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Annual, daily and intradiurnal variation of *Celtis* pollen in the city of La Plata, Argentina

Daniela S. Nitiu
Cátedra de Palinología de la Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Paseo del Bosque s/n, 1900 La Plata, Argentina
(E-mail: nitiud@sinectis.com.ar)

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Abstract

The behaviour of *Celtis* airborne pollen was studied for a period of three years (1998–2000) in the city of La Plata. The pollen grains were captured with a Lanzoni trap and the maximum pollination period was observed to occur during the end of winter and spring in the three years. The annual values of pollen concentration varied, and a significant decrease was observed during 2000. The greatest airborne pollen record was in October with an average of 82.3% in relation to its total concentration during 1998–2000. Based on the intradiurnal behaviour analysis, it was observed that the maximum pollination peak occurs at 2H when the temperature reaches its maximum values. Considering the three sampling years, the meteorological variables that most influenced the processes of pollen emission, dispersion and transportation in the atmosphere were: maximum and minimum temperature and rainfall.

1. Introduction

The values of *Celtis* pollen concentration in the atmosphere of the city of La Plata are significant at the end of winter and spring when it exceeds 1% of the annual concentration in the three years (Nitiu and Romero, 2002, a).

Celtis is one of the 12 taxa with the greatest record of airborne pollination during the year (Nitiu and Romero, 2002, b) and the available information shows that the pollen has allergological importance, since it can cause positive reactions in the sensitized population (Latorre, 1997).

The aeropalynological study of this taxon is significant because it is one of the few arboreal native genera naturally found in this area and is highly representative mainly in the coastal section of the city. Different species of *Celtis* are found in the streets of the urban center according to the census of 1995.

The purpose of this paper is to analyse the seasonal, daily and intradiurnal pollen behaviour of *Celtis* based on the different meteorological variables. This analysis will be very useful to estimate how and to what extent these variables affect production, release, dispersion and transportation of pollen and consequently the annual pollination cycles.

There are no previous contributions on this subject for this widely populated area.

2. Material and methods

The city of La Plata (35° S and 58° W) is located in the East of Argentina, on the coast of the Rio de La Plata river above sea level and covers 16 km^2. In biogeographic terms, the city belongs to the Provincia Fitogeografica Pampeana, East District (Cabrera, 1976).

The climate of this region is humid with marked seasonality. The annual temperature average is 16.5 °C, with a maximum average temperature of 38.2 °C and a minimum average temperature of −2 °C. The annual average rain is 1132.9 mm and the dominant winds are from NE to SE.

In the urban area of the city of La Plata, the Ulmaceae family is represented by seven taxa: *Celtis australis, C. occidentalis, C. spinosa, C. tala, Ulmus*

sp., *U. procera and U. pumila*. The number of plants of *Celtis australis* in squares, boulevards and streets is 635, of *C. occidentalis* 14, of *C. spinosa* 149, of *C. tala* 27, of *Ulmus* sp. 11, of *U. procera* 179 and of *U. pumila* 699, according to the Census of 1995 carried out by the Municipality of the city of La Plata.

The sampling was carried out using a Lanzoni VPPS 2000 weekly changing volumetric trap (Hirst, 1952) located on the terrace of a building near the geographic center of the city approximately 15 m above ground level. This captor worked without interruption throughout the period of the study (1998–2000), constantly aspirating 10 liters of air per minute.

The trapped pollen grains were analysed and determined with an optical microscope through five-hourly bands (2H, 8H, 10H, 14H, 20H). Data were expressed as grains/m^3.

The period of maximum pollen production (MPP) was calculated for each year and defined as the period of the year in which between 5 and 95% of pollen grains of a certain type are collected (Emberlin and Norris-Hill, 1991).

3. Results

3.1 *Pollen count*

The total record of airborne pollen in the period 1998–2000 between the months of September and December, the pollen period of *Celtis*, was 141,19; 105,05 and 88,94 pollen grains respectively. The arboreal airborne pollen concentration during the same period was 109.000 in 1998, 85.000 in 1999 and 65.000 in 2000 (Figure 1).

An analysis of the data in Table 1 shows that the number of pollen grains of *Celtis* counted during the pollination period was 2893 in 1998; 2653 in 1999 and 1262 in 2000, contributing to the atmosphere between 2.04% in 1998, 2.52% in 1999 and 1.41% in 2000.

The pollen season started between the beginning and end of September and finished by mid December depending on the year (Figure 2). The total amount of accumulated pollen was 6808 grains/m^3 in the three years. Based on the pollen records, the greatest concentration peak was found in October with 2250 grains/m^3 in 1998, 2146 grains/m^3 in 1999 and 1206 grains/m^3 in 2000, representing a total average of 82.3% over its total pollen concentration (Table 2). This coincides with the month of maximum arboreal pollen count in the city.

The period of maximum pollen production (MPP) was recorded between 23 and 47 days, and an average of 35 days was obtained with a variation coefficient (VC) of 19.39% (Table 1). Maximum airborne pollen concentration was recorded on 18, 19 and 21 October and records of 259 grains/m^3 in 1998 and 299.7 grains/m^3 were found during 1999 and 2000 (Figure 2). The curves of accumulated percentage in the atmosphere were similar during the three sampling years (Figure 3).

3.2 *Intradiurnal variation*

The daily *Celtis* pollen behaviour showed differences in the hourly concentration values in the various years (Figure 4).

At 2H, an average of 13.33% was recorded slightly decreasing towards 8H with the first sunbeams, with an average of 11.37% and increasing towards 10H with 22.74%. The highest daily pollen peak was recorded at 2H with an average of 35.21%, favoured mainly by the high temperatures and the minimum relative humidity. Then the peak decreased towards 8H with an average of 18.64% when the temperatures began to fall by the end of the day.

The daily data obtained during 2000 show the lowest concentration of the three years at 8H with 8.5% and the highest concentration at 2H with an average of 37.23% (Figure 4).

3.3 *Pollen concentration and meteorological variables*

Values of medium and maximum temperature in August, before anthesis, were similar during the three years, with an average of 15 °C and 11.2 °C. The minimum temperature showed slightly lower values from 1998 to 2000 with 9.2 °C, 8.08 °C and 7.57 °C. The lowest rain values were seen during 1998 with 9.3 mm, whereas in 1999 and 2000, the rain values were significant with a monthly record of 90.3 mm and 78.2 mm respectively affecting the period of flowering and consequent pollination of the species. The values of relative humidity percentages were similar in the three years with an average of 83.3% the same as the wind velocity mean which was 9.6 km/h (Table 2).

In relation to the pollination period of the three years, the most stable meteorological variable as regards quantity and presence during the analysed months was the rainfall (Figure 5). During 1998, the monthly rain records between September and November were very similar, with average values of

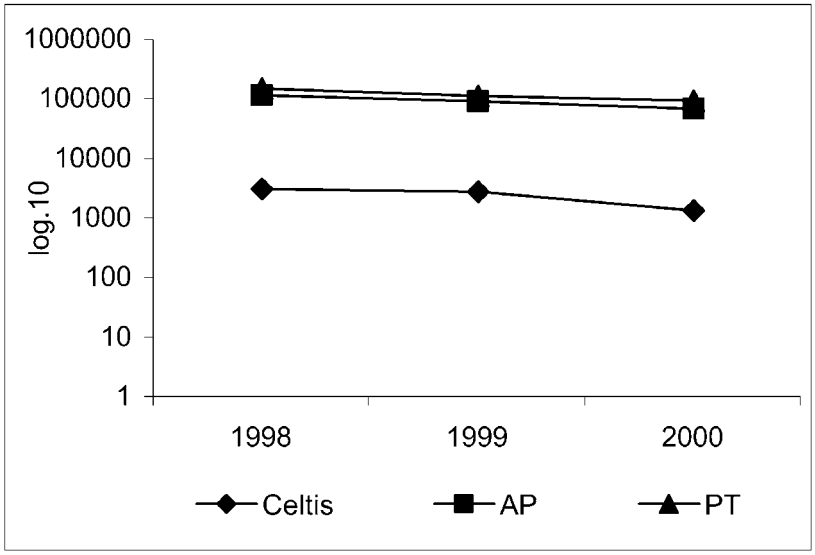

Figure 1. Annual concentration of *Celtis* pollen compared to the total arboreal pollen and to the total of pollen recorded in the years 1998–1999 and 2000 expressed in logarithms.

Table 1. Most important data characterising the pollination periods of *Celtis* in the atmosphere of La Plata

	1998	1999	2000
Start of season	05 Sept.	01 Sept.	27 Sept.
End of season	20 Dec.	11 Dec.	10 Dec.
No. of days	107	81	75
Mean pollen grains/m^3	27	32	16
Total pollen grains/m^3	2893	2653	1262
Max. daily pollen count (grains/m^3)	259	299	299
Date of max. daily pollen count	18 Oct.	19 Oct.	21 Oct.
Maximum hour	14	14	14
MPP (maximum pollen production)	34 days	47 days	23 days
Period of MPP	7 Oct.–9 Nov.	21 Sept.–6 Nov.	8 Oct.–30 Oct.

63.76 mm. During 1999, an abrupt drop was recorded in October compared to the previous and following months with an average of the period of 57.93 mm and during 2000, the rain records were greater and relatively uniform with a high average of 83.93 mm. These conditions are reflected in the percentage of relative humidity which during 1998 showed an average of 75.14%, 79.25% in 1999 and 81.79% in 2000 (Table 2). No differences were seen in the monthly temperature variables, both maximum and minimum, in the years showing averages of 21.31 °C, 13.97 °C and 17.47 °C respectively, nor in the speed velocity records that remained at 11 km/h.

4. Discussion

The total pollen register in the atmosphere of the city of La Plata showed variations of concentration at the end of Winter (September–December) in the three sampling years. The total concentration of arboreal pollen and specifically *Celtis* pollen showed the same results.

The *Celtis* airborne pollen content represented an average of 2.03% compared to the total pollen and an average of 2.62% compared to the arboreal pollen during the three years.

The annual differences of *Celtis* concentration fell 4% between 1998 and 1999 and 20% between 1999 and 2000. This was reflected in the period of

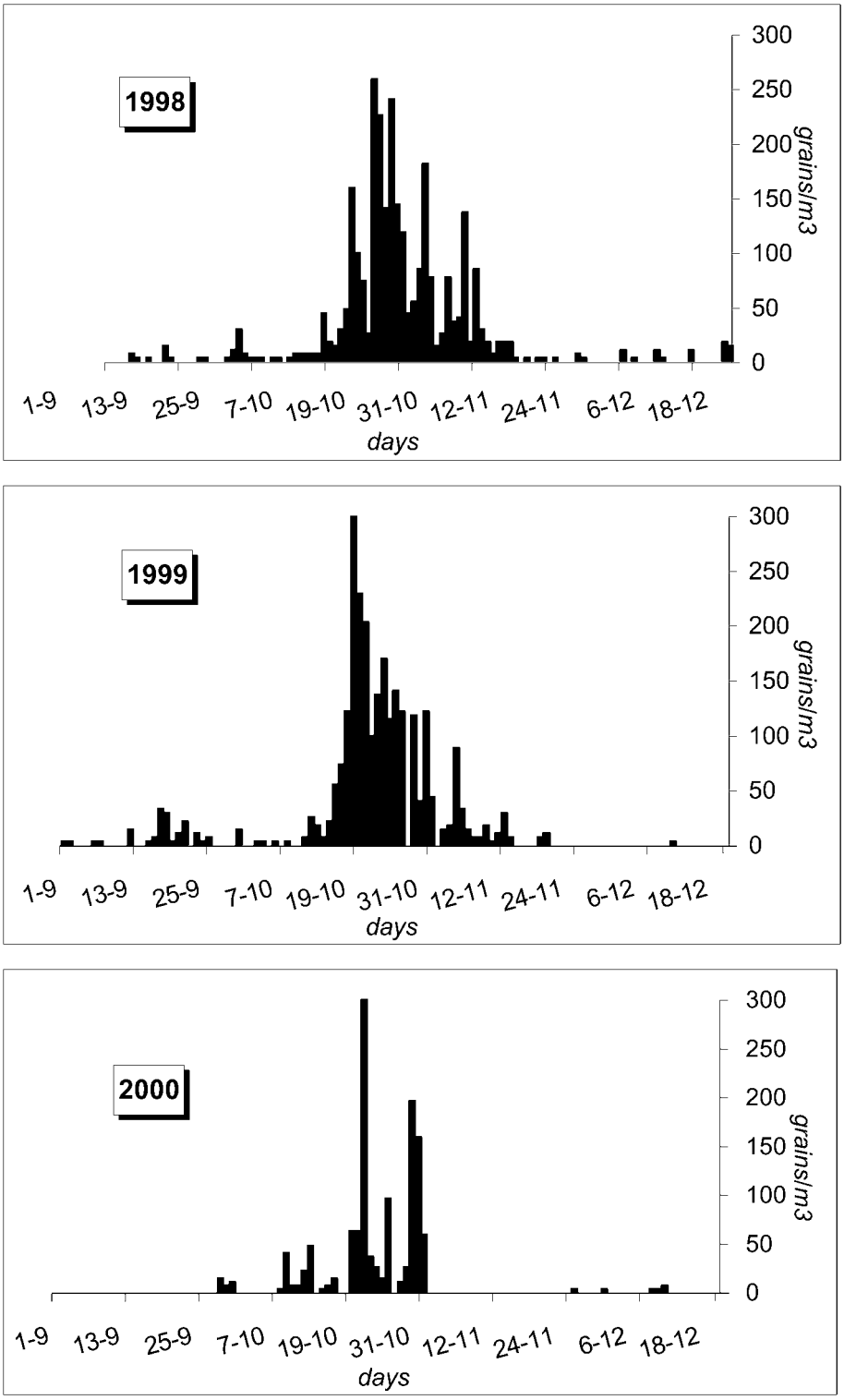

Figure 2. Pollen season of *Celtis* in the various periods expressed in daily sums of pollen grains.

Table 2. Monthly records of the various meteorological variables analysed for each pollination period

	Total pollen (gr/m^3)	Average temp. (°C)	Maximum temp. (°C)	Minimum temp. (°C)	Rainfall (mm)	Relative hum. (%)	Wind speed (km/h)
1998							
September	111	13.2	15.36	11.36	61.4	76.6	11.58
October	2250	16.8	21.28	12.82	66.4	76.27	10.02
November	459	18.63	22.32	14.89	63.5	76.34	11.22
December	74	21.07	25.27	16.69	165.5	71.37	11.99
1999							
September	185	14	17.39	10.58	87	81.53	11.35
October	2146	16.14	20.07	12.82	18.4	82.61	11.85
November	318	18.1	22.44	14.79	68.4	80.68	11.98
December	4	21.18	26.55	17.8	45.6	72.21	10.26
2000							
September	33	13.46	17.12	9.79	90.6	85.14	10
October	1206	17.37	20.38	14.37	72.8	85.58	11.39
November	7	18.28	21.75	14.82	88.4	80.97	10.12
December	15	21.45	25.93	16.97	118.2	75.47	10.26

maximum pollen production as in the lower total number of days of permanence in the atmosphere.

The maximum values of pollen concentration during the three years were recorded at 2H when the conditions of higher temperature and lower humidity were more favourable for anther ripeness and pollen grain emission to the atmosphere. This hourly behaviour was observed in another tree species such as *Acer*, *Fraxinus* and *Platanus* for this same area in 1998 by Nitiu and Mallo (2002).

Based on the diurnal and seasonal behaviour of *Celtis*, it could be inferred that the influence of abundant rains, a greater percentage of the ambient relative humidity and a lower value of the minimum temperature recorded both in the month before anthesis (August) and during September, are the main factors that determine the beginning of plant flowering and its following pollen cycle. These conditions are present mainly in the year 2000; and this could account for the delay of the beginning of pollen emission.

Once the pollen grains are released into the atmosphere, the influence of another meteorological variable playing an important role in their presence and flotation is recorded. This is basically the maximum temperature which is optimum in the hours of greatest sun radiation favouring the process of anther ripeness and its further pollen emission and permanence of the grains in the atmosphere (Caramiello et al., 1990, 1994; Emberlin et al., 1993). During this period, mainly in the month of October, the destabilizing factor is rain, which, during 1998, shows a monthly record not exceeding 66.4 mm. During 1999, the lowest rainfall of the studied period was 18.4 mm and in October 2000 the maximum rainfall was 72.8 mm.

Dispersion is another important phenomenon that influences the estimated quantity of pollen grains recorded in the atmosphere. Dispersion is directly influenced by the wind direction and velocity that act as antisedimentary factors of the aeronavigating pollen, as well as by the rains and humidity preventing the pollen grains from being transported by the air. In our case, the wind velocity remained in 11 km/h as an average in the three years, with predominance of the NE sector until the end of the presence in the atmosphere. During 2000, an abrupt pollen decrease was recorded in the atmosphere after the period of maximum pollination during the month of November. This episode would reflect the direct influence of the rains which are more significant during this month, carrying the pollen in the water curtain that they produce.

Previous aeropalynological studies have been carried out in various areas of the city of La Plata by Silenzi (1966) and Morbelli (1970) recording the presence of the taxon in the air for the same period. Within the same phytogeographic area, for the city of Buenos Aires, Majas and Romero (1992) obtained

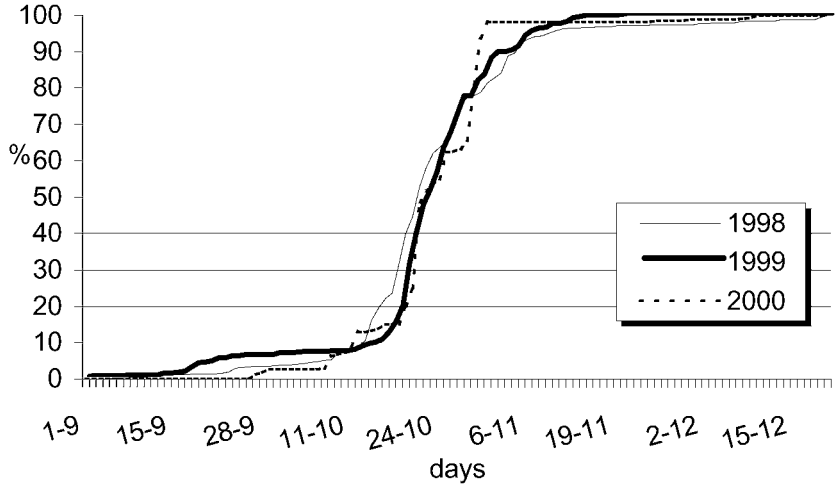

Figure 3. Curves of accumulated percentage of pollen grains for each sampling period in the three years.

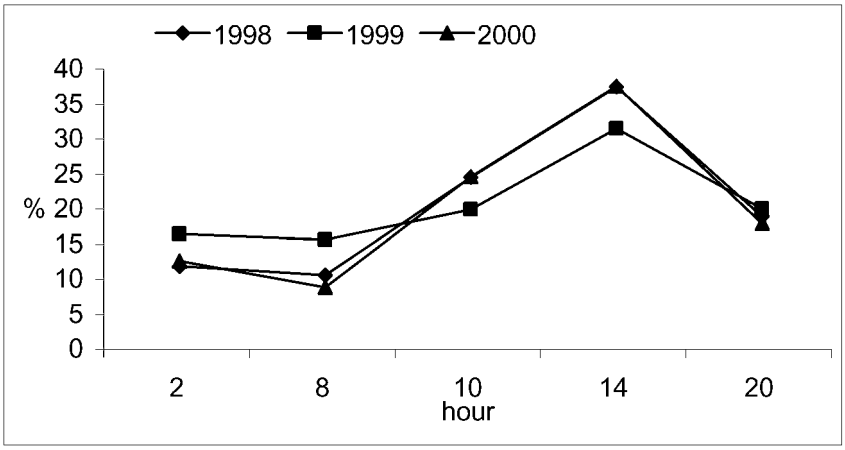

Figure 4. Percentage of intradiurnal representation of *Celtis* pollen.

the record in the atmosphere mainly during the month of October and for the city of Mar del Plata, Latorre (1997); Latorre and Perez (1997) recorded pollen curves between October and November.

Given the importance of *Celtis* for its expression in the arboreal pollen spectrum of the area and for its allergenic potential, it is essential to describe and interpret its pollen behaviour over a period of some years in relation to the meteorological variables. These variables directly influence its presence and concentration (Zerborni et al., 1991) which are very important both for the beginning of flowering and for its pollen fluctuation and representation in the atmosphere. In future works, other taxa will be studied with pollen representation in the atmosphere in order to identify and characterise the aerobiota of the area, since it contains many anemophilous arboreal plants with allergenic potential (Nitiu et al., 1999) The accumulation of great quantities of pollen in the atmosphere can produce pollinosis effects in the respiratory tract of human beings (Fumularo et al., 1992). These consequences could be avoided by adopting a conscious forestry city planning policy.

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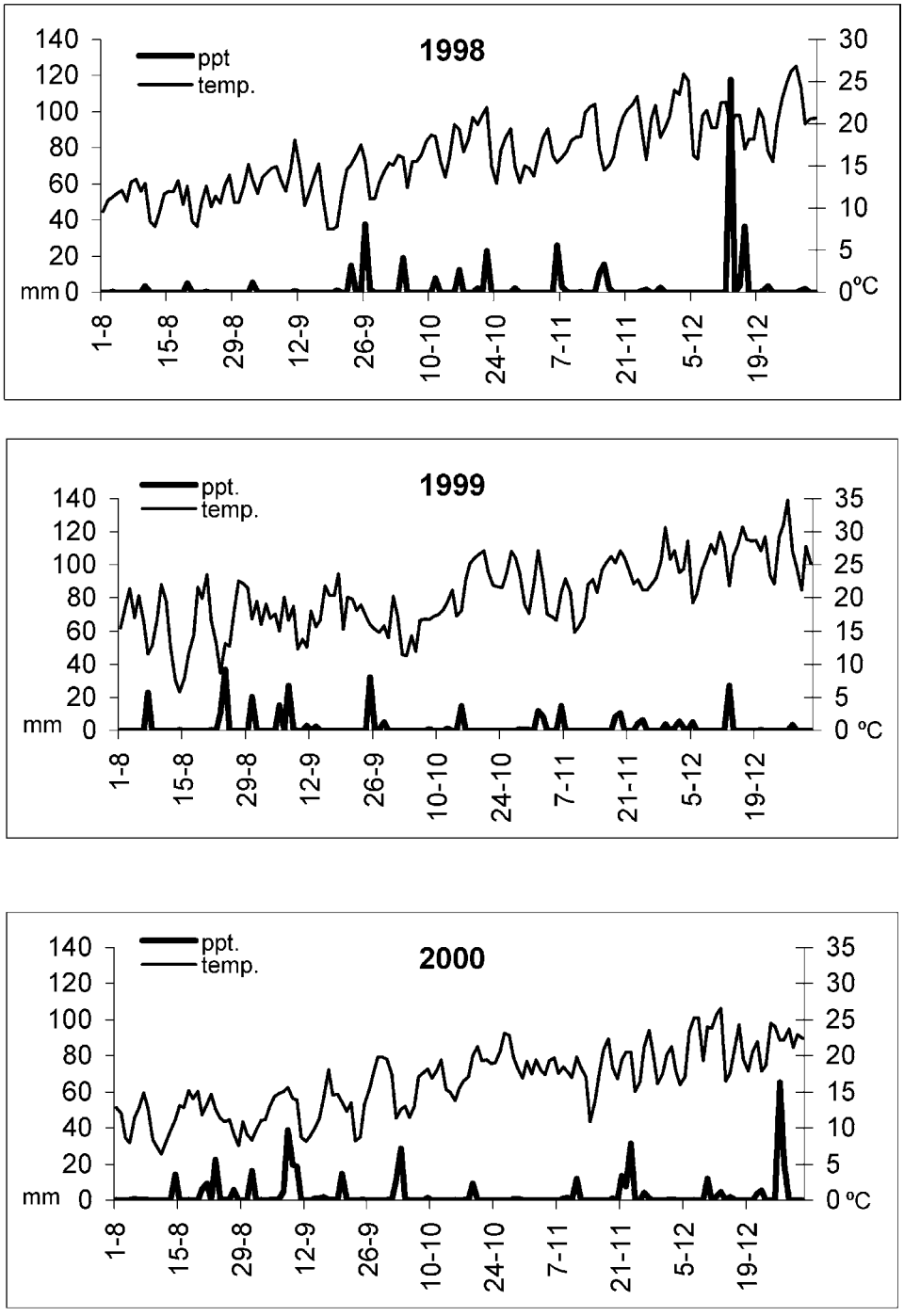

Figure 5. Relationship between daily values of average temperature and records of rains in the three periods.

gical data were provided by the Seismology Department and Meteorological Information of the College of Astronomic and Geophysic Sciences of the National University of La Plata. Argentina.

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