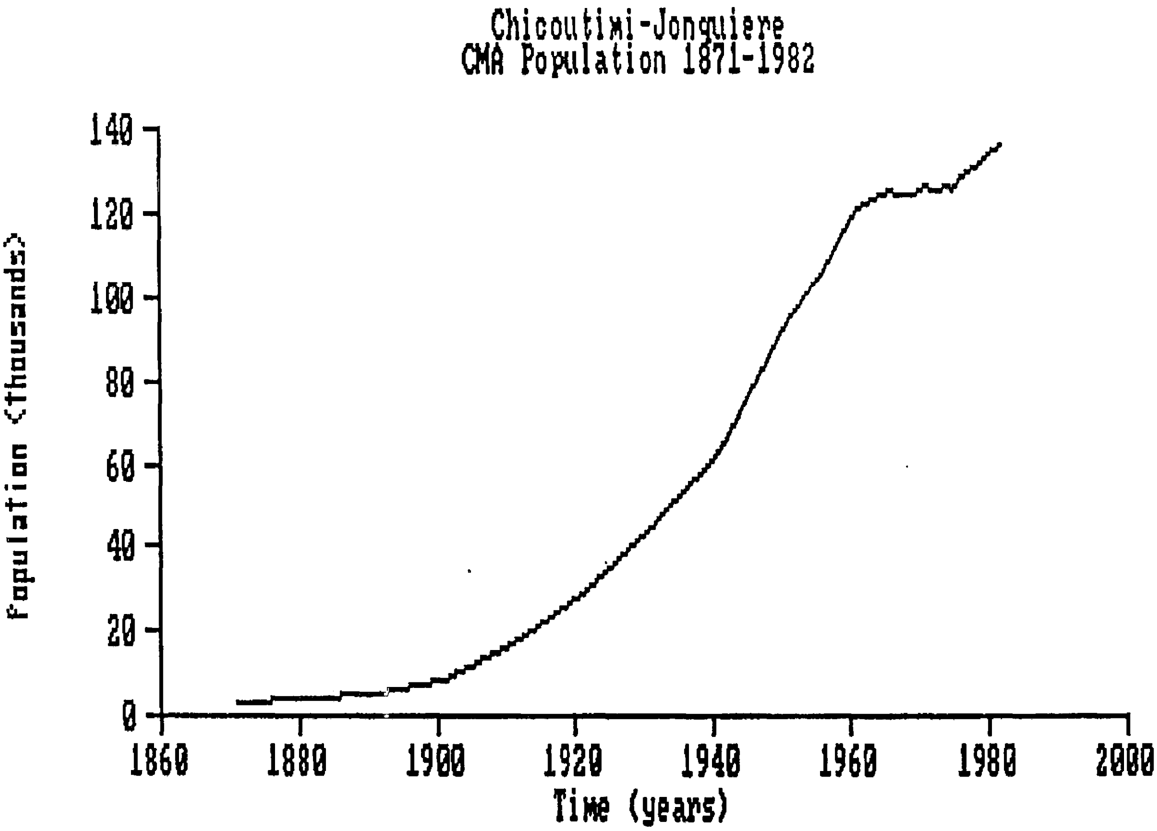

Figure # A.4

YEAR	CHIC-JNQ	YEAR	CHIC-JNQ
1871	2.952	1969	124.058
1881	4.100	1970	125.424
1891	4.825	1971	126.401
1901	8.107	1972	125.378
1911	17.447	1973	125.825
1921	29.215	1974	127.203
1931	45.185	1975	125.791
1941	63.161	1976	128.643
1951	94.775	1977	129.562
1956	106.850	1978	130.868
1961	120.933	1979	132.484
1966	125.693	1980	133.712
1967	124.655	1981	135.172
1968	124.162	1982	136.648

Table # A.4

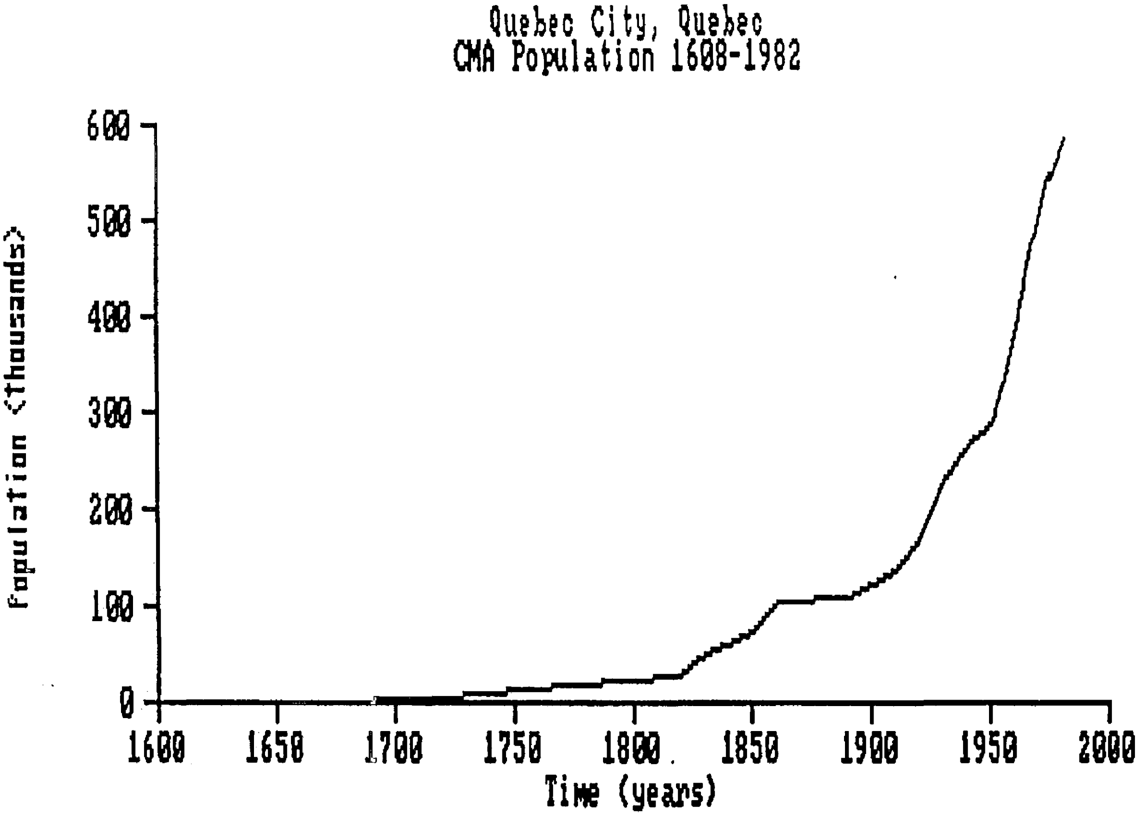

Figure # A.5

YEAR	QUEBEC	YEAR	QUEBEC
1608	.049	1941	265.332
1640	.190	1951	289.294
1665	.963	1956	328.405
1685	2.120	1961	379.067
1695	2.726	1966	455.889
1706	3.116	1967	467.365
1716	4.000	1968	472.438
1739	8.101	1969	484.836
1754	14.081	1970	489.697
1819	26.817	1971	501.365
1825	38.897	1972	515.384
1831	48.824	1973	529.196
1851	74.011	1974	537.127
1861	105.582	1975	549.494
1871	105.070	1976	542.158
1881	109.904	1977	549.410
1891	111.038	1978	555.859
1901	121.158	1979	562.021
1911	137.487	1980	569.659
1921	167.539	1981	576.075
1931	229.845	1982	582.563

Table # A.5

Trois-Rivieres, Quebec
CMA Population 1666-1982

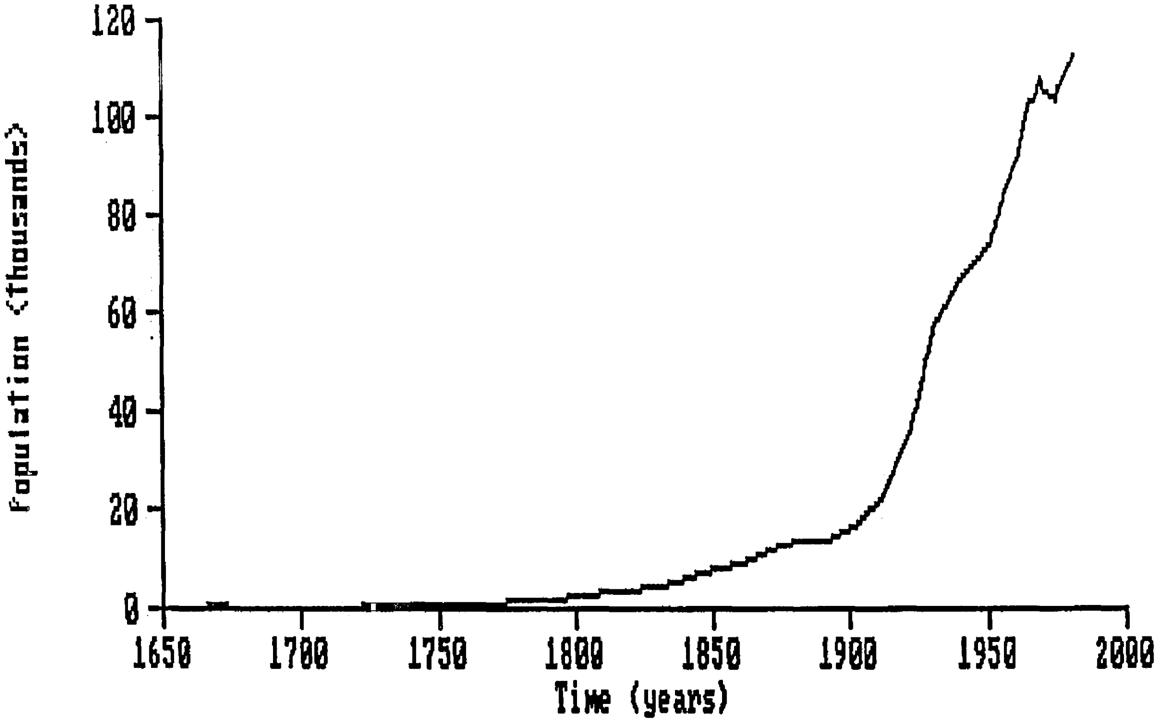

Figure # A.6

YEAR	TROIS-RIVIERES	YEAR	TROIS-RIVIERES
1666	.733	1956	85.003
1681	.242	1961	90.923
1706	.327	1966	102.679
1739	.609	1967	102.717
1760	.944	1968	103.954
1790	1.954	1969	106.532
1815	4.028	1970	107.816
1831	4.233	1971	105.327
1851	7.953	1972	104.768
1861	9.295	1973	104.297
1871	12.197	1974	103.619
1881	13.889	1975	103.428
1891	13.428	1976	106.031
1901	16.082	1977	106.874
1911	22.060	1978	107.927
1921	36.039	1979	109.398
1931	57.119	1980	110.472
1941	67.684	1981	111.453
1951	74.237	1982	112.442

Table # A.6

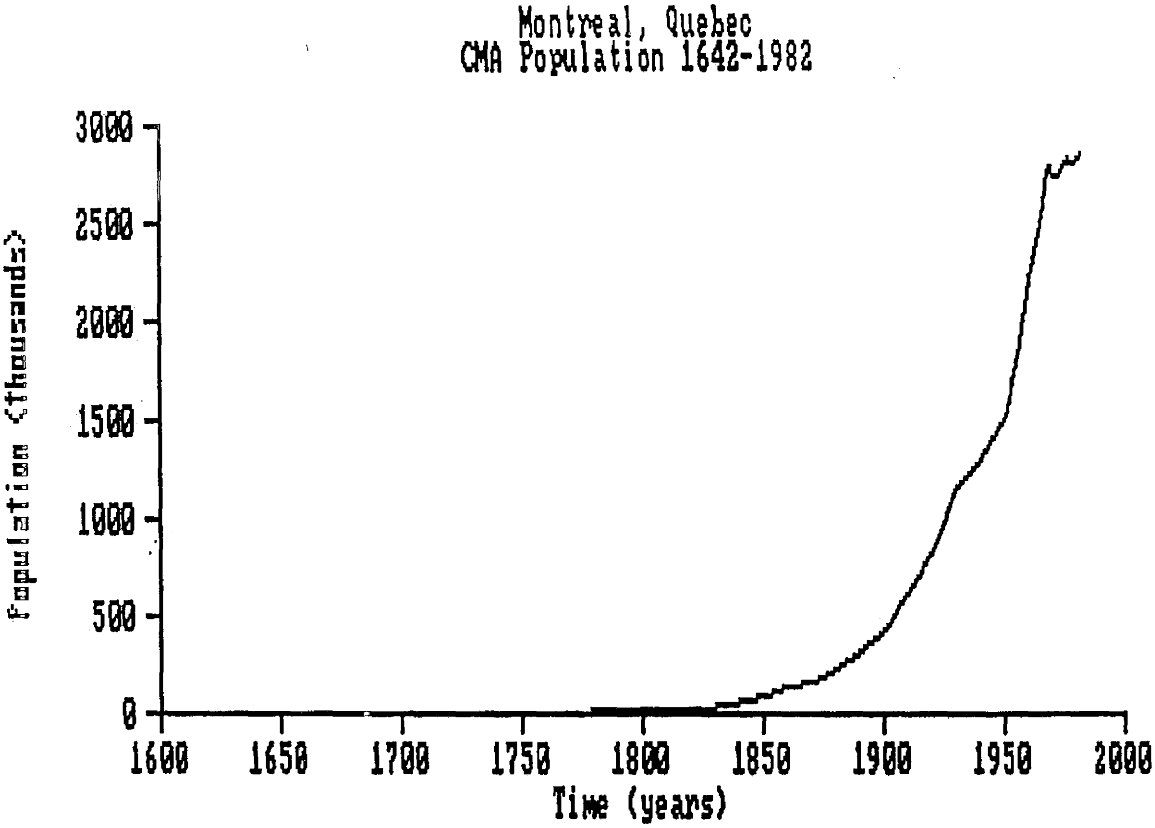

Figure # A.7

YEAR	MONTREAL		
1642	.625	1951	1639.308
1681	1.418	1956	1830.232
1698	1.185	1961	2215.627
1706	2.025	1966	2557.920
1739	4.210	1967	2587.237
1754	4.000	1968	2709.050
1765	5.733	1969	2780.317
1790	18.000	1970	2777.596
1825	31.516	1971	2729.271
1844	57.715	1972	2748.650
1851	91.647	1973	2745.801
1861	138.077	1974	2751.432
1871	168.531	1975	2797.521
1881	226.010	1976	2802.547
1891	324.704	1977	2821.883
1901	422.180	1978	2800.156
1911	649.093	1979	2803.416
1921	847.319	1980	2809.885
1931	1174.525	1981	2828.349
1941	1306.656	1982	2846.935

Table # A.7

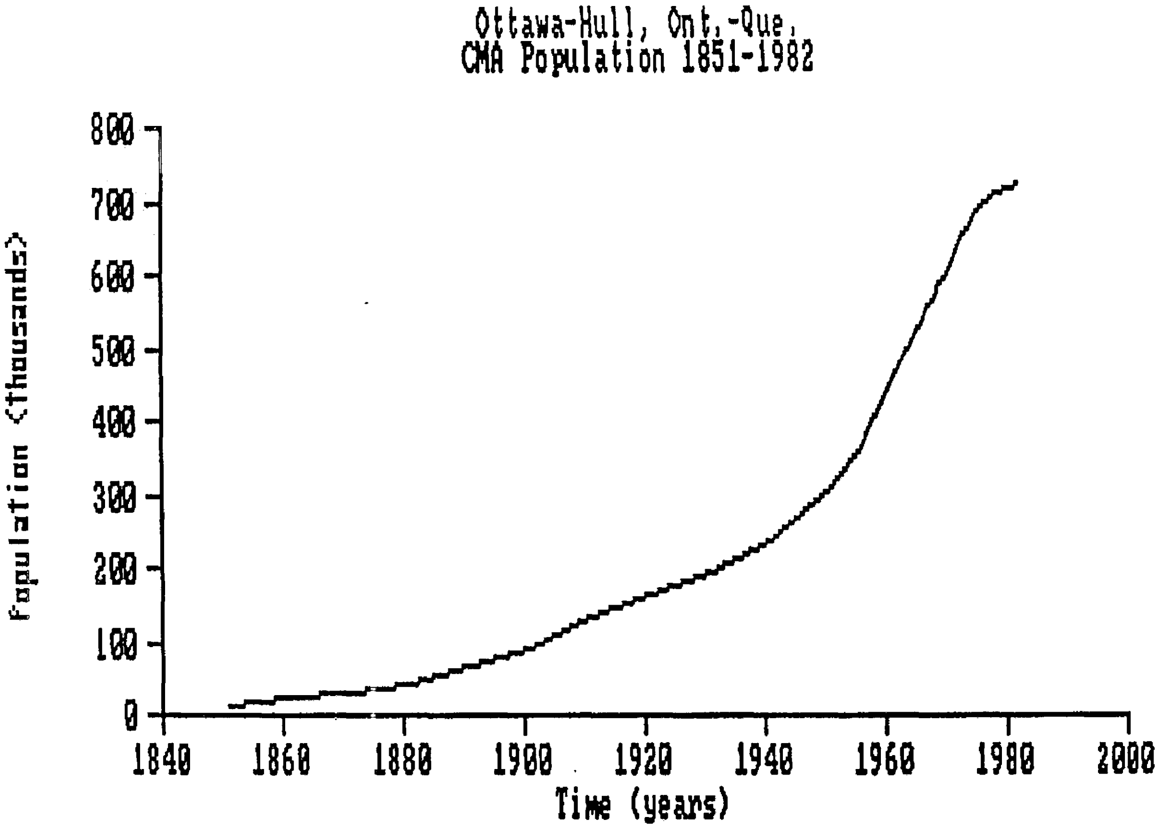

Figure # A.8

YEAR	OTTAWA-HULL	YEAR	OTTAWA-HULL
1851	11.950	1968	568.457
1861	22.590	1969	590.584
1871	33.179	1970	600.928
1881	42.214	1971	619.861
1891	67.997	1972	636.725
1901	92.289	1973	655.886
1911	134.075	1974	668.593
1921	166.078	1975	686.019
1931	195.382	1976	693.288
1941	238.624	1977	701.591
1951	311.587	1978	709.733
1956	367.756	1979	713.056
1961	457.038	1980	714.950
1966	544.042	1981	717.978
1967	558.674	1982	721.039

Table # A.8

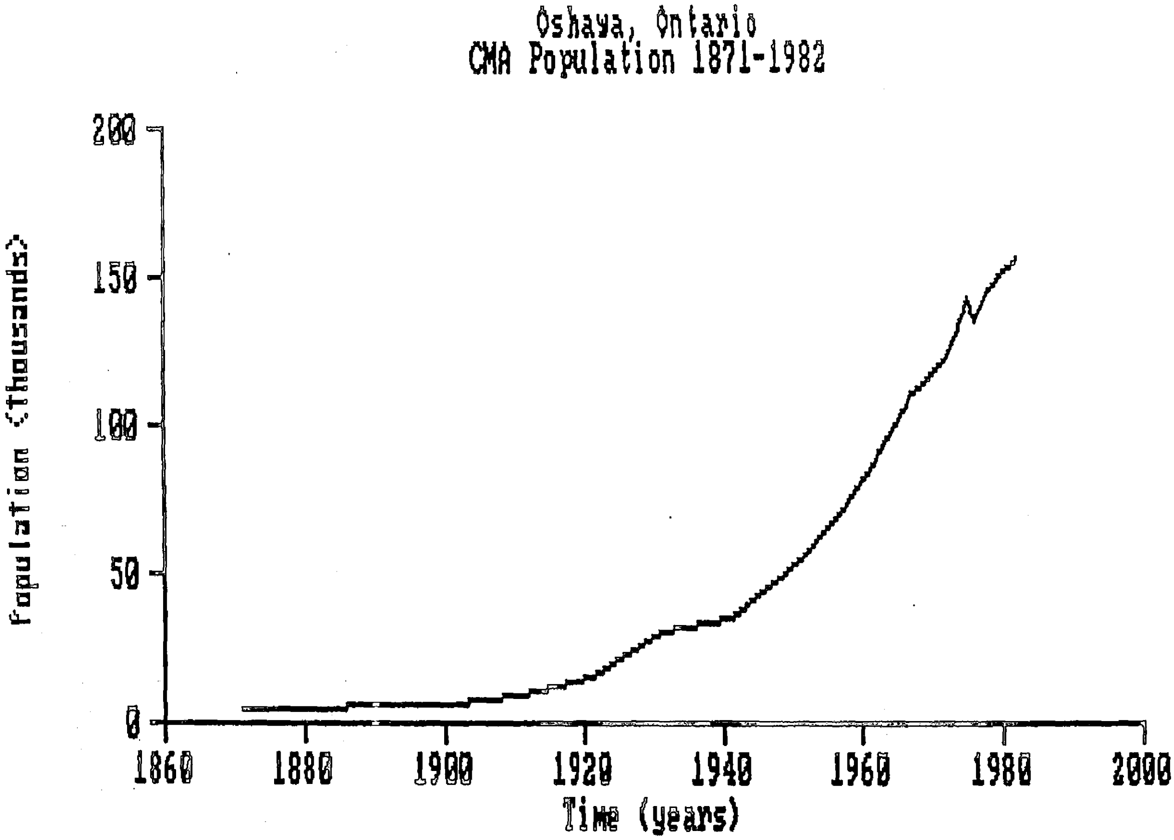

Figure # A.9

YEAR	OSHAWA		
1871	4.208	1969	114.856
1881	5.274	1970	118.476
1891	5.372	1971	120.318
1901	5.806	1972	123.491
1911	9.825	1973	129.365
1921	15.776	1974	135.952
1931	30.969	1975	142.595
1941	35.427	1976	135.196
1951	54.771	1977	140.913
1956	68.798	1978	146.675
1961	85.921	1979	149.757
1966	106.453	1980	152.343
1967	110.869	1981	154.217
1968	113.061	1982	156.114

Table # A.9

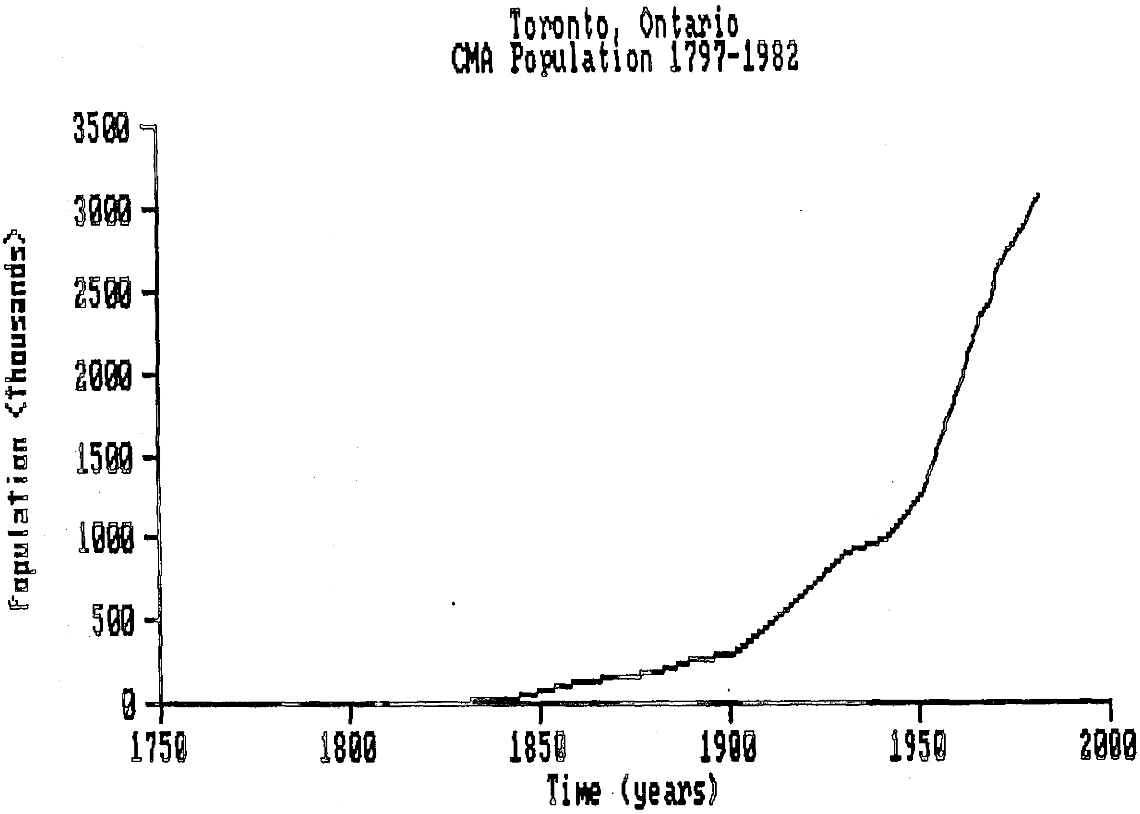

Figure # A.10

YEAR	TORONTO	YEAR	TORONTO	YEAR	TORONTO
1797	.650	1825	4.527	1901	300.108
1799	1.136	1826	4.641	1911	475.801
1800	1.088	1827	4.905	1921	683.476
1801	.907	1828	6.034	1931	898.342
1802	.864	1829	6.779	1941	997.080
1804	1.166	1830	7.722	1951	1261.861
1805	1.277	1831	10.716	1956	1571.952
1806	1.085	1832	14.863	1961	1919.409
1807	1.117	1833	16.453	1966	2267.293
1808	1.317	1834	24.980	1967	2332.612
1809	1.557	1835	26.365	1968	2380.247
1811	1.846	1836	26.065	1969	2424.377
1812	1.898	1837	29.351	1970	2515.863
1813	1.687	1838	33.941	1971	2602.098
1814	1.865	1839	32.813	1972	2655.213
1816	1.944	1840	35.348	1973	2691.759
1817	2.343	1841	38.742	1974	2740.335
1818	2.856	1848	63.458	1975	2774.721
1819	3.169	1850	67.813	1976	2803.101
1820	3.348	1851	83.092	1977	2835.786
1821	4.209	1861	121.016	1978	2867.177
1822	3.607	1871	151.373	1979	2900.700
1823	3.591	1881	186.796	1980	2949.885
1824	4.549	1891	277.205	1981	2998.947
				1982	3048.825

Table # A.10

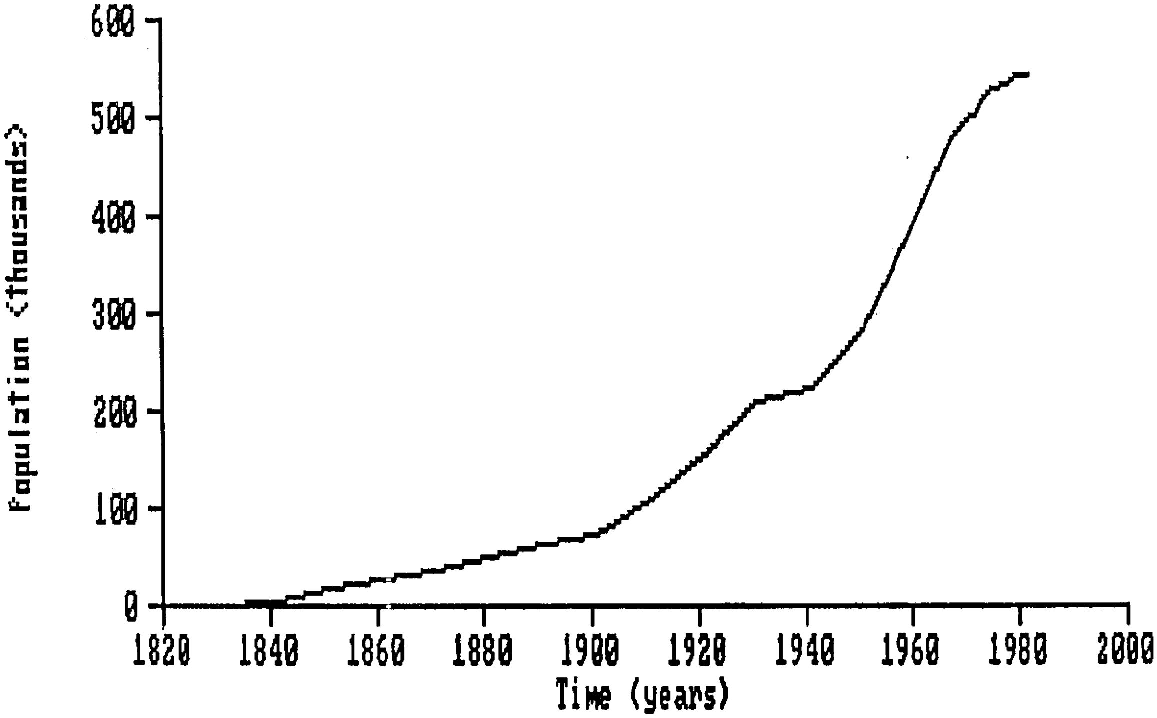

Figure # A.11

YEAR	HAMILTON	YEAR	HAMILTON
1834	1.845	1961	401.071
1837	4.304	1966	461.630
1839	3.908	1967	476.526
1841	4.609	1968	484.124
1848	13.350	1969	488.849
1851	19.064	1970	494.562
1861	25.797	1971	503.122
1871	36.092	1972	503.319
1881	48.547	1973	513.937
1891	66.094	1974	520.341
1901	71.055	1975	528.176
1911	110.658	1976	529.371
1921	154.103	1977	531.669
1931	209.988	1978	533.862
1941	224.554	1979	536.442
1951	281.901	1980	540.713
1956	341.513	1981	542.095
		1982	543.480

Table # A.11

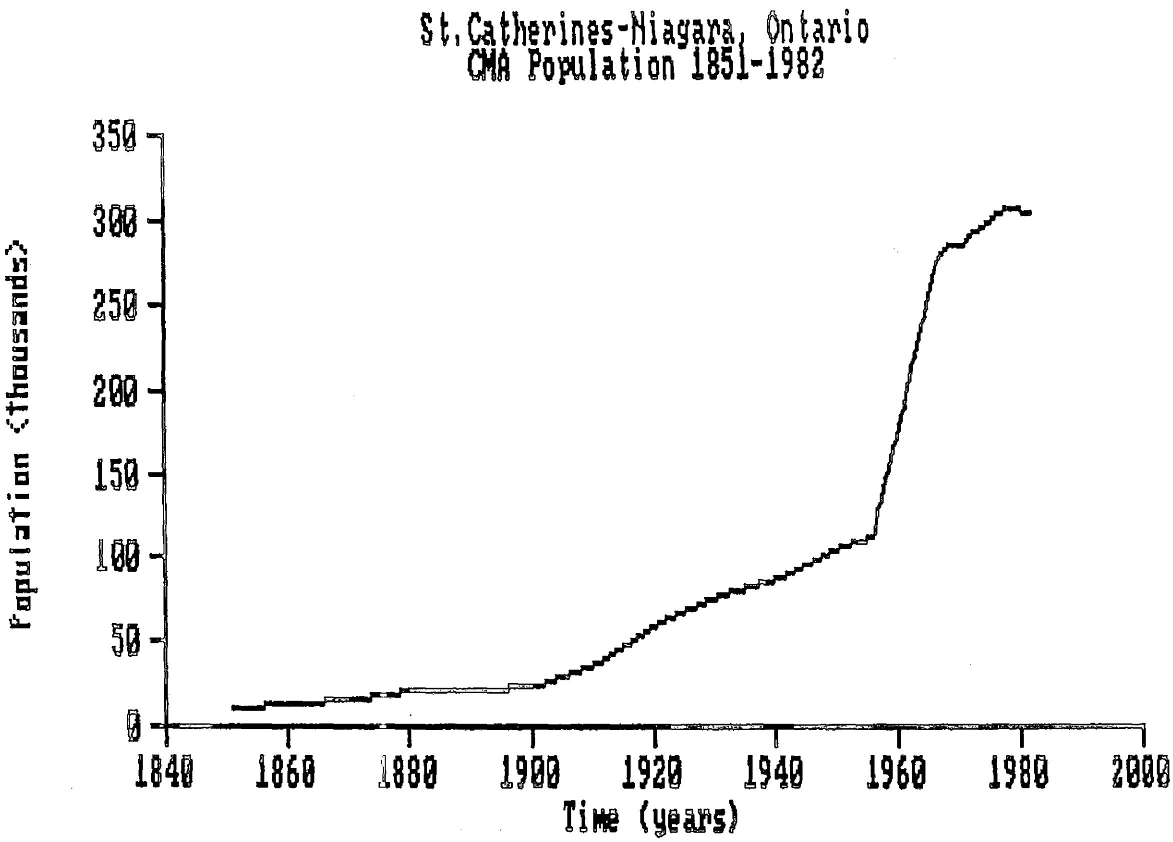

Figure # A.12

YEAR	KITCHENER		
1871	4.061	1969	226.429
1881	6.002	1970	233.104
1891	10.993	1971	238.574
1901	14.430	1972	242.253
1911	22.497	1973	249.414
1921	32.220	1974	260.249
1931	45.589	1975	267.048
1941	52.790	1976	272.158
1951	93.284	1977	276.434
1956	118.270	1978	280.145
1961	162.871	1979	282.822
1966	202.216	1980	286.065
1967	209.394	1981	287.801
1968	218.275	1982	289.548

Table # A.12

Kitchener, Ontario
CMA Population 1871-1982

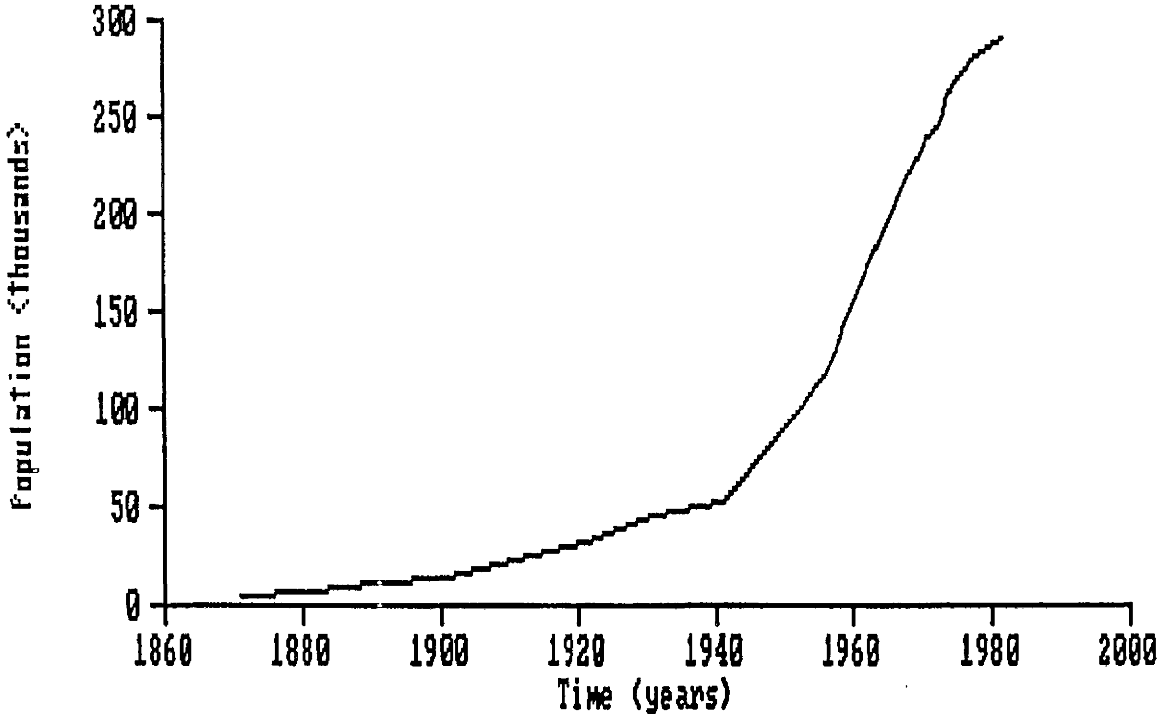

Figure # A.13

YEAR	ST.CATHERINES
1851	9.372
1871	16.541
1881	20.913
1891	21.857
1901	24.775
1911	37.943
1921	60.488
1931	76.470
1941	88.806
1951	106.254
1956	110.467
1961	186.507
1966	268.861
1967	276.414
1968	281.969
1969	284.295
1970	285.049
1971	285.802
1972	289.560
1973	291.922
1974	296.680
1975	299.133
1976	301.921
1977	303.927
1978	305.851
1979	305.710
1980	305.403
1981	304.353
1982	303.306

Table # A.13

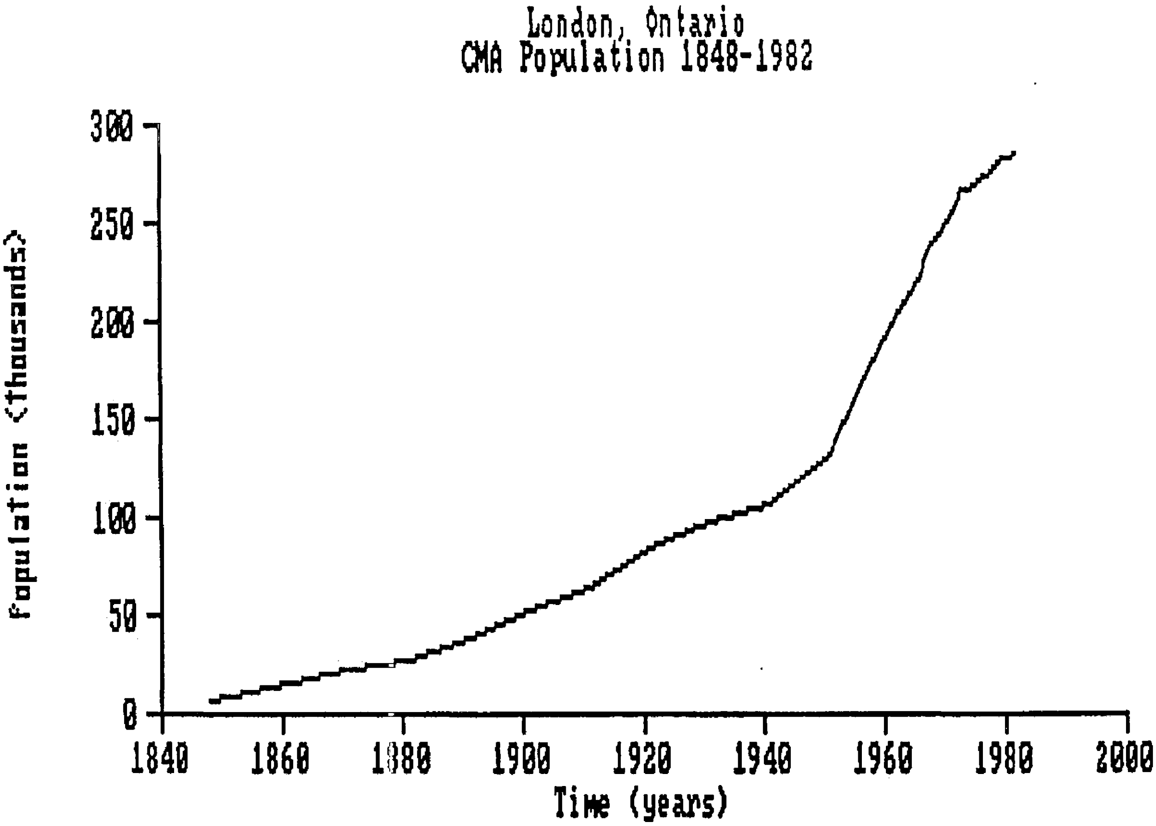

Figure # A.14

YEAR	LONDON
1848	6.321
1871	21.816
1881	27.230
1891	38.462
1901	52.370
1911	63.849
1921	84.064
1931	98.115
1941	107.748
1951	131.480
1956	167.118
1961	196.148
1966	224.402
1967	233.621
1968	239.803
1969	242.504
1970	248.733
1971	252.981
1972	258.598
1973	266.254
1974	266.296
1975	269.368
1976	270.383
1977	272.770
1978	276.940
1979	279.597
1980	281.989
1981	283.668
1982	285.357

Table # A.14

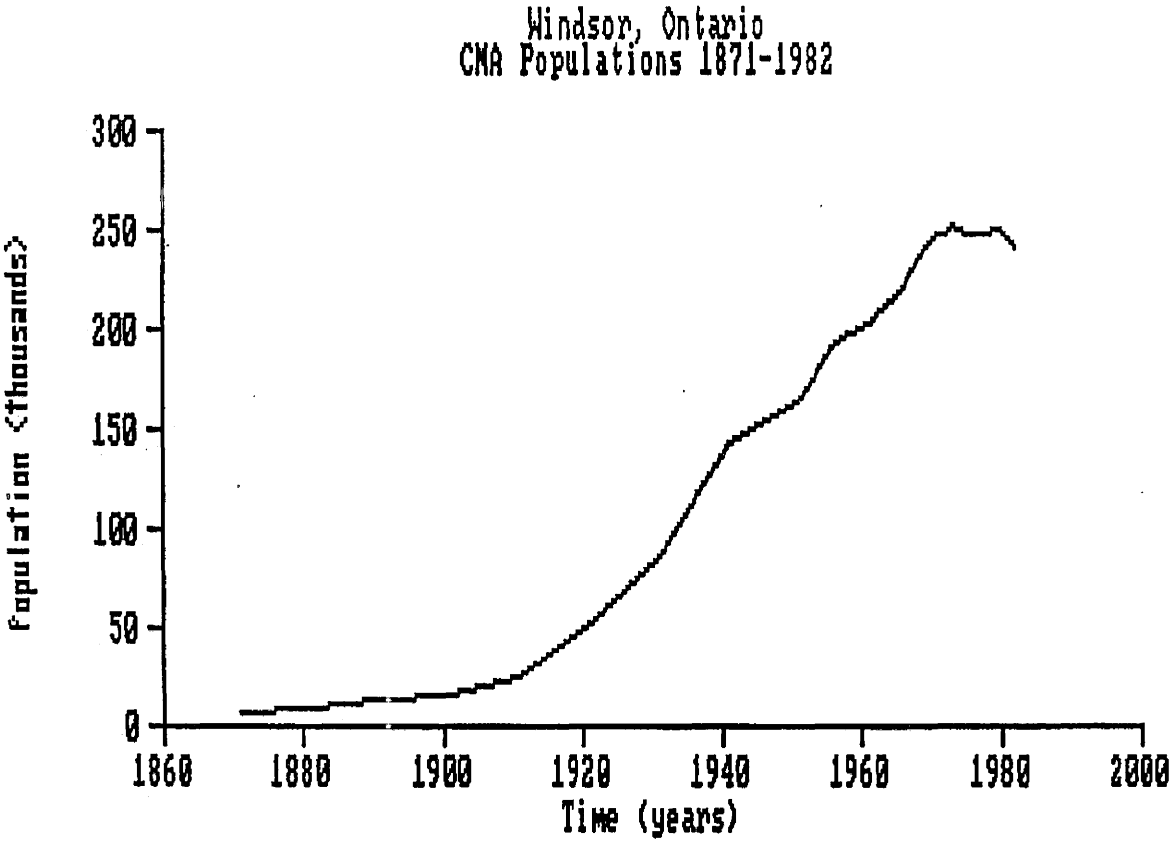

Figure # A.15

YEAR	WINDSOR		
1871	5.844	1969	242.633
1881	9.016	1970	245.904
1891	14.184	1971	248.718
1901	16.700	1972	249.642
1911	24.499	1973	252.573
1921	53.029	1974	250.017
1931	86.718	1975	249.397
1941	144.710	1976	247.582
1951	164.962	1977	248.068
1956	194.962	1978	249.264
1961	202.305	1979	250.215
1966	221.485	1980	250.132
1967	229.121	1981	246.110
1968	234.206	1982	242.152

Table # A.15

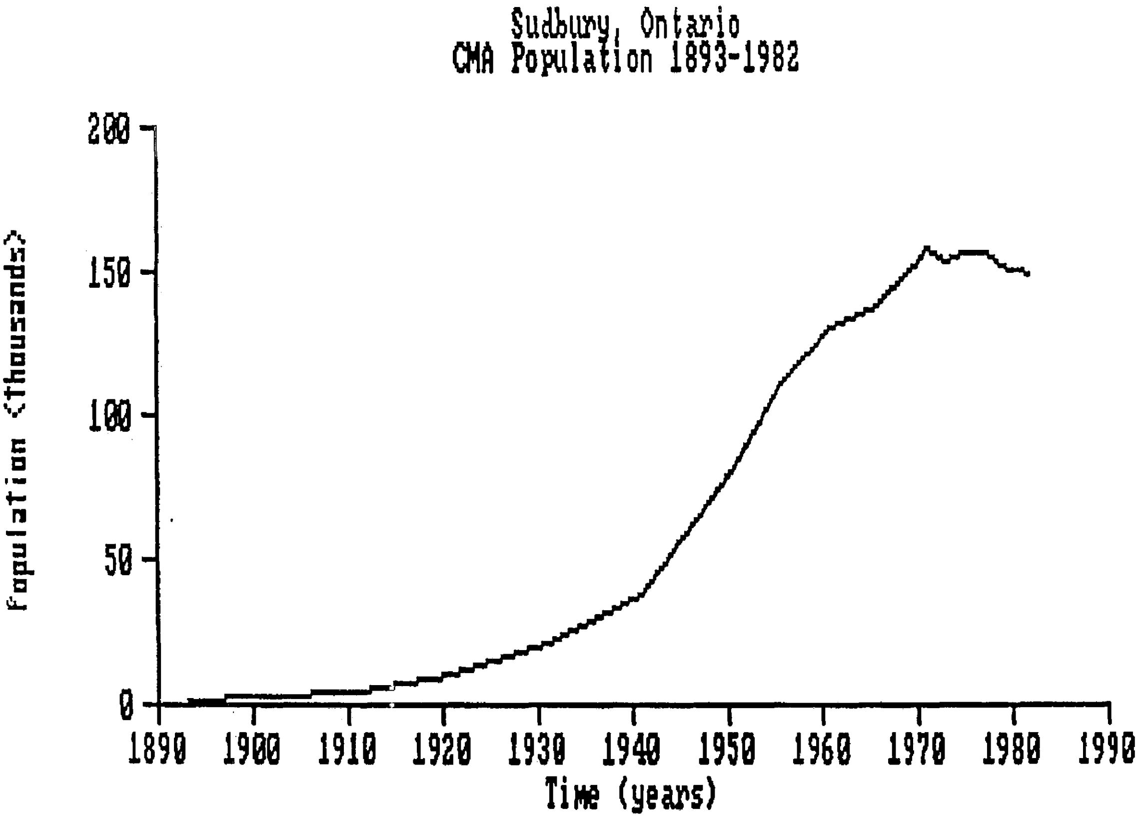

Figure # A.16

YEAR	SUDBURY		
1893	.942	1970	152.737
1901	2.402	1971	157.721
1911	4.919	1972	156.405
1921	10.218	1973	153.882
1931	21.948	1974	155.034
1941	38.168	1975	156.030
1951	84.013	1976	157.030
1956	113.286	1977	156.925
1961	131.197	1978	155.854
1966	138.760	1979	152.133
1967	142.237	1980	150.425
1968	146.508	1981	149.923
1969	150.460	1982	149.423

Table # A.16

Thunder Bay, Ontario
CMA Population 1881-1982

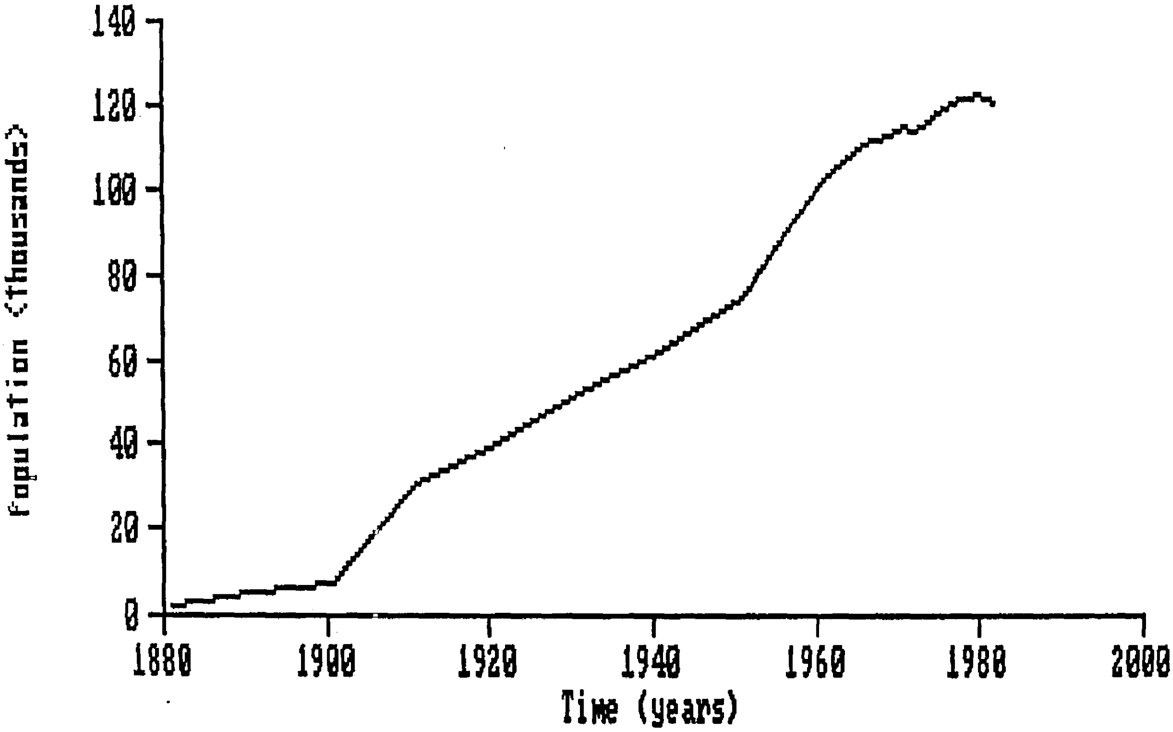

Figure # A.17

YEAR	THUNDER BAY	YEAR	THUNDER BAY
1881	2.222	1969	112.780
1891	5.511	1970	113.584
1901	7.742	1971	114.708
1911	31.344	1972	113.910
1921	40.060	1973	114.848
1931	52.123	1974	116.025
1941	62.205	1975	117.915
1951	74.753	1976	119.253
1956	88.294	1977	120.660
1961	102.323	1978	121.117
1966	110.555	1979	121.889
1967	112.040	1980	122.028
1968	112.138	1981	121.379
		1982	120.733

Table # A.17

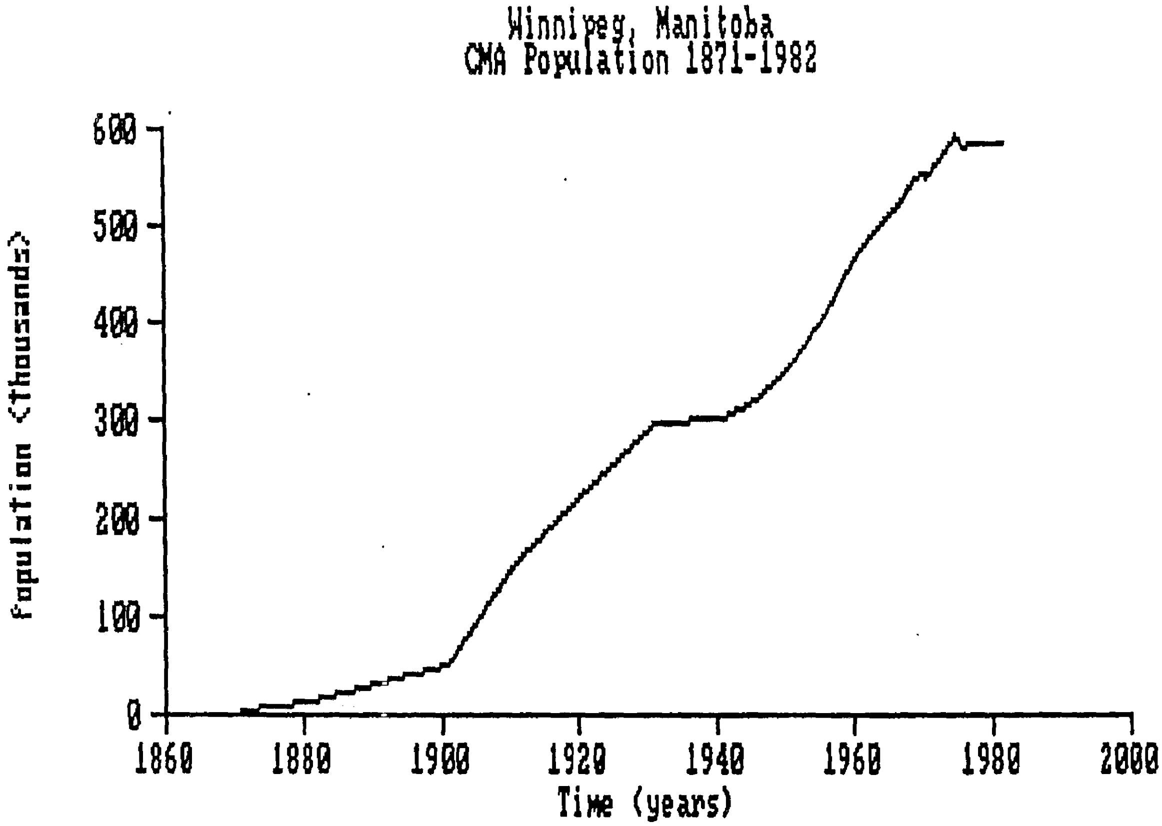

Figure # A.18

YEAR	WINNIPEG
1871	2.949
1881	12.514
1891	30.153
1901	48.488
1911	156.969
1921	229.212
1931	294.905
1941	302.024
1946	320.484
1951	357.229
1956	412.741
1961	476.543
1966	517.748
1967	522.125
1968	534.439
1969	549.806
1970	553.979
1971	549.808
1972	560.111
1973	570.976
1974	581.688
1975	592.554
1976	578.217
1977	583.026
1978	585.778
1979	585.019
1980	583.637
1981	584.842
1982	586.049

Table # A.18

Regina, Saskatchewan
CMA Population 1901-1982

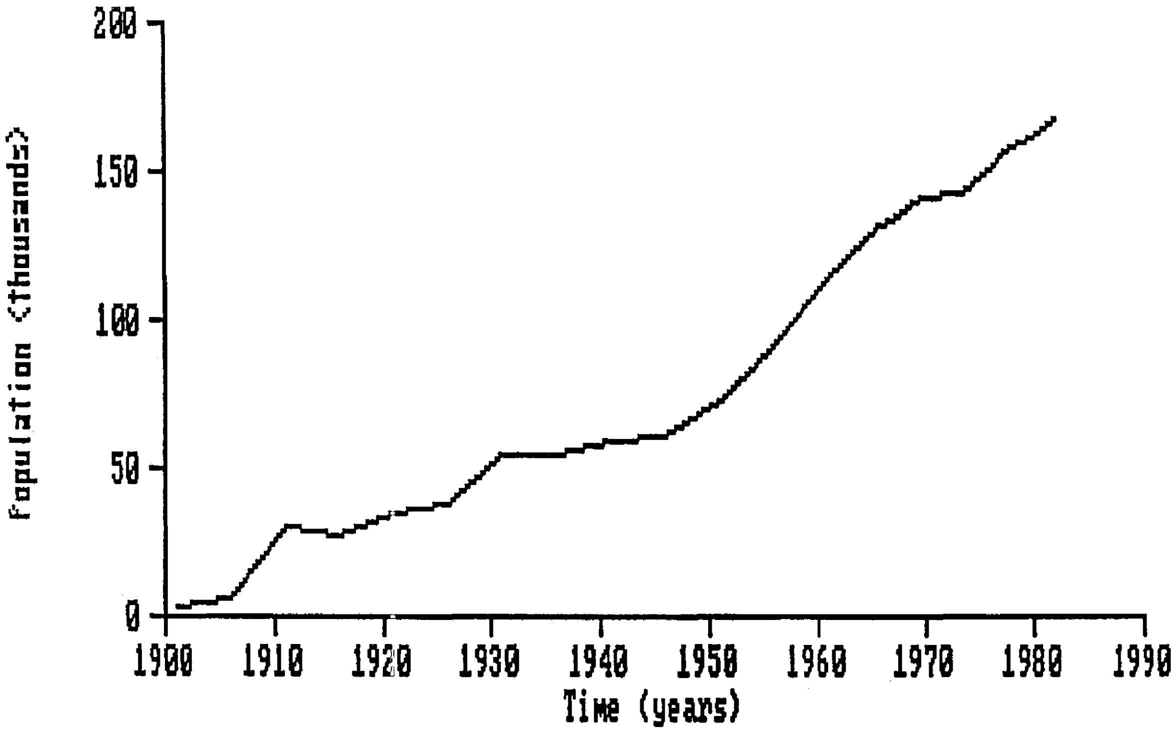

Figure # A.19

YEAR	REGINA		
1901	2.293	1968	137.307
1906	6.292	1969	139.945
1911	30.817	1970	140.779
1916	26.649	1971	140.734
1921	35.120	1972	143.081
1926	38.075	1973	143.017
1931	54.273	1974	144.166
1936	54.421	1975	147.346
1941	59.409	1976	151.191
1946	61.450	1977	154.536
1951	72.731	1978	157.726
1956	91.215	1979	159.373
1961	113.749	1980	161.759
1966	132.432	1981	164.313
1967	134.231	1982	166.908

Table # A.19

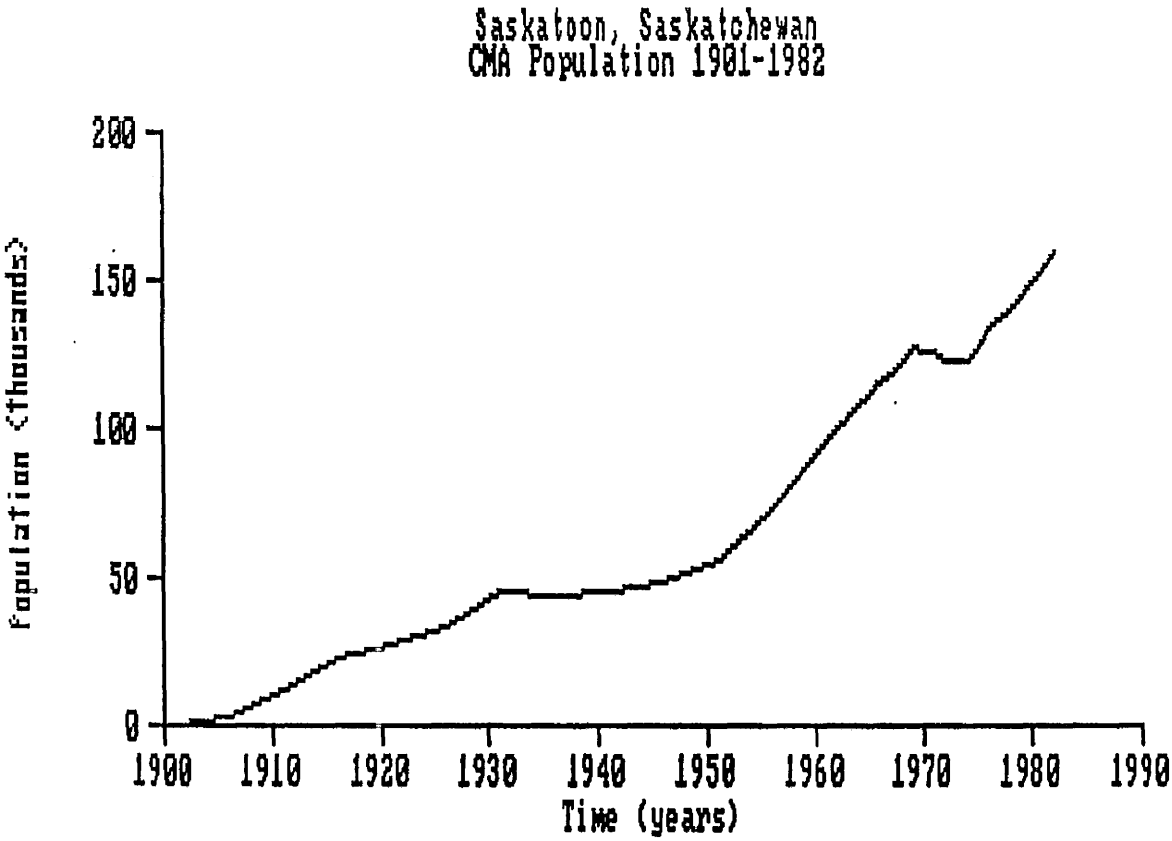

Figure # A.20

YEAR	SASKATOON	YEAR	SASKATOON
1901	.118	1968	123.783
1906	3.161	1969	128.095
1911	12.604	1970	126.563
1916	22.100	1971	126.490
1921	27.025	1972	123.513
1926	32.795	1973	122.682
1931	45.455	1974	123.150
1936	43.820	1975	126.097
1941	45.178	1976	133.793
1946	48.329	1977	136.828
1951	55.679	1978	139.867
1956	72.930	1979	144.029
1961	95.564	1980	148.837
1966	115.937	1981	154.210
1967	118.633	1982	159.777

Table # A.20

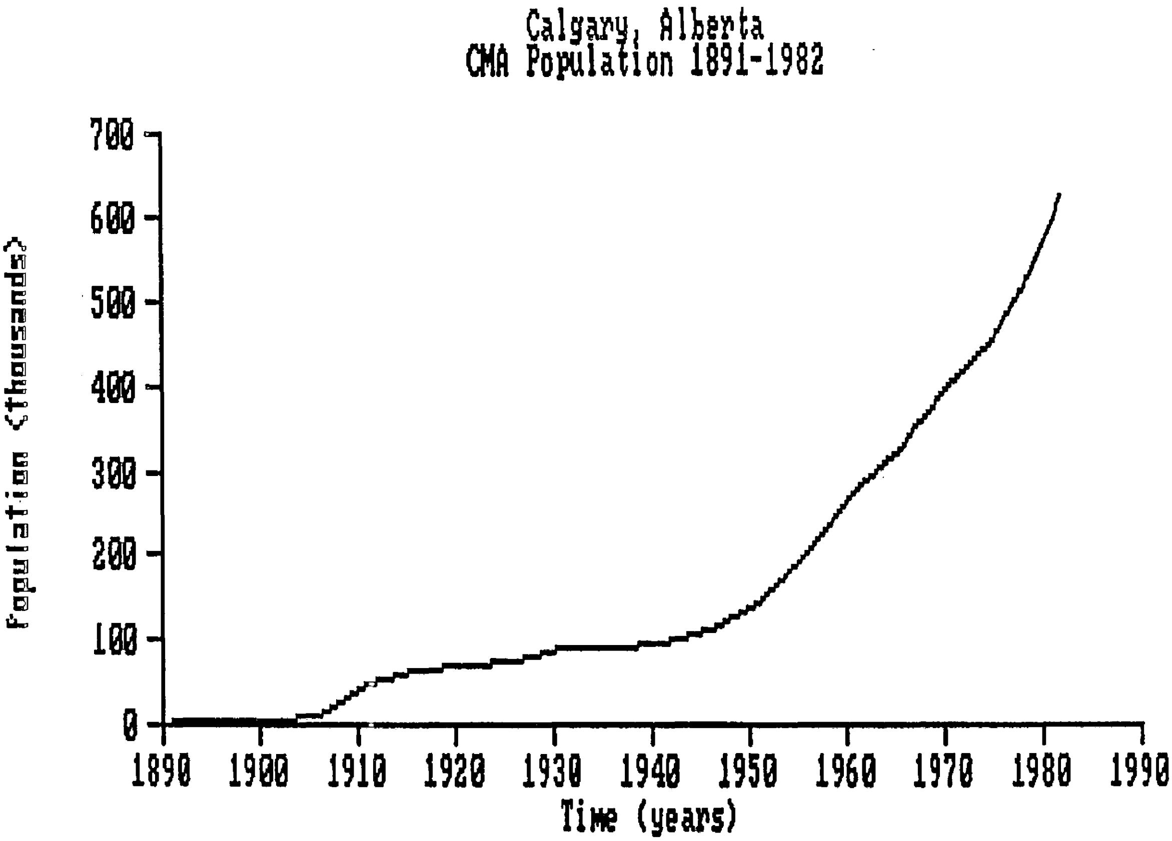

Figure # A.21

YEAR	CALGARY		
1891	4.266	1967	349.118
1901	4.567	1968	363.587
1906	13.163	1969	380.081
1911	48.074	1970	392.918
1916	62.165	1971	404.613
1921	69.635	1972	416.782
1926	72.064	1973	430.270
1931	92.137	1974	440.835
1936	91.747	1975	453.438
1941	97.794	1976	471.397
1946	110.048	1977	493.323
1951	142.315	1978	514.857
1956	201.022	1979	536.895
1961	279.062	1980	562.720
1966	331.636	1981	592.743
		1982	624.368

Table # A.21

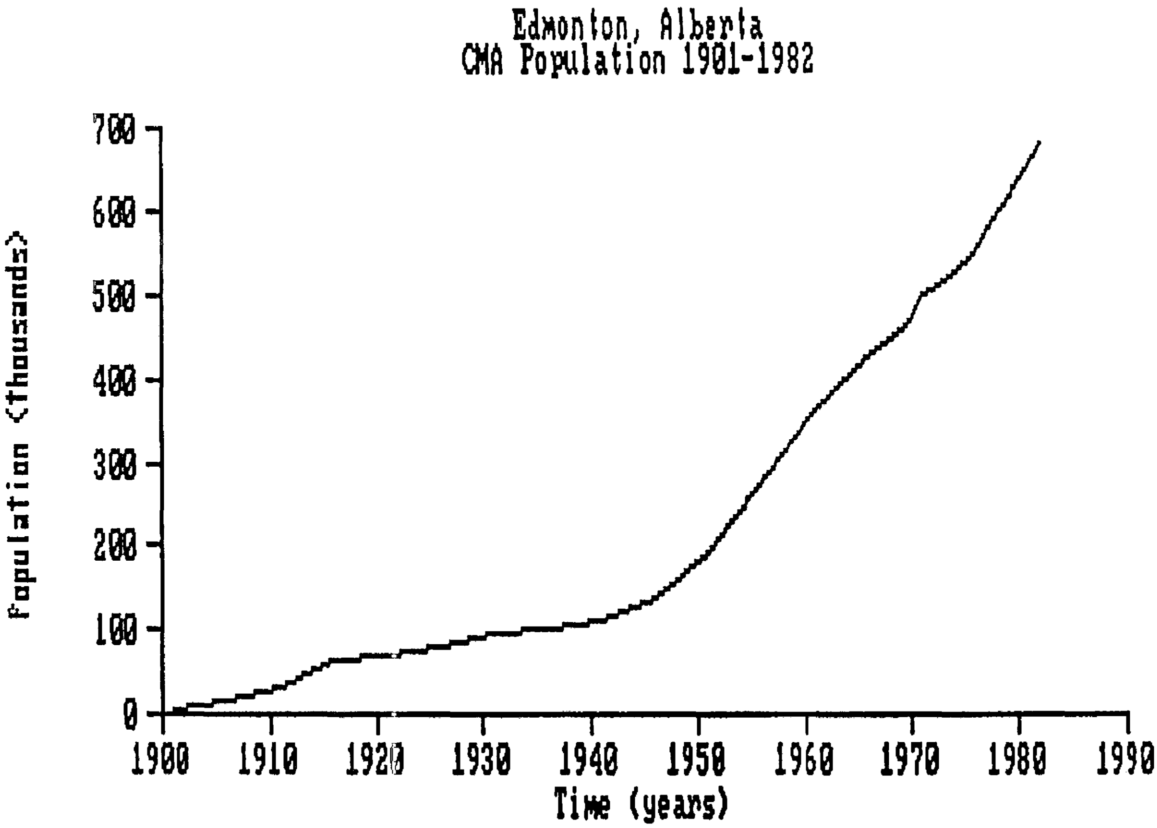

Figure # A.22

YEAR	EDMONTON		
1901	3.177	1968	444.820
1906	13.512	1969	455.268
1911	30.129	1970	468.344
1916	65.153	1971	497.842
1921	71.173	1972	507.705
1926	78.847	1973	518.546
1931	95.828	1974	528.128
1936	103.786	1975	539.918
1941	113.518	1976	556.270
1946	136.870	1977	575.805
1951	193.547	1978	594.467
1956	274.895	1979	612.788
1961	359.779	1980	633.807
1966	427.206	1981	657.057
1967	435.287	1982	681.160

Table # A.22

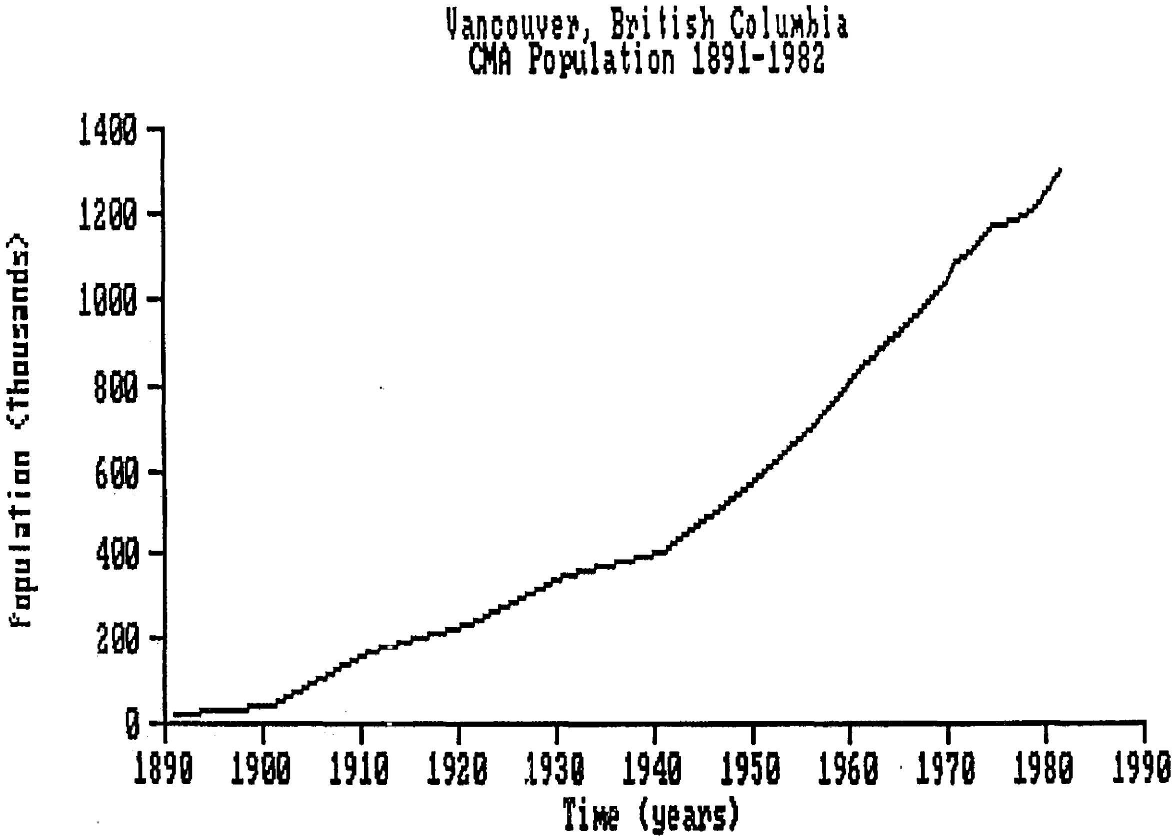

Figure # A.23

YEAR	VANCOUVER
1891	19.466
1901	41.793
1911	171.602
1921	231.542
1931	348.519
1941	409.262
1951	587.635
1956	695.760
1961	828.248
1966	933.091
1967	961.676
1968	986.976
1969	1007.281
1970	1032.955
1971	1082.352
1972	1100.627
1973	1122.671
1974	1147.017
1975	1169.792
1976	1166.348
1977	1176.985
1978	1190.580
1979	1206.044
1980	1235.830
1981	1268.183
1982	1301.383

Table # A.23

Victoria, British Columbia
CMA Population 1871-1982

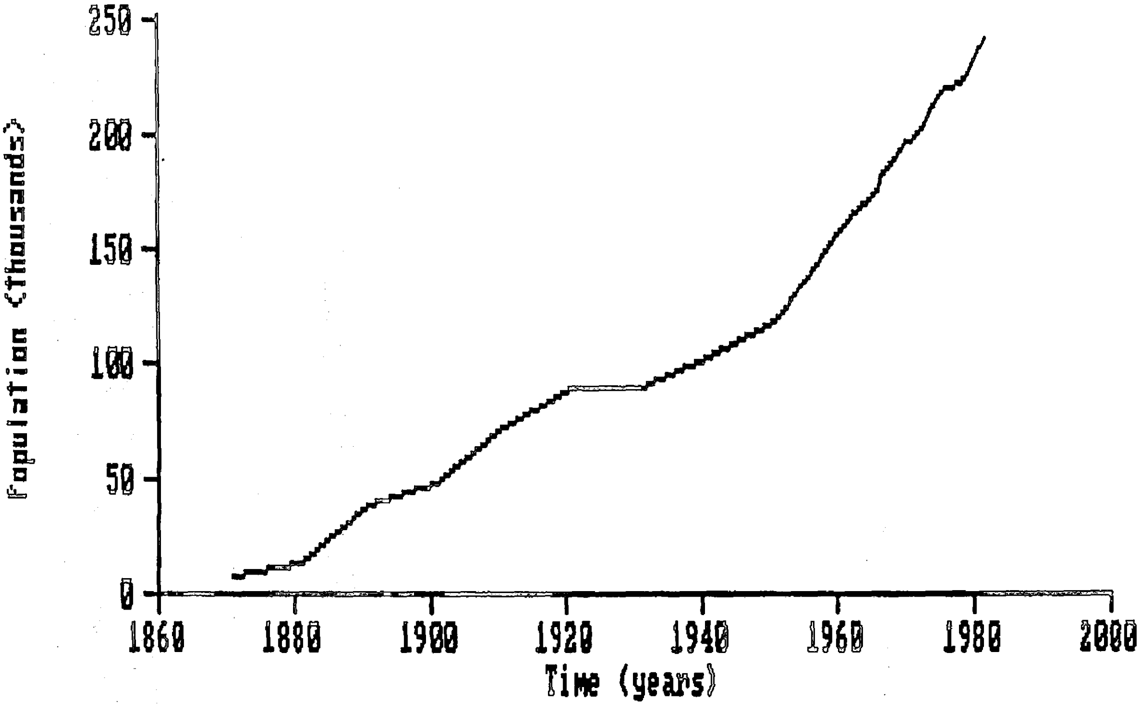

Figure # A.24

YEAR	VICTORIA		
1871	7.565	1969	190.739
1881	13.686	1970	195.784
1891	38.902	1971	195.800
1901	48.322	1972	199.217
1911	73.134	1973	204.241
1921	89.603	1974	209.629
1931	90.279	1975	215.174
1941	101.797	1976	218.250
1951	118.380	1977	218.740
1956	138.992	1978	220.074
1961	159.088	1979	222.566
1966	175.262	1980	228.133
1967	182.543	1981	233.481
1968	186.427	1982	238.954

Chart # A.24

APPENDIX B

Rankings, Rank-Size Distributions and

Logarithmic Rank-Size Distributions

for Fourteen periods 1851-1981

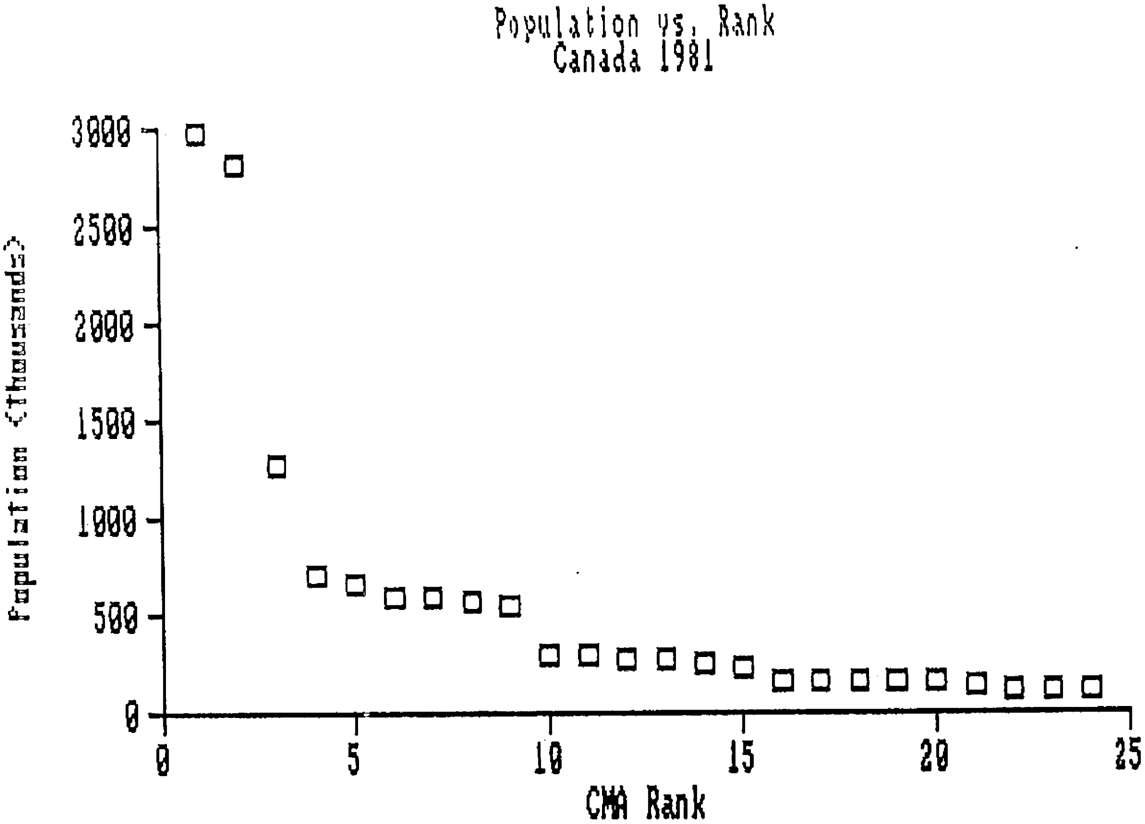

Figure # B.1.a

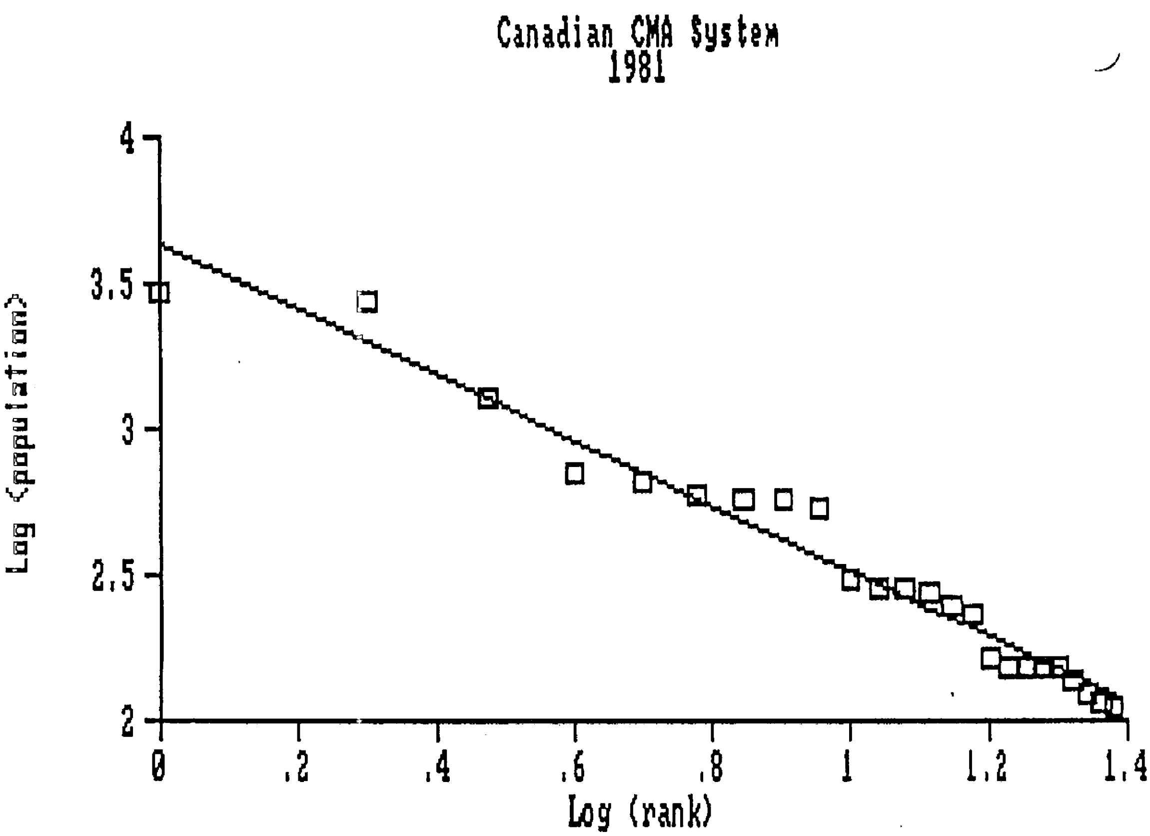

Figure # B.1.b

RANK	CMA	1981
1.	TORONTO	2998.947
2.	MONTREAL	2828.349
3.	VANCOUVER	1268.183
4.	OTTAWA-H	717.978
5.	EDMONTON	657.057
6.	CALGARY	592.743
7.	WINNIPEG	584.842
8.	QUEBEC	576.075
9.	HAMILTON	542.095
10.	ST.CATRNS	304.353
11.	KITCHENER	287.801
12.	LONDON	283.668
13.	HALIFAX	277.727
14.	WINDSOR	246.110
15.	VICTORIA	233.481
16.	REGINA	164.313
17.	ST.JOHN'S	154.820
18.	OSHAWA	154.217
19.	SASKATOON	154.210
20.	SUDBURY	149.923
21.	CHIC-JNQ	135.172
22.	THUNDERBY	121.379
23.	ST.JOHN	114.048
24.	TROIS-RIV	111.453

Table # B.1

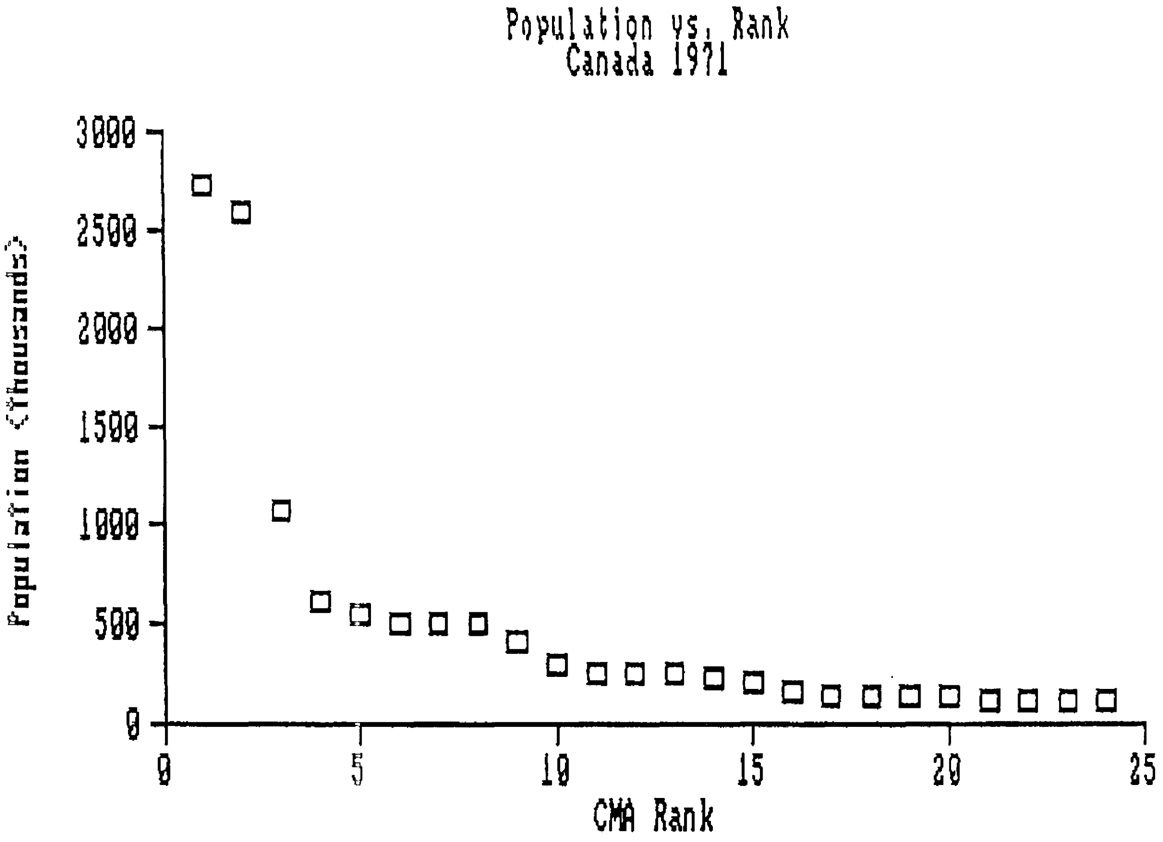

Figure # B.2.a

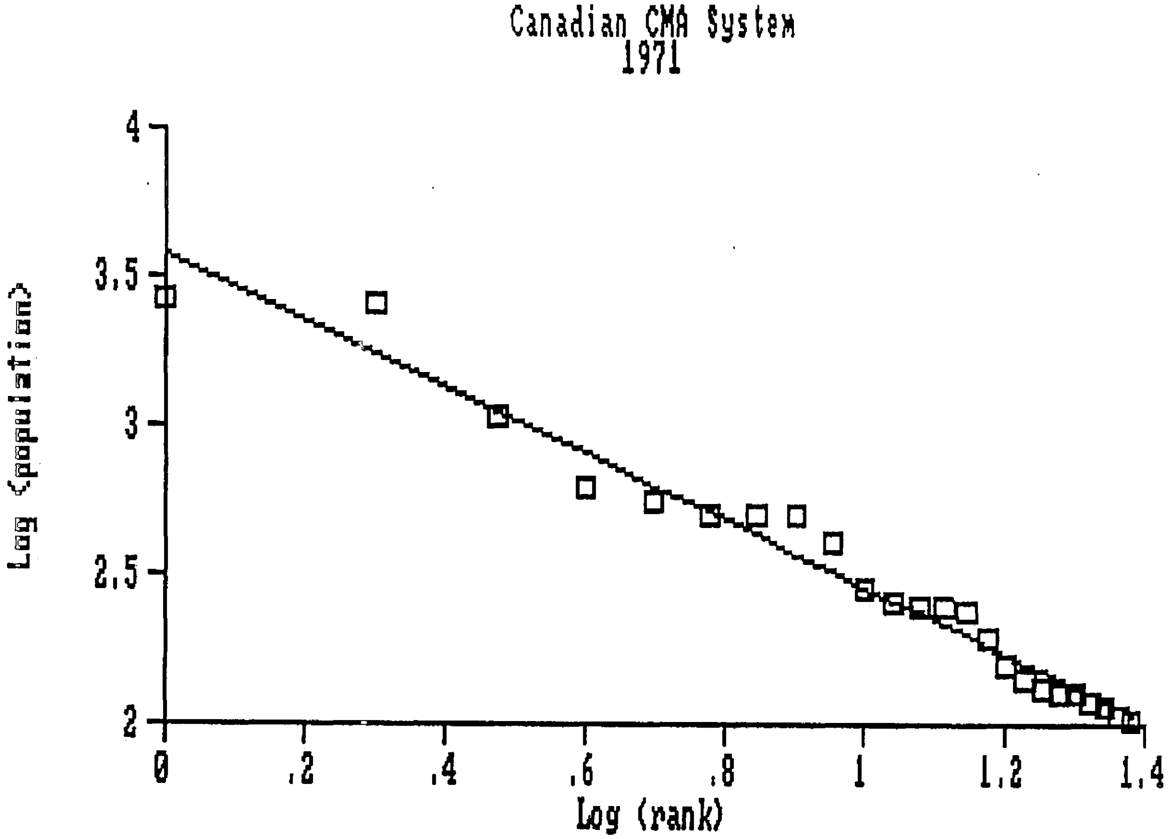

Figure # B.2.b

RANK	CMA	1971
1.	MONTREAL	2729.271
2.	TORONTO	2602.098
3.	VANCOUVER	1082.352
4.	OTTAWA-H	619.861
5.	WINNIPEG	549.808
6.	HAMILTON	503.122
7.	QUEBEC	501.365
8.	EDMONTON	497.842
9.	CALGARY	404.613
10.	ST.CATRNS	285.802
11.	LONDON	252.981
12.	HALIFAX	250.581
13.	WINDSOR	248.718
14.	KITCHENER	238.574
15.	VICTORIA	195.800
16.	SUDBURY	157.721
17.	REGINA	140.734
18.	ST.JOHN'S	133.662
19.	SASKATOON	126.490
20.	CHIC-JNQ	126.401
21.	OSHAWA	120.318
22.	THUNDERBY	114.708
23.	ST.JOHN	106.744
24.	TROIS-RIV	105.327

Table # B.2

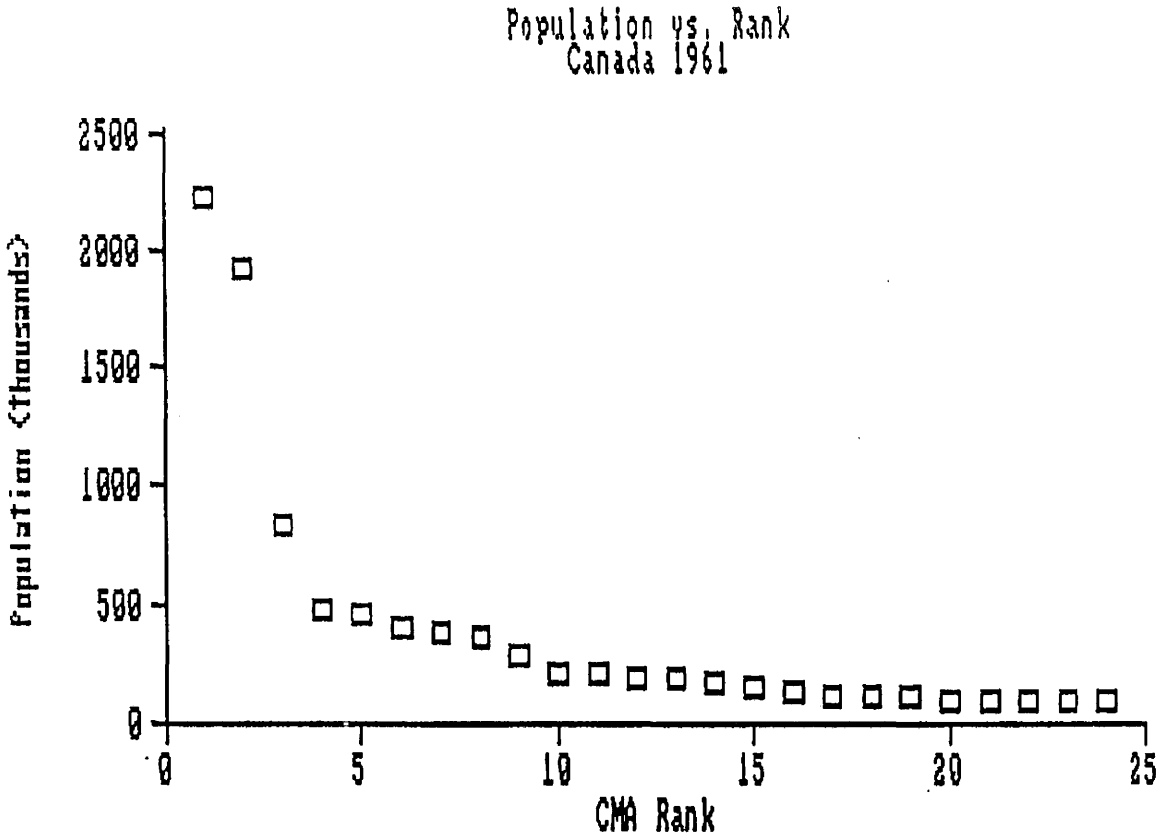

Figure # B.3.a

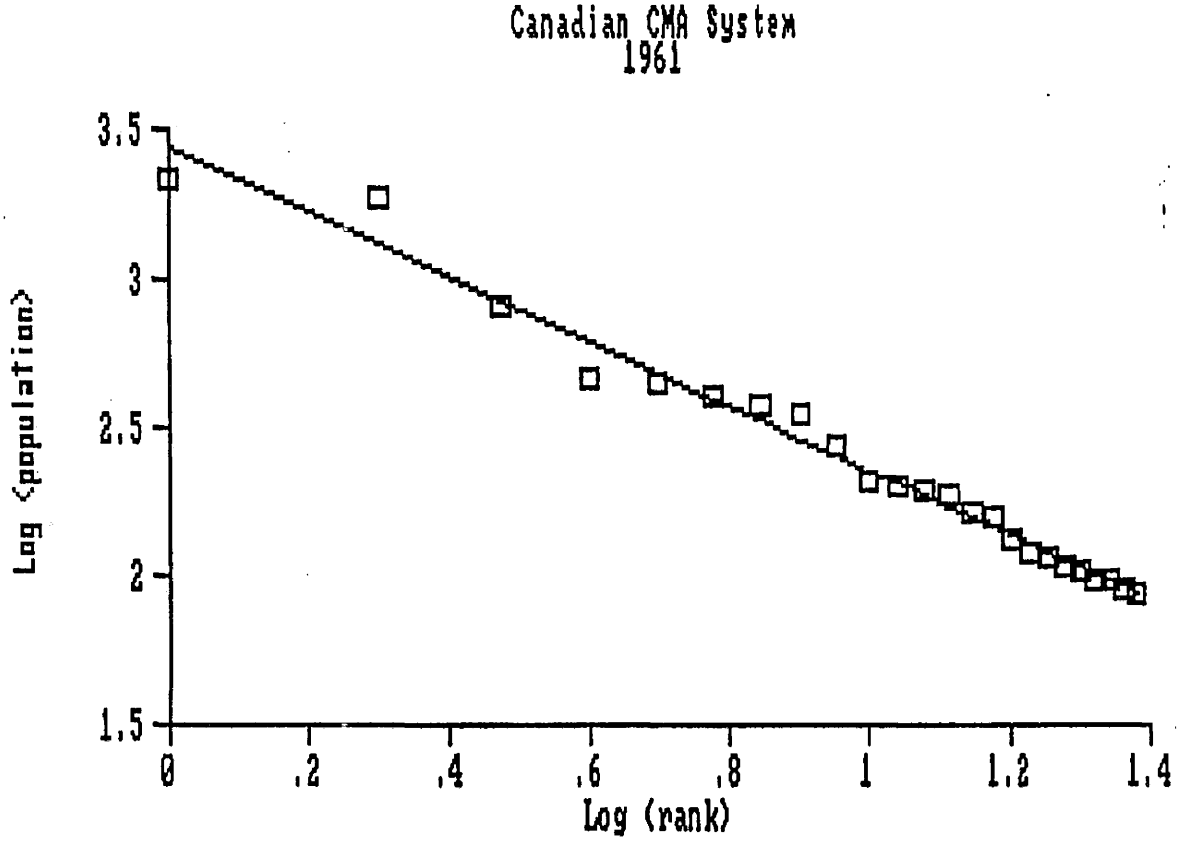

Figure # B.3.b

RANK	CMA	1961
1.	MONTREAL	2216.627
2.	TORONTO	1919.409
3.	VANCOUVER	828.248
4.	WINNIPEG	476.543
5.	OTTAWA-H	457.038
6.	HAMILTON	401.071
7.	QUEBEC	379.067
8.	EDMONTON	359.779
9.	CALGARY	279.062
10.	HALIFAX	212.688
11.	WINDSOR	202.305
12.	LONDON	196.148
13.	ST.CATRNS	186.507
14.	KITCHENER	162.871
15.	VICTORIA	159.088
16.	SUDBURY	131.197
17.	CHIC-JNQ	120.933
18.	REGINA	113.749
19.	ST.JOHN'S	106.666
20.	THUNDERBY	102.323
21.	ST.JOHN	98.083
22.	SASKATOON	95.564
23.	TROIS-RIV	90.923
24.	OSHAWA	85.921

Table # B.3

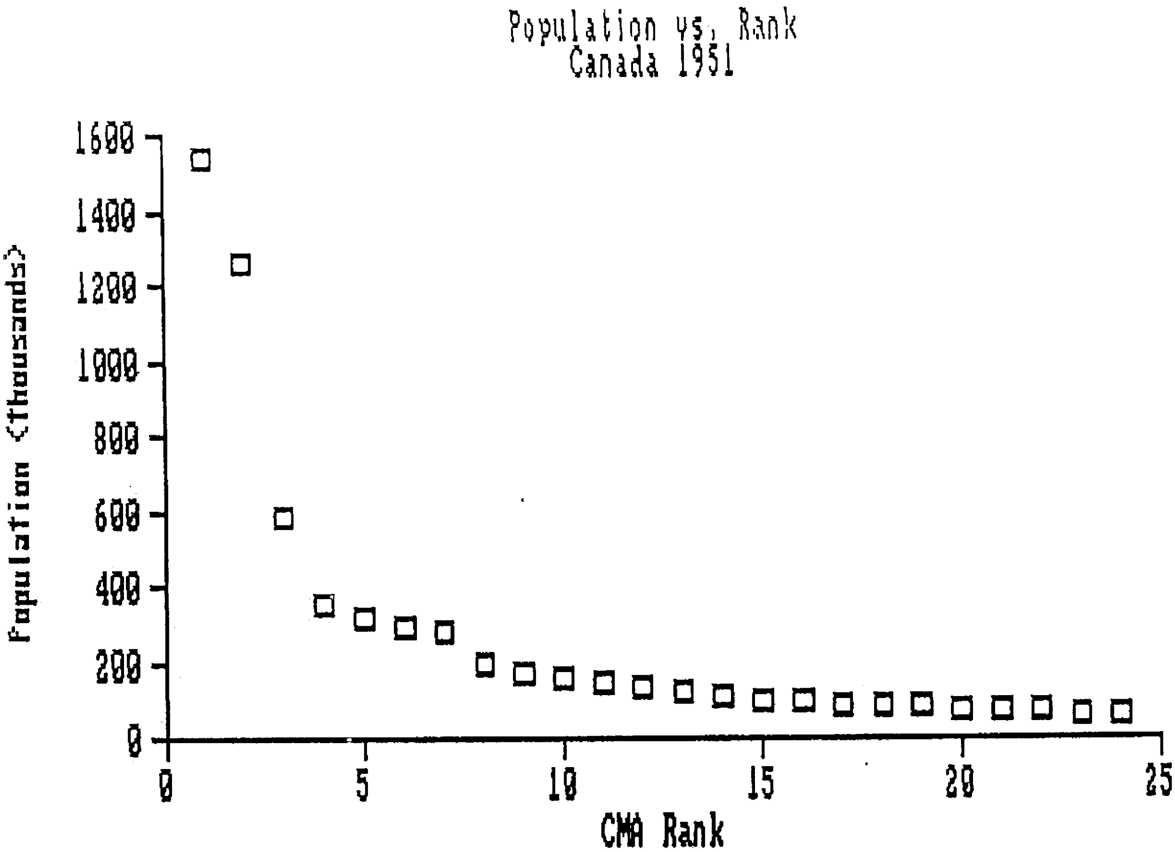

Figure # B.4.a

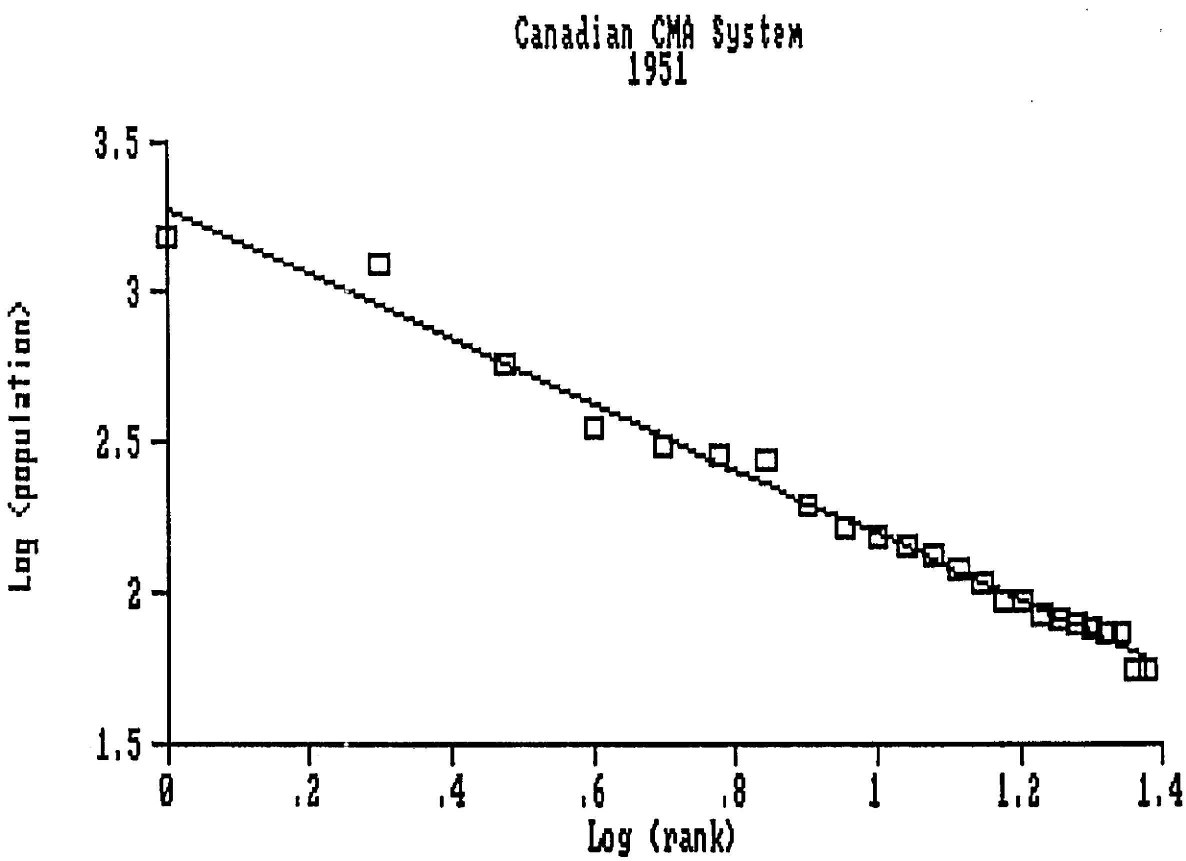

Figure # B.4.b

RANK	CMA	1951
1.	MONTREAL	1539.308
2.	TORONTO	1261.861
3.	VANCOUVER	587.635
4.	WINNIPEG	357.229
5.	OTTAWA-H	311.587
6.	QUEBEC	289.294
7.	HAMILTON	281.901
8.	EDMONTON	193.547
9.	WINDSOR	164.962
10.	HALIFAX	152.269
11.	CALGARY	142.315
12.	LONDON	131.480
13.	VICTORIA	118.380
14.	ST.CATRNS	106.254
15.	CHIC-JNQ	94.775
16.	KITCHENER	93.284
17.	SUDBURY	84.013
18.	ST.JOHN	80.689
19.	ST.JOHN'S	79.562
20.	THUNDERBY	74.753
21.	TROIS-RIV	74.237
22.	REGINA	72.731
23.	SASKATOON	55.679
24.	OSHAWA	54.771

Table # B.4

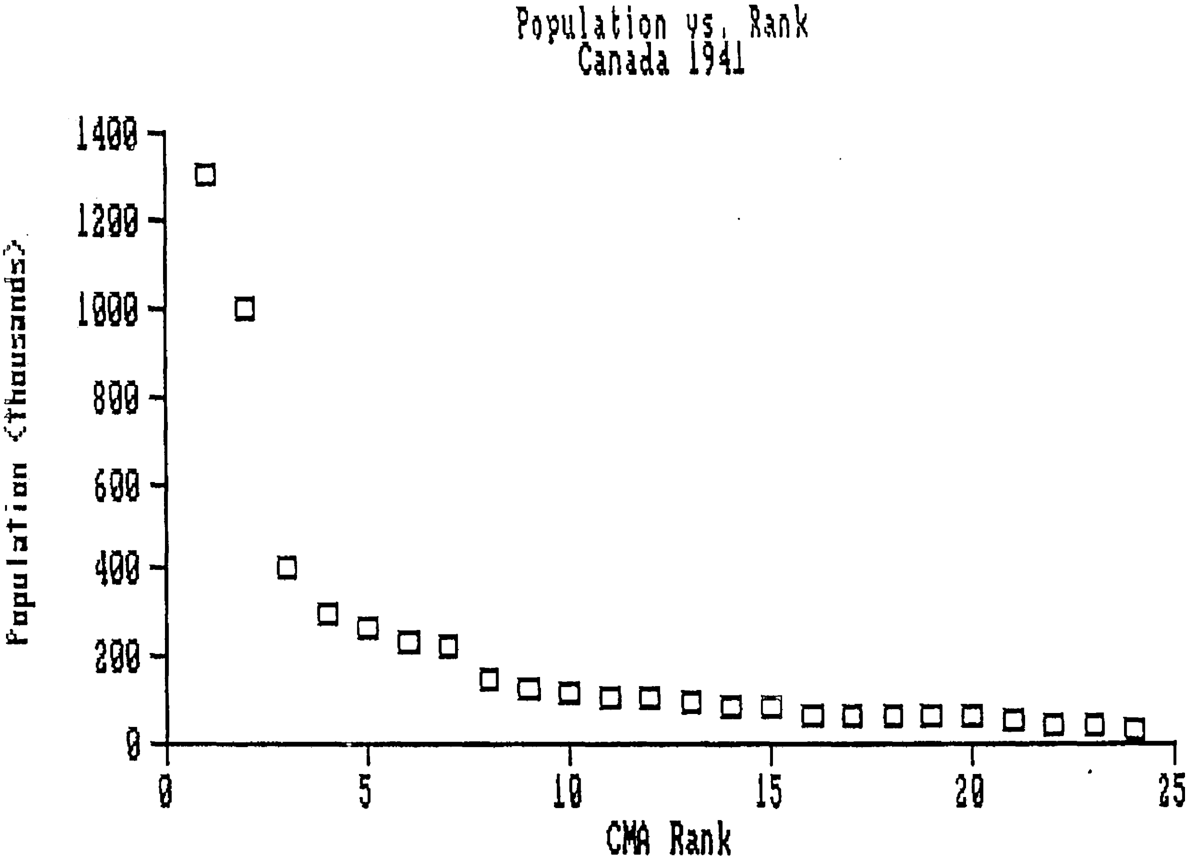

Figure # B.5.a

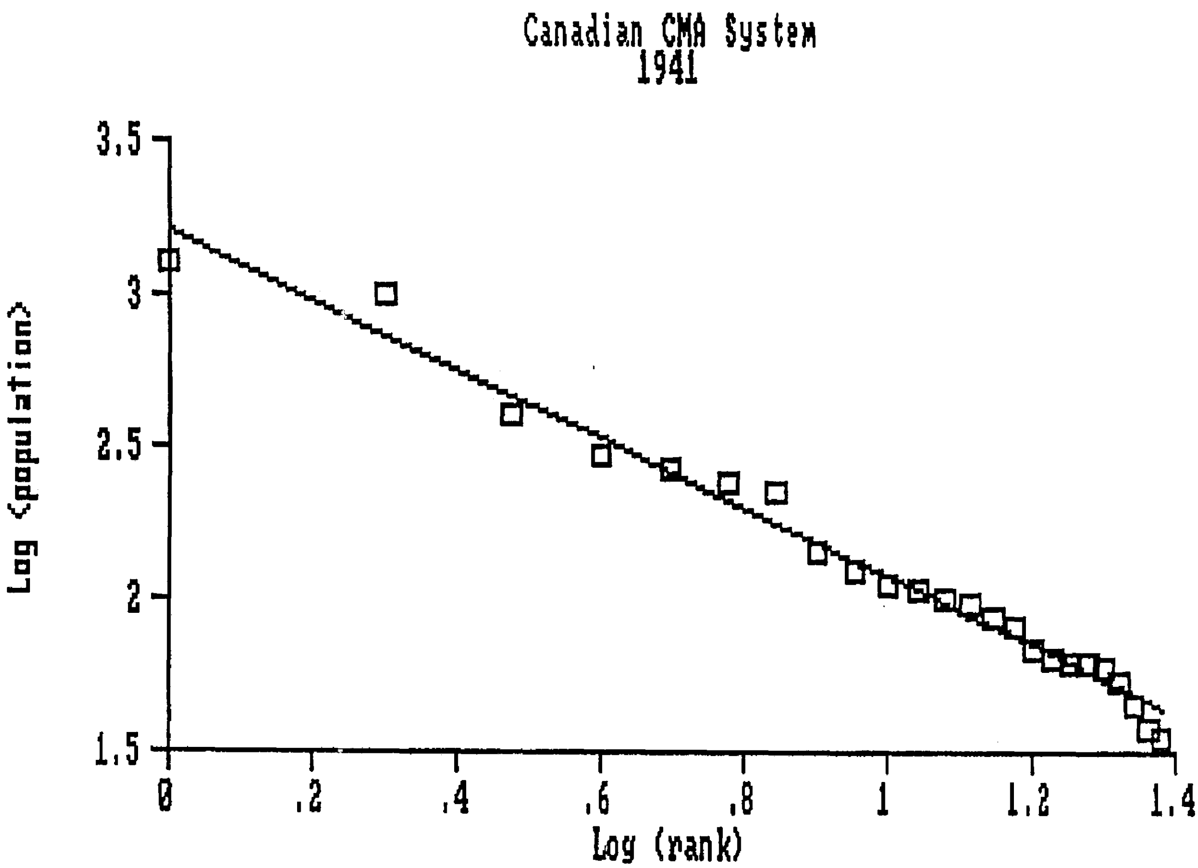

Figure # B.5.b

RANK	CMA	1941
1.	MONTREAL	1306.656
2.	TORONTO	997.080
3.	VANCOUVER	409.262
4.	WINNIPEG	302.024
5.	QUEBEC	265.332
6.	OTTAWA-H	238.624
7.	HAMILTON	224.554
8.	WINDSOR	144.710
9.	HALIFAX	124.763
10.	EDMONTON	113.518
11.	LONDON	107.748
12.	VICTORIA	101.797
13.	CALGARY	97.794
14.	ST.CATRNS	88.806
15.	ST.JOHN	82.785
16.	TROIS-RIV	67.684
17.	CHIC-JNQ	63.161
18.	THUNDERBY	62.205
19.	ST.JOHN'S	61.108
20.	REGINA	59.409
21.	KITCHENER	52.790
22.	SASKATOON	45.178
23.	SUDBURY	38.168
24.	OSHAWA	35.427

Table # B.5

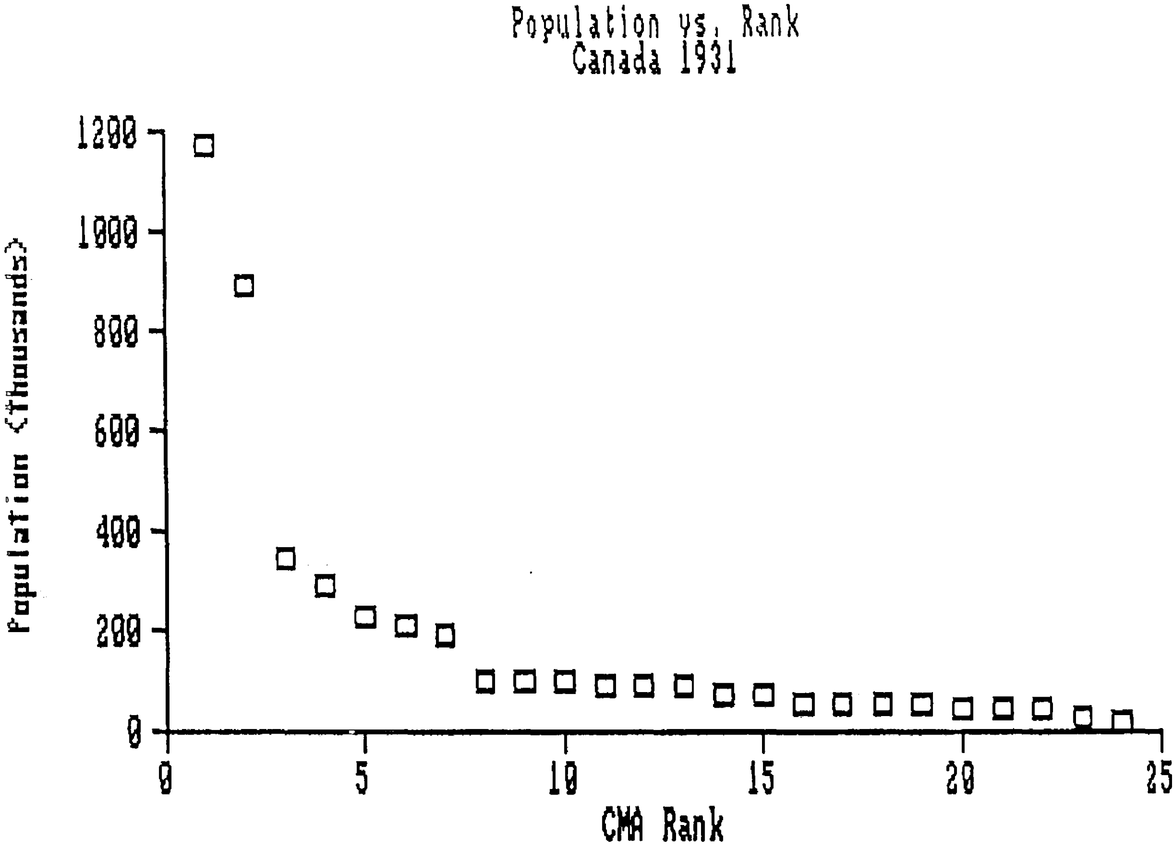

Figure # B.6.a

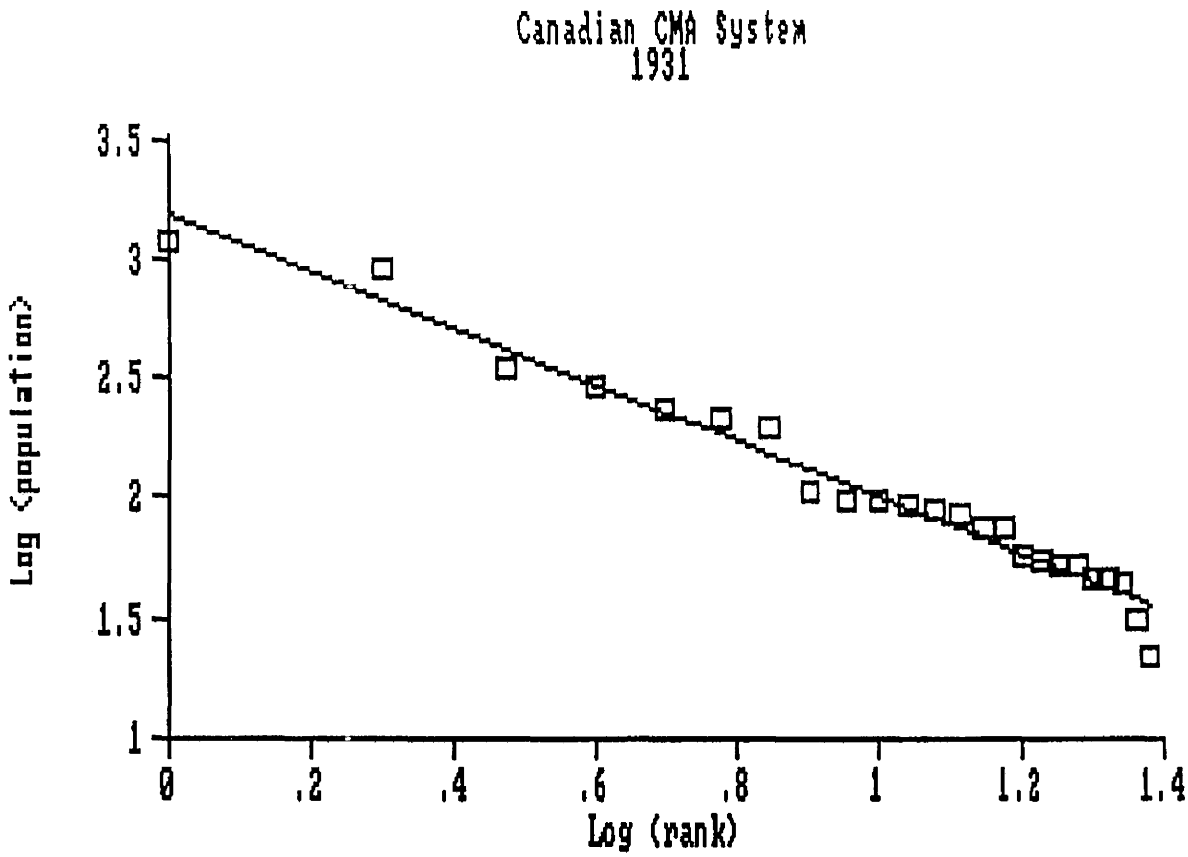

Figure # B.6.b

RANK	CMA	1931
1.	MONTREAL	1174.525
2.	TORONTO	898.342
3.	VANCOUVER	348.519
4.	WINNIPEG	294.905
5.	QUEBEC	229.845
6.	HAMILTON	209.988
7.	OTTAWA-H	195.382
8.	HALIFAX	104.916
9.	LONDON	98.115
10.	EDMONTON	95.828
11.	CALGARY	92.137
12.	VICTORIA	90.279
13.	WINDSOR	86.718
14.	ST.CATRNS	76.470
15.	ST.JOHN	76.022
16.	TROIS-RIV	57.119
17.	REGINA	54.273
18.	ST.JOHN'S	52.861
19.	THUNDERBY	52.123
20.	KITCHENER	45.589
21.	SASKATOON	45.455
22.	CHIC-JNQ	45.185
23.	OSHAWA	30.969
24.	SUDBURY	21.948

Table # B.6

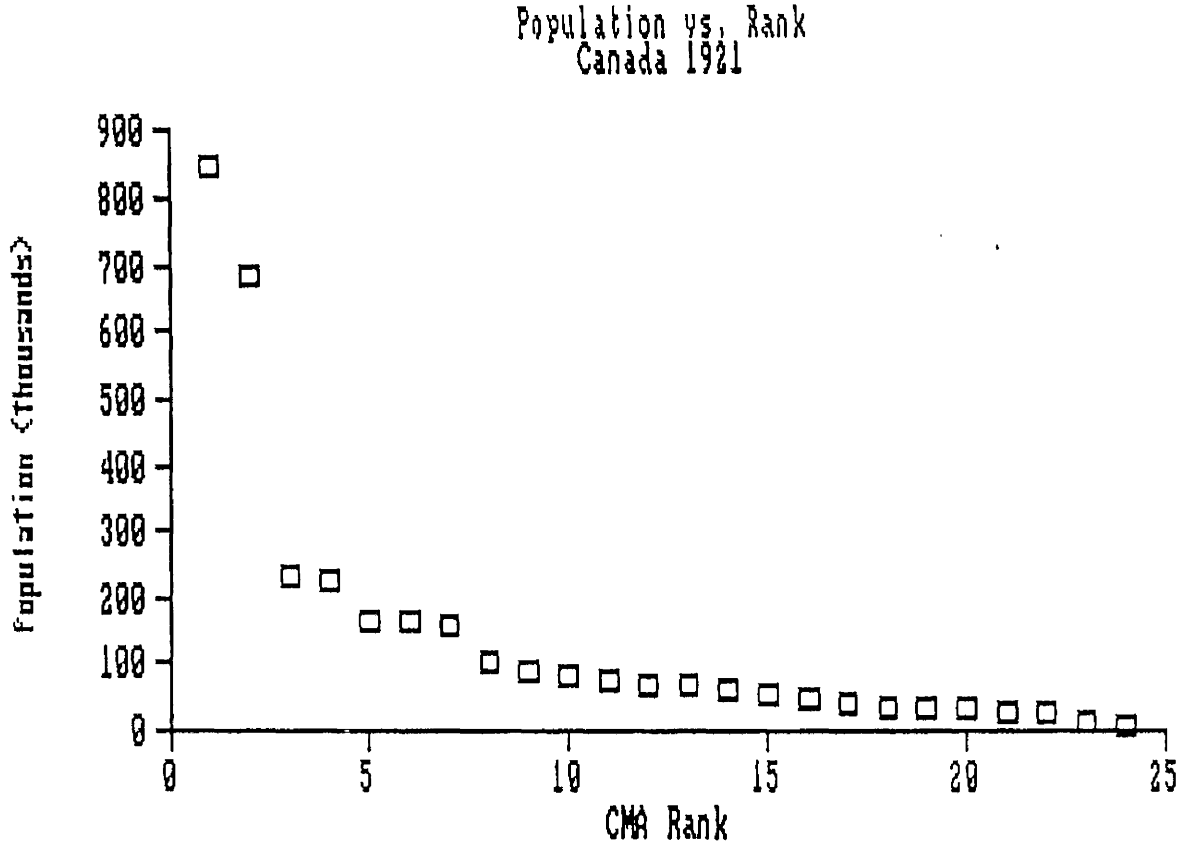

Figure # B.7.a

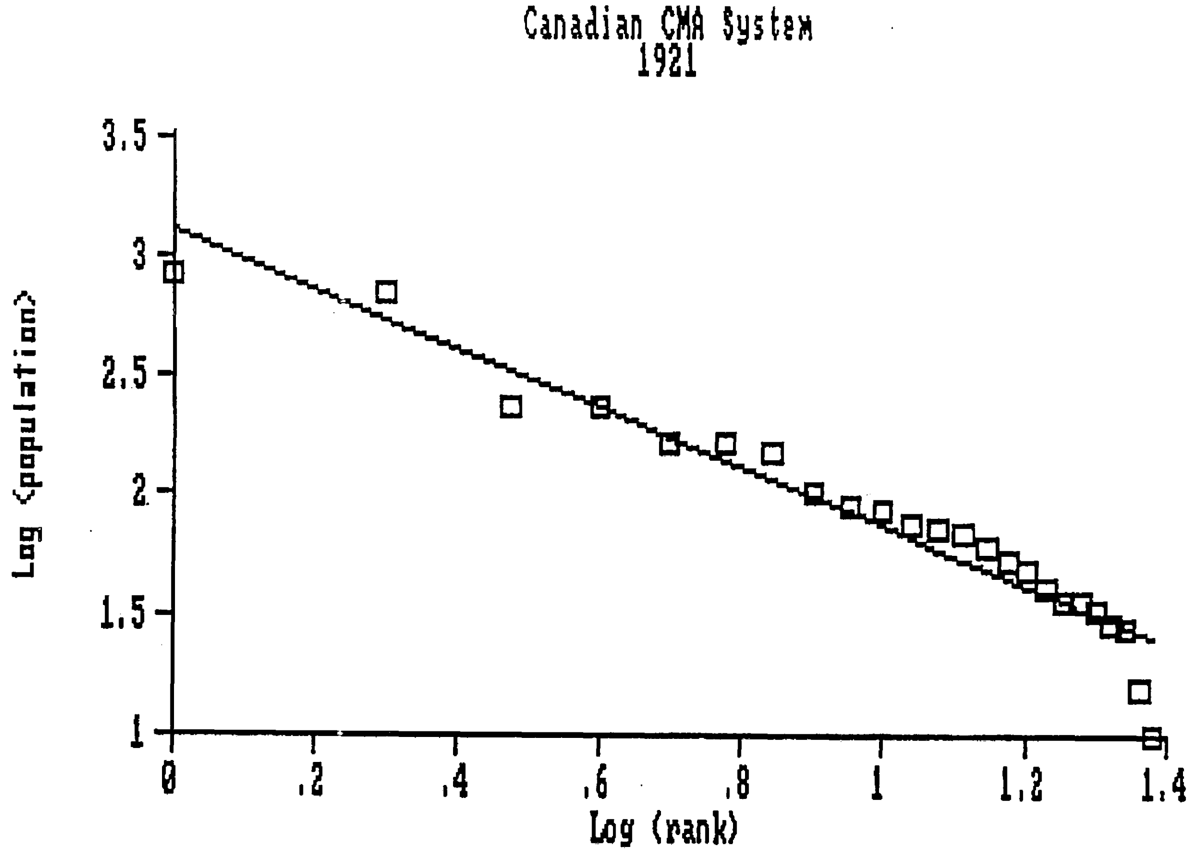

Figure # B.7.b

RANK	CMA	1921
1.	MONTREAL	847.319
2.	TORONTO	683.476
3.	VANCOUVER	231.542
4.	WINNIPEG	229.212
5.	QUEBEC	167.539
6.	OTTAWA-H	166.078
7.	HAMILTON	154.103
8.	HALIFAX	103.318
9.	VICTORIA	89.603
10.	LONDON	84.064
11.	ST.JOHN	75.465
12.	EDMONTON	71.173
13.	CALGARY	69.635
14.	ST.CATRNS	60.488
15.	WINDSOR	53.029
16.	ST.JOHN'S	47.801
17.	THUNDERBY	40.060
18.	TROIS-RIV	36.039
19.	REGINA	35.120
20.	KITCHENER	32.220
21.	CHIC-JNQ	29.215
22.	SASKATOON	27.025
23.	OSHAWA	15.776
24.	SUDBURY	10.218

Table # B.7

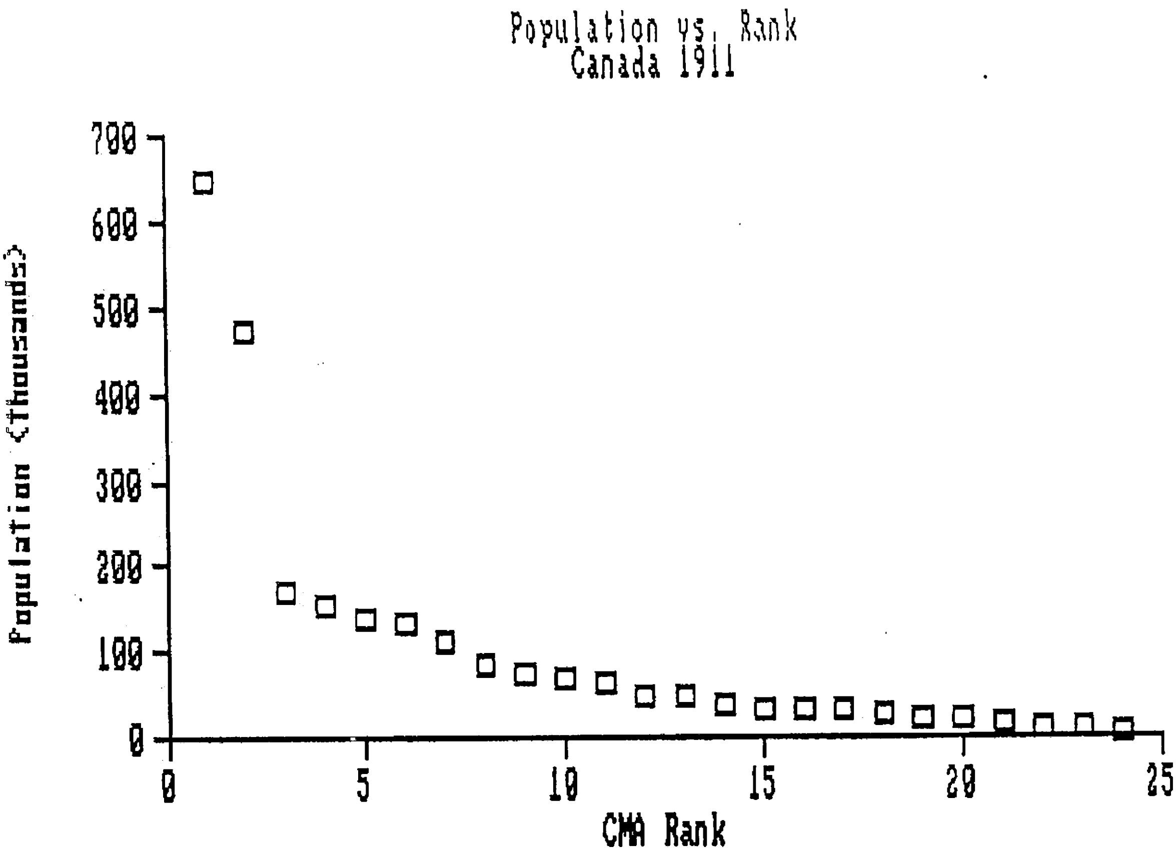

Figure # B.8.a

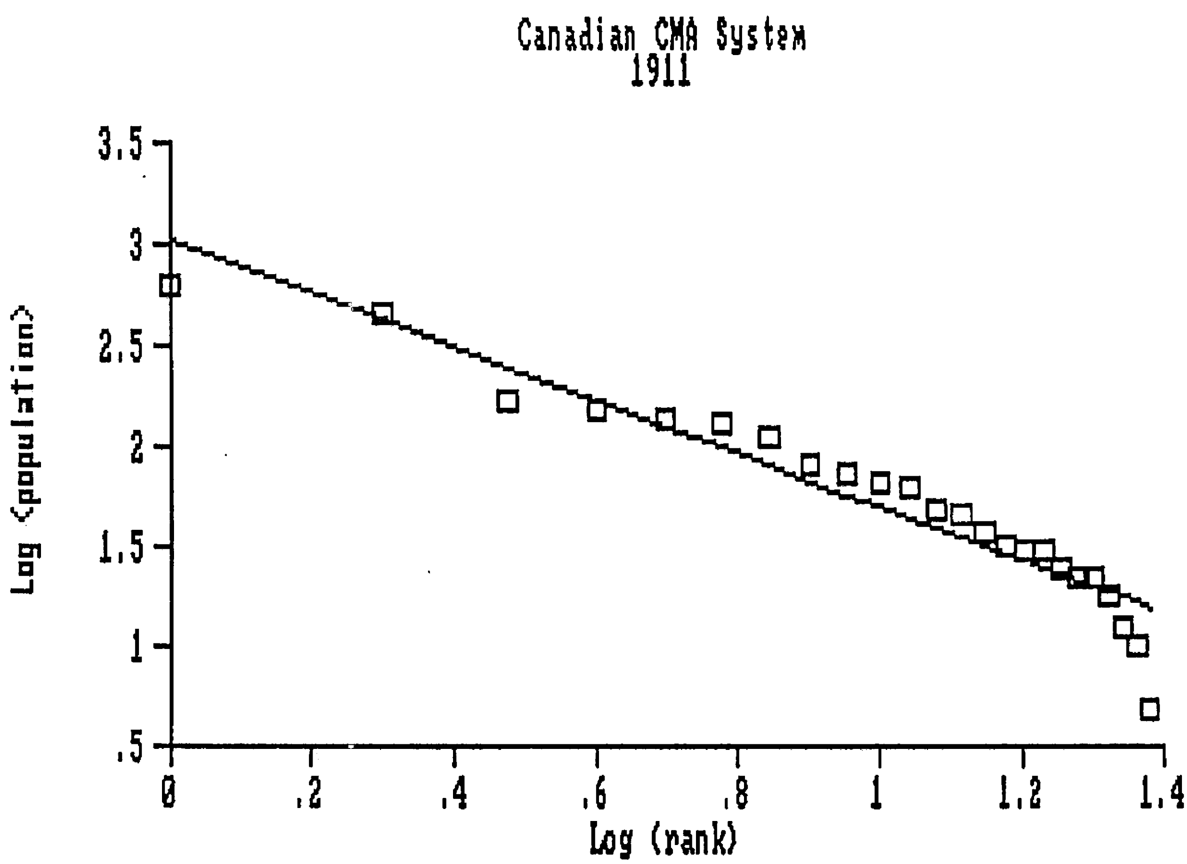

Figure # B.8.b

RANK	CMA	1911
1.	MONTREAL	649.093
2.	TORONTO	475.801
3.	VANCOUVER	171.602
4.	WINNIPEG	156.969
5.	QUEBEC	137.487
6.	OTTAWA-H	134.075
7.	HAMILTON	110.658
8.	HALIFAX	82.515
9.	VICTORIA	73.134
10.	ST.JOHN	68.017
11.	LONDON	63.849
12.	CALGARY	48.074
13.	ST.JOHN'S	45.685
14.	ST.CATRNS	37.943
15.	THUNDERBY	31.344
16.	REGINA	30.817
17.	EDMONTON	30.129
18.	WINDSOR	24.499
19.	KITCHENER	22.497
20.	TROIS-RIV	22.060
21.	CHIC-JNQ	17.447
22.	SASKATOON	12.604
23.	OSHAWA	9.825
24.	SUDBURY	4.919

Table # B.8

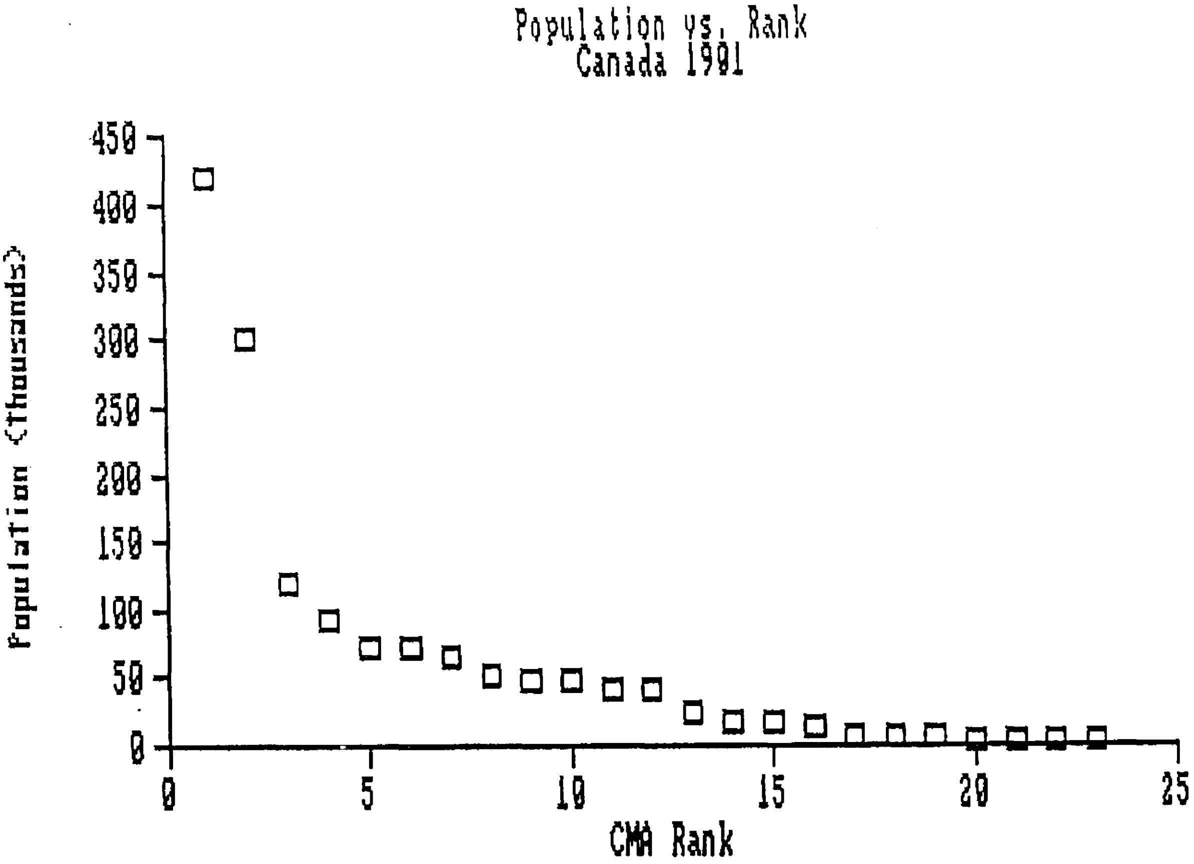

Figure # B.9.a

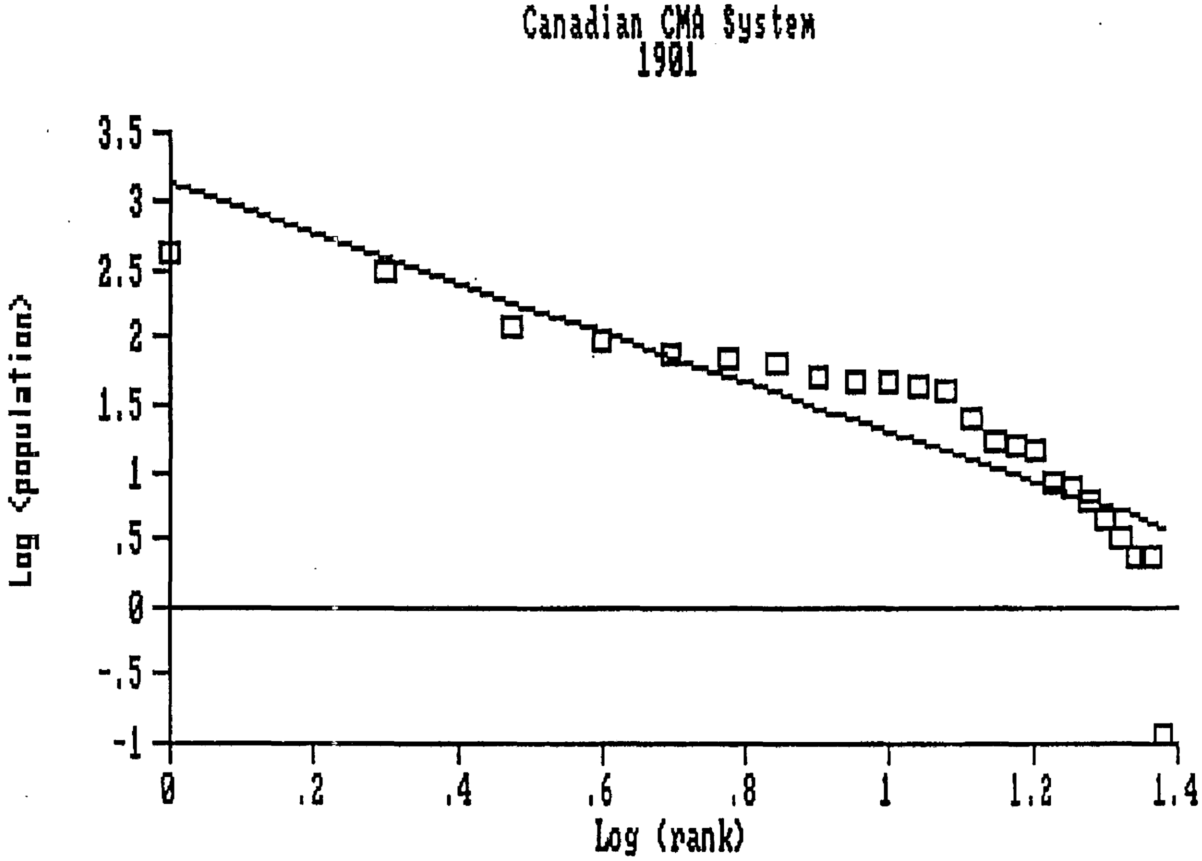

Figure # B.9.b

RANK	CMA	1901
1.	MONTREAL	422.180
2.	TORONTO	300.108
3.	QUEBEC	121.158
4.	OTTAWA-H	92.289
5.	HALIFAX	72.272
6.	HAMILTON	71.055
7.	ST.JOHN	65.137
8.	LONDON	52.370
9.	WINNIPEG	48.488
10.	VICTORIA	48.322
11.	VANCOUVER	41.793
12.	ST.JOHN'S	39.995
13.	ST.CATRNS	24.775
14.	WINDSOR	16.700
15.	TROIS-RIV	16.082
16.	KITCHENER	14.430
17.	CHIC-JNQ	8.107
18.	THUNDERBY	7.742
19.	OSHAWA	5.806
20.	CALGARY	4.567
21.	EDMONTON	3.177
22.	SUDBURY	2.402
23.	REGINA	2.293

Table # B.9

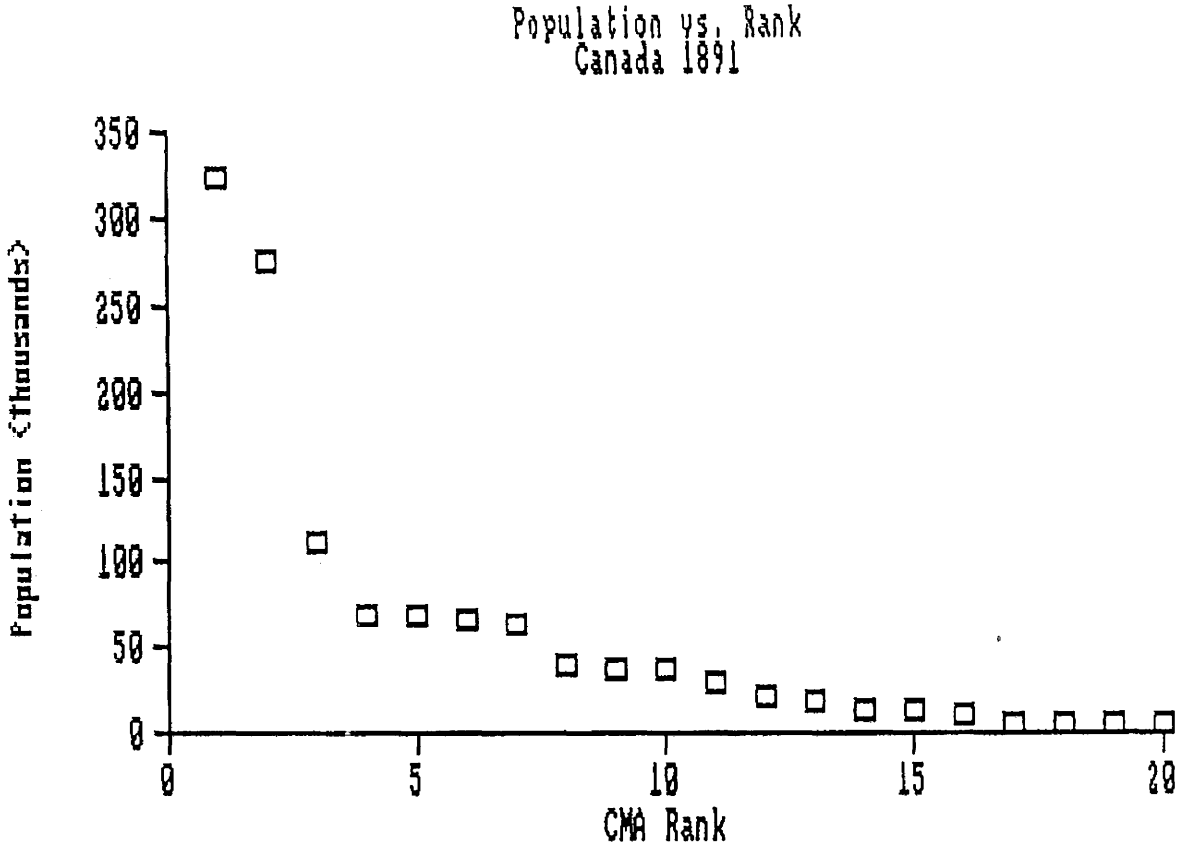

Figure # B.10.a

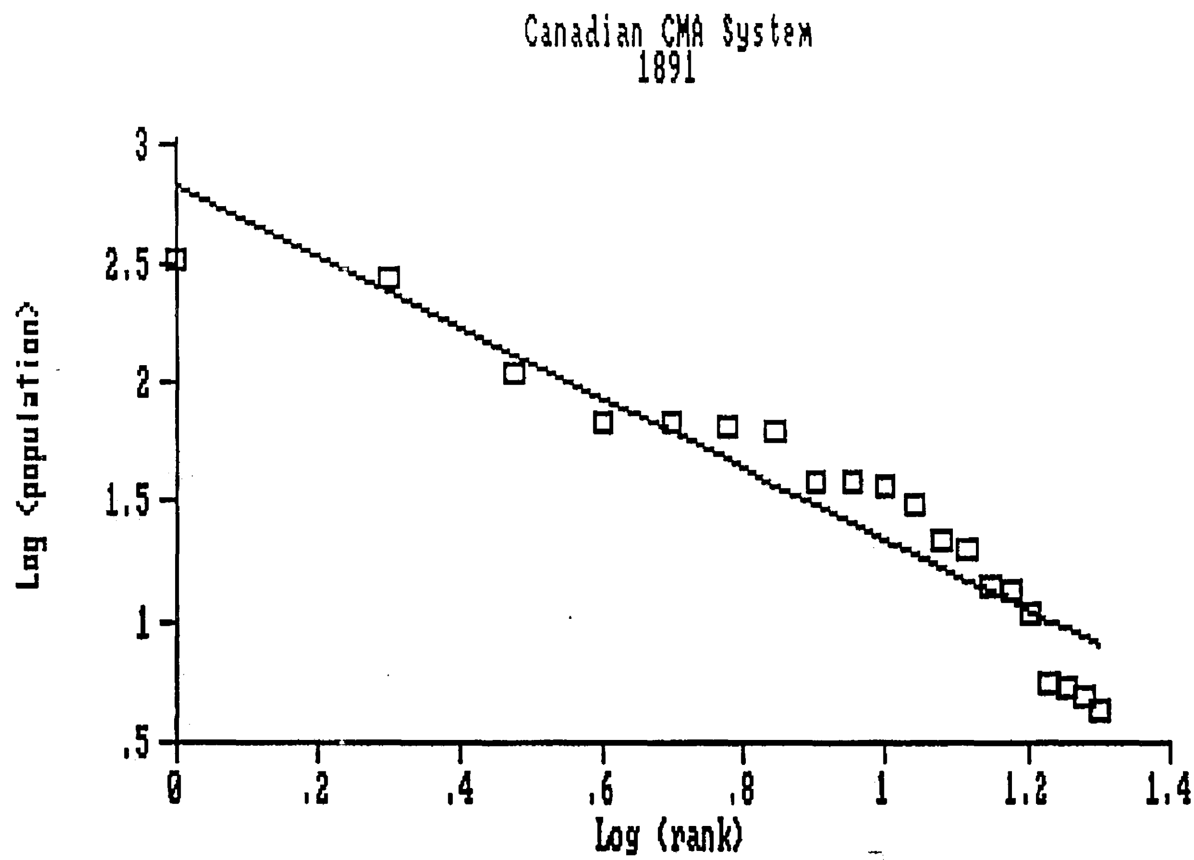

Figure # B.10.b

RANK	CMA	1891
1.	MONTREAL	324.704
2.	TORONTO	277.205
3.	QUEBEC	111.038
4.	HALIFAX	68.033
5.	OTTAWA-H	67.997
6.	HAMILTON	66.094
7.	ST.JOHN	62.686
8.	VICTORIA	38.902
9.	LONDON	38.462
10.	ST.JOHN'S	36.027
11.	WINNIPEG	30.153
12.	ST.CATRNS	21.857
13.	VANCOUVER	19.466
14.	WINDSOR	14.184
15.	TROIS-RIV	13.428
16.	KITCHENER	10.993
17.	THUNDERBY	5.511
18.	OSHAWA	5.372
19.	CHIC-JNQ	4.825
20.	CALGARY	4.266

Table # B.10

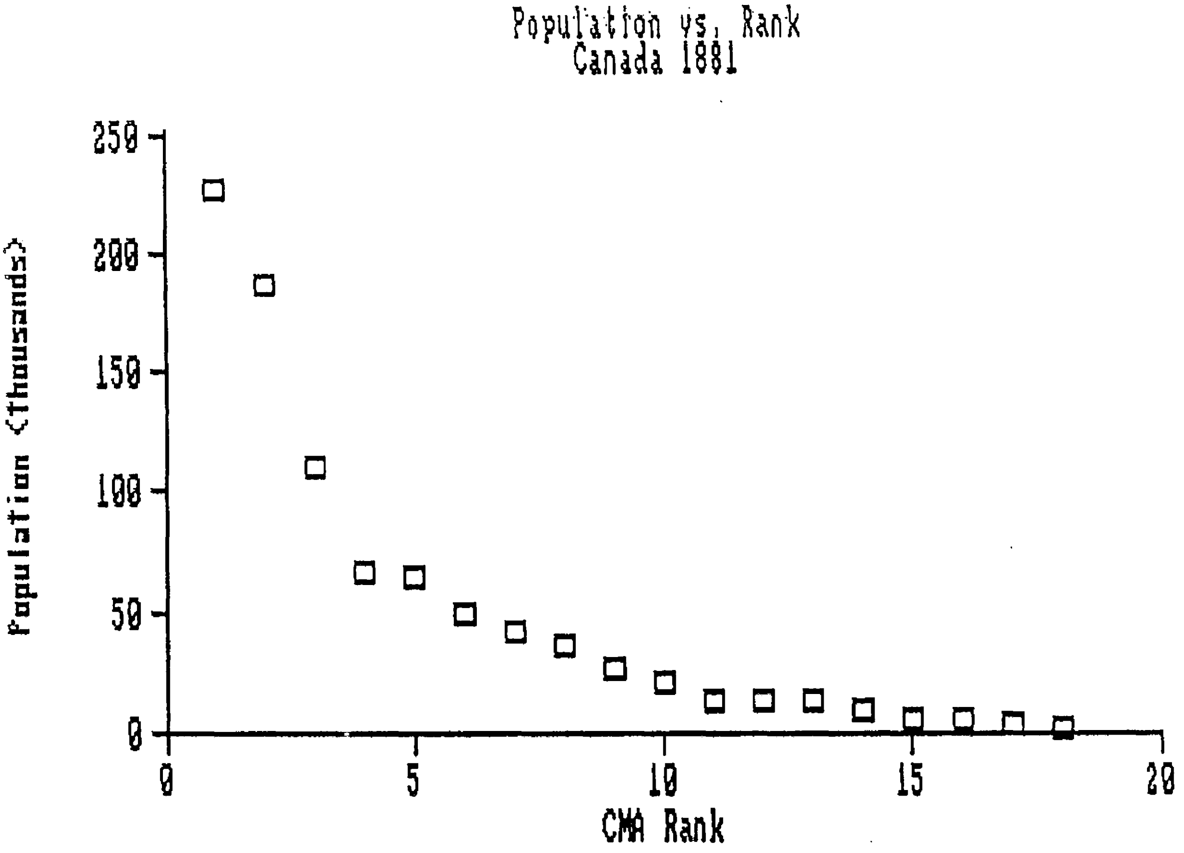

Figure # B.11.a

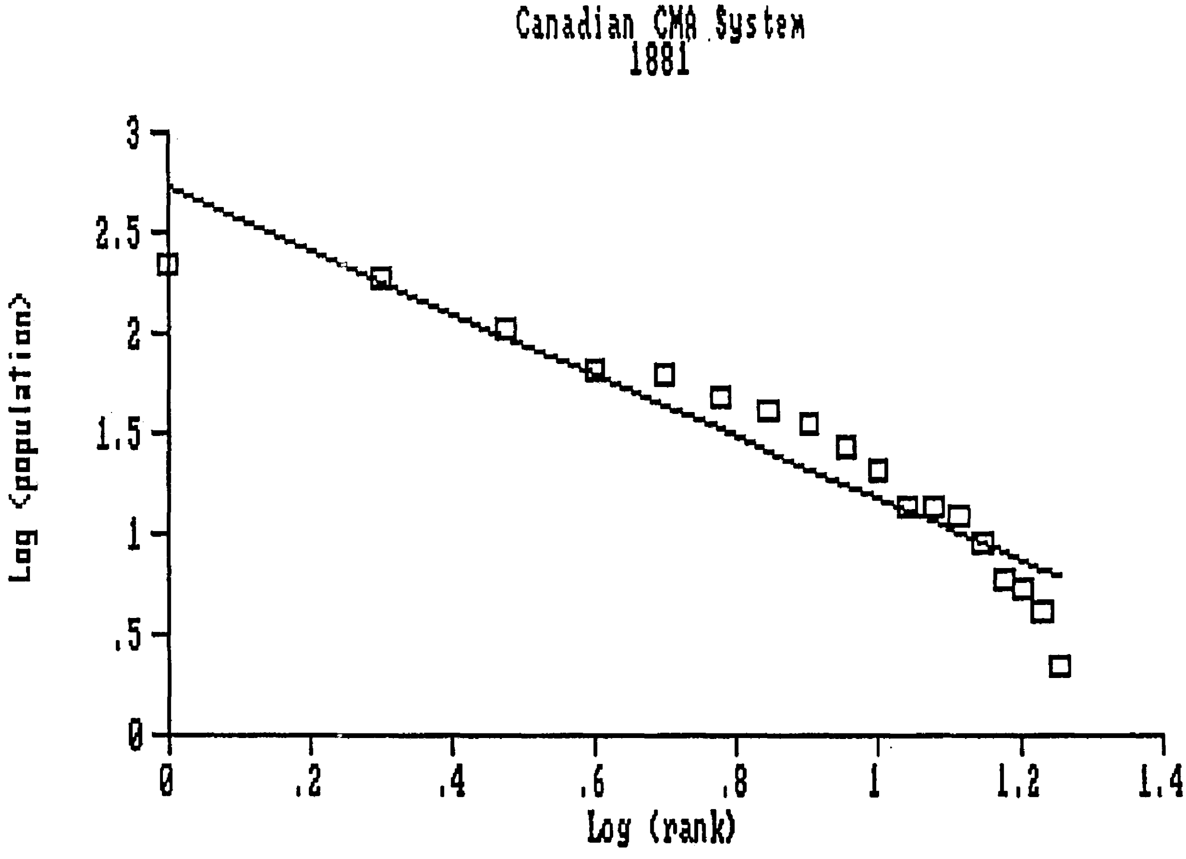

Figure # B.11.b

RANK	CMA	1881
1.	MONTREAL	226.010
2.	TORONTO	186.796
3.	QUEBEC	109.904
4.	ST.JOHN	66.164
5.	HALIFAX	63.897
6.	HAMILTON	48.547
7.	OTTAWA-H	42.214
8.	ST.JOHN'S	35.874
9.	LONDON	27.230
10.	ST.CATRNS	20.913
11.	TROIS-RIV	13.889
12.	VICTORIA	13.686
13.	WINNIPEG	12.514
14.	WINDSOR	9.016
15.	KITCHENER	6.002
16.	OSHAWA	5.274
17.	CHIC-JNQ	4.100
18.	THUNDERBY	2.222

Table # B.11

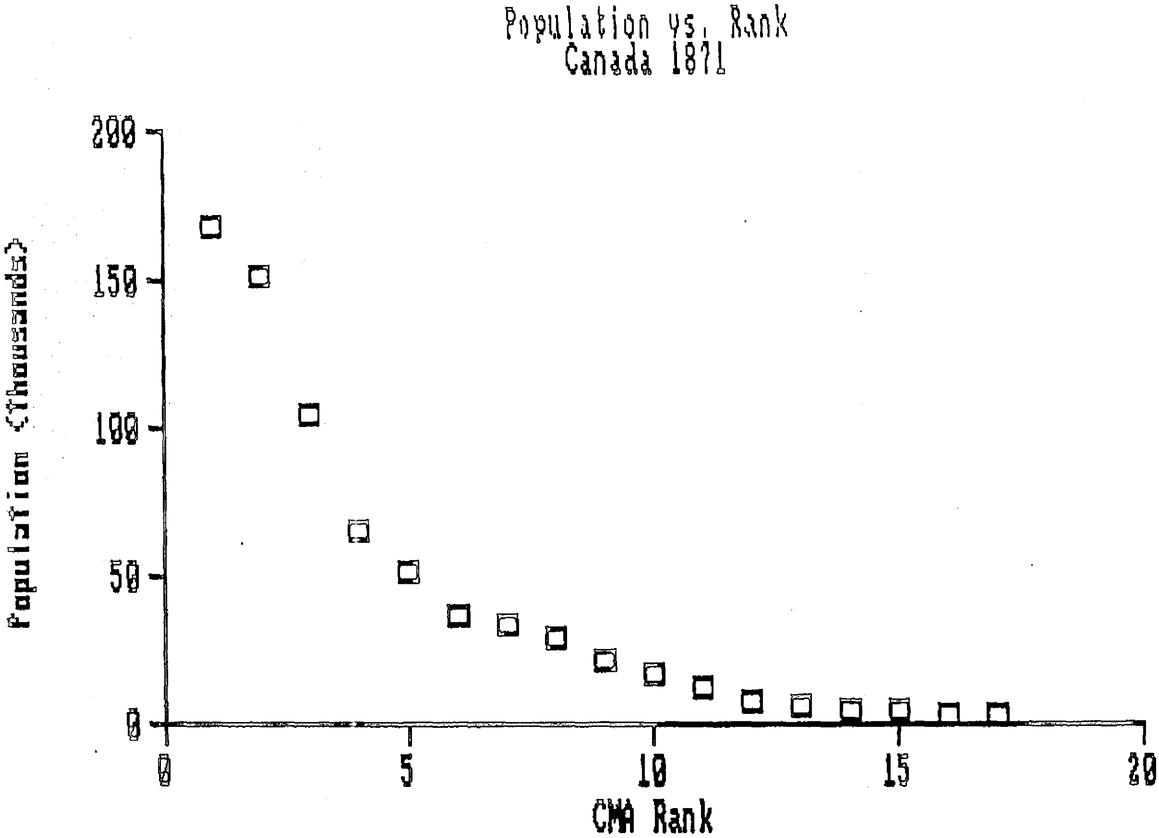

Figure # B.12.a

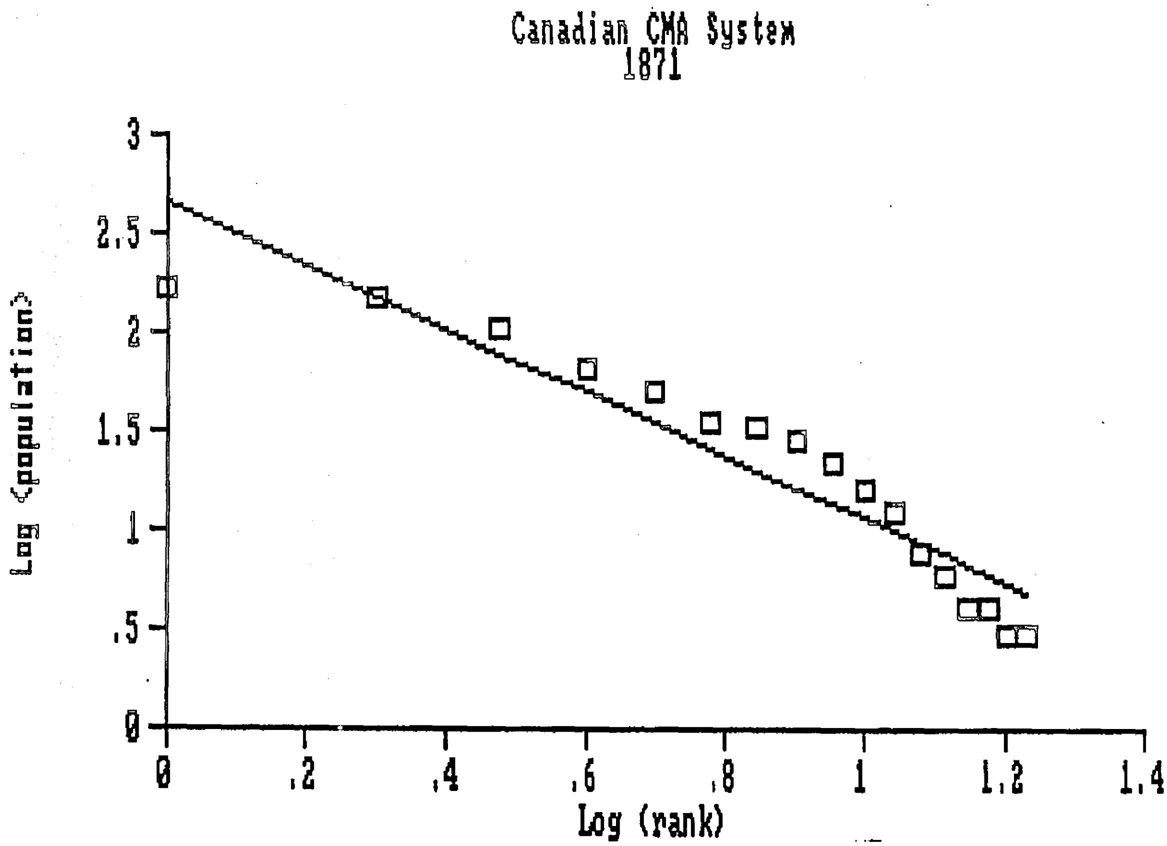

Figure # B.12.b

RANK	CMA	1871
1.	MONTREAL	168.531
2.	TORONTO	151.373
3.	QUEBEC	105.070
4.	ST.JOHN	66.120
5.	HALIFAX	52.360
6.	HAMILTON	36.092
7.	OTTAWA-H	33.179
8.	ST.JOHN'S	29.540
9.	LONDON	21.816
10.	ST.CATRNS	16.541
11.	TROIS-RIV	12.197
12.	VICTORIA	7.565
13.	WINDSOR	5.844
14.	OSHAWA	4.208
15.	KITCHENER	4.061
16.	CHIC-JNQ	2.952
17.	WINNIPEG	2.949

Table # B.12

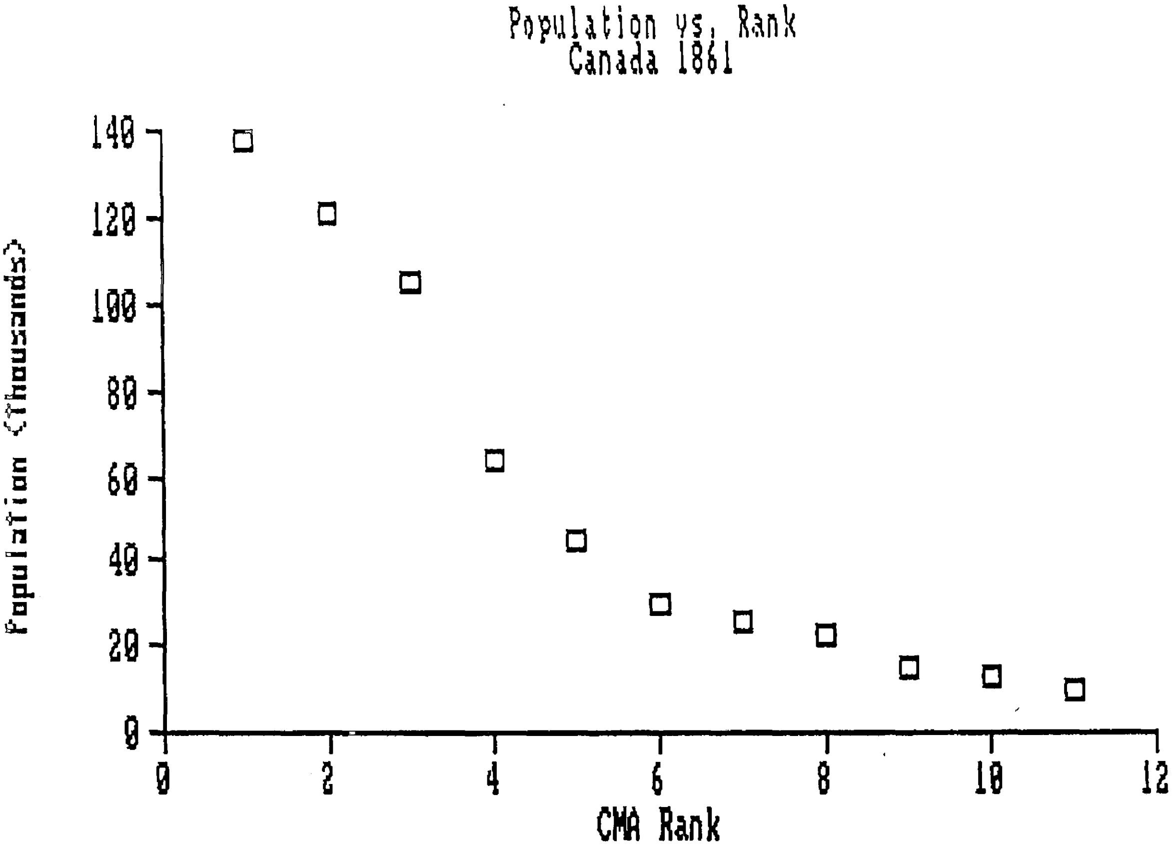

Figure # B.13.a

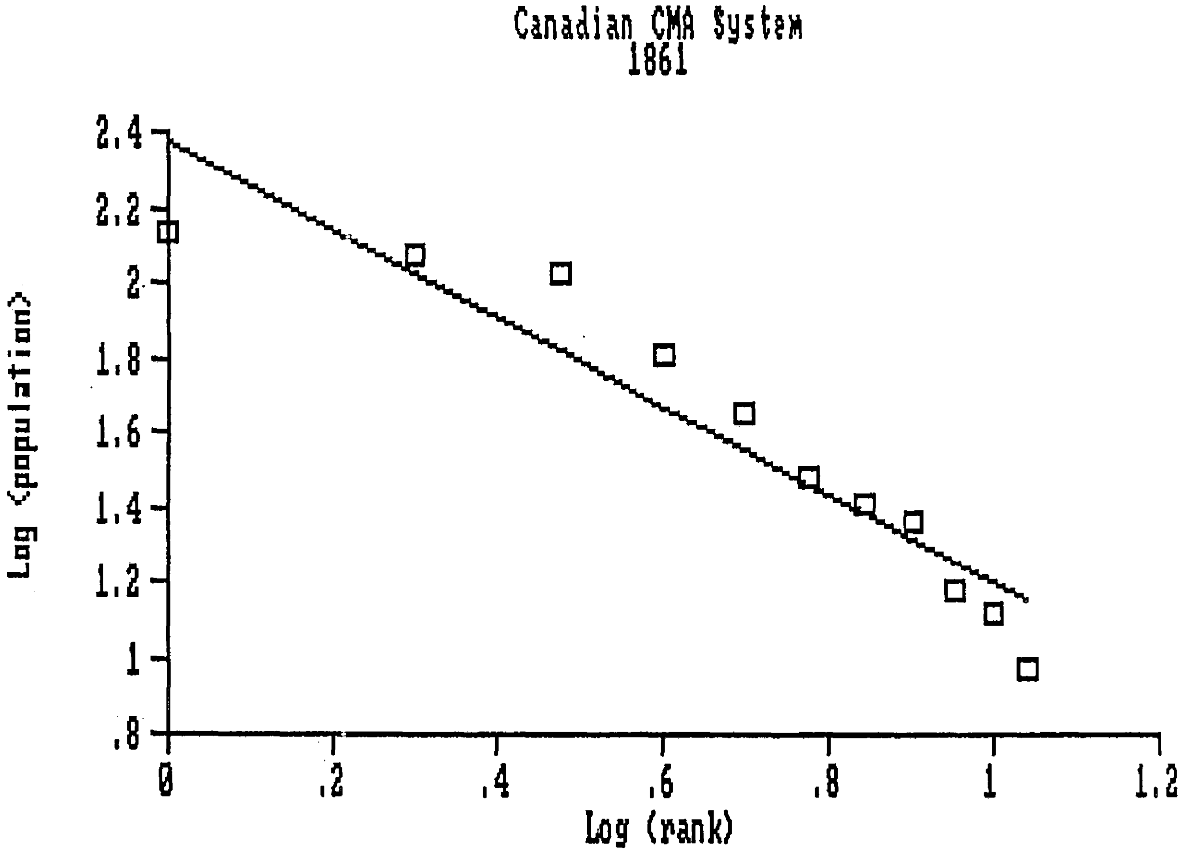

Figure # B.13.b

RANK	CMA	1861
1.	MONTREAL	138.077
2.	TORONTO	121.016
3.	QUEBEC	105.582
4.	ST.JOHN	63.921
5.	HALIFAX	44.296
6.	ST.JOHN'S	29.934
7.	HAMILTON	25.797
8.	OTTAWA-H	22.590
9.	LONDON	15.079
10.	ST.CATRNS	12.957
11.	TROIS-RIV	9.295

Table # B.13

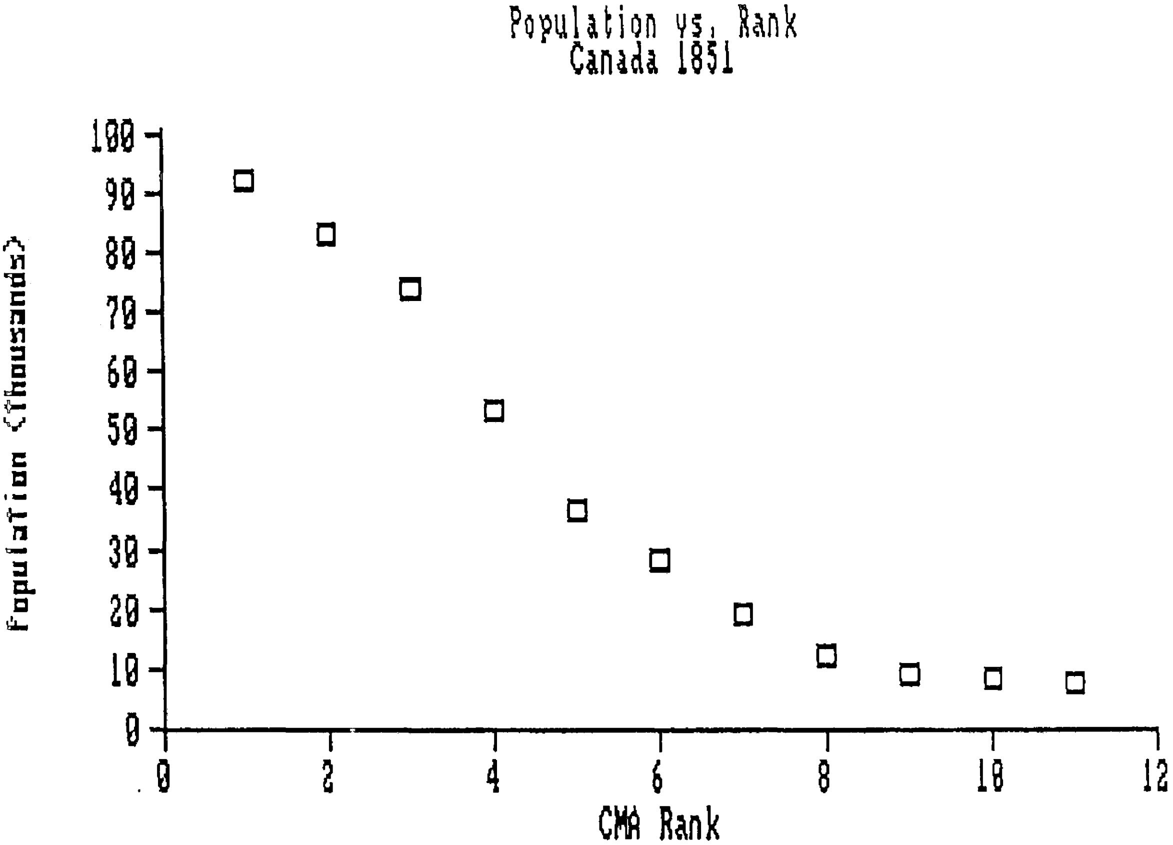

Figure # B.14.a

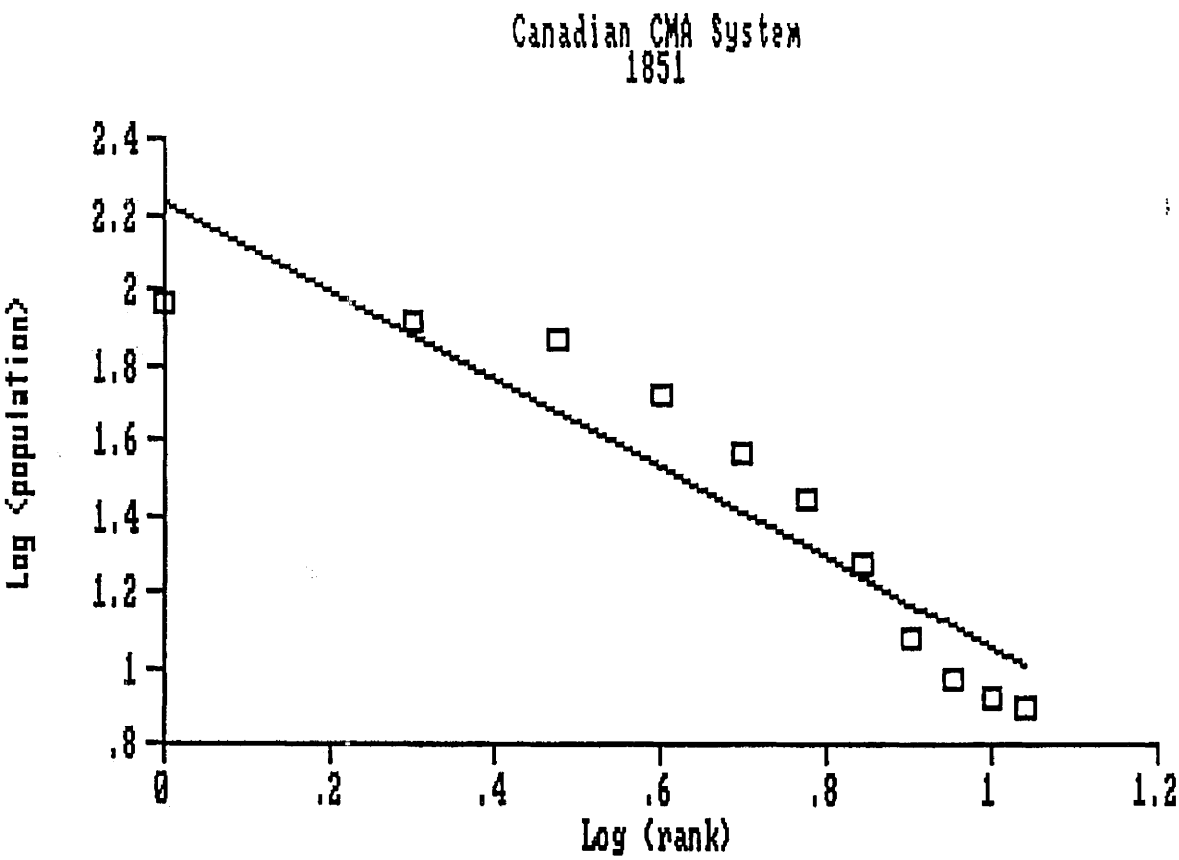

Figure # B.14.b

RANK	CMA	1851
1.	MONTREAL	91.647
2.	TORONTO	83.092
3.	QUEBEC	74.011
4.	ST.JOHN	53.223
5.	HALIFAX	36.725
6.	ST.JOHN'S	27.836
7.	HAMILTON	19.064
8.	OTTAWA-H	11.950
9.	ST.CATRNS	9.372
10.	LONDON	8.342
11.	TROIS-RIV	7.953

Table # B.14

B I B L I O G R A P H Y

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