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F. J. Gonzalez Minero^a

^a Dpto. Biología Vegetal y Ecología, Universidad de Sevilla, Apdo. Correos 874, Sevilla, E-41012, Spain

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Relationship between air temperature and the start of pollen emission in some arboreal taxa in Southwestern Spain

F. J. GONZALEZ MINERO, J. MORALES, C. TOMAS and P. CANDAU

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This work presents the first results obtained from the air of Seville relating the mean temperature of the months prior to pollination with the start of pollen emission in *Alnus glutinosa*, *Ulmus*, Moraceae, *Platanus hispanica*, *Quercus*, and *Olea europaea*. Pollen counts were made using a Burkard sampler which sampled the air of Seville between 1993 and 1997 (both inclusive). The start of pollen emission was taken as the day from January 1 on which the main pollination periods (1, 2.5, 5 and 10%) began. The data were related to the mean of the mean temperatures of the preceding months. The accumulated daily temperatures >0, 5 and 10°C from the beginning of the months prior to pollination and from the hypothetical end of dormancy were also calculated. While further years of observation will enable more-reliable forecasting models, we have found some relationship between prior temperature and the start of pollen emission in these six pollen types. The best results so far are those for *Alnus glutinosa*, *Ulmus*, and *Olea europaea*.

F. J. Gonzalez Minero, J. Morales, C. Tomas and P. Candau, Dpto. Biología Vegetal y Ecología. Universidad de Sevilla, Apdo. Correos 874, E-41012, Sevilla, Spain.

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The construction of models forecasting the start of pollen emission in allergenic types, using retrospective data of airborne pollen counts and measurements of air temperature, is of interest in aeropalynological studies — above all in the field of allergies (Davies & Smith 1974, Spieksma 1988) — because of their immediate application. Recent years have seen abundant literature relating air temperature to the start of pollen emission: *Betula* and *Pinus* (Jazon et al. 1977), *Betula* (Kupias 1977), *Ulmus campestris* and *Taxus baccata* (Richard 1985), *Olea europaea* and Gramineae (Frenguelli et al. 1989), *Alnus* and *Populus* (Frenguelli et al. 1991), *Betula* (Ruffaldi & Greffier 1991), *Alnus*, *Ulmus* and *Betula* (Andersen 1991), *Corylus avellana* (Frenguelli et al. 1992), and *Olea europaea* (González Minero & Candau 1996). At the same time, the public dissemination of pollen information via the communication media and computer-based networks has become increasingly widespread and expected. Thus, there is a need for agile, simple instruments enabling reliable forecasts of pollen concentrations. The study of air temperature has proved to be of great use in forecasting pollen emission.

The present work reports the first results relating air temperature to the start of pollen emission in the air of Seville (SW Spain) for *Alnus glutinosa*, *Ulmus* spp., Moraceae, *Platanus hispanica*, *Quercus* spp., and *Olea europaea*. Moreover, the data constitute the longest uninterrupted series of pollen counts made in the air of Seville using the Hirst method, as previous reports on the aerobiology of the city are based on the Cour method (Candau & González Minero 1992, González Minero & Candau 1997a).

MATERIAL AND METHODS

The city of Seville is in the south-west of the Iberian Peninsula (37°23'N, 5°58'W), in the Guadalquivir valley, on the banks of the

river of the same name. Its climate is Mediterranean, characterized by an annual mean temperature of 18.8°C, and an annual total precipitation of 600 mm spread irregularly through the year. The intra-annual variation in mean monthly temperature gives mild winters, with December and January being the coldest months at 10.9 and 10.4°C respectively, and an extremely dry, hot period between May and September, with the highest monthly mean temperatures in July and August, exceeding 26°C (data supplied by the Tablada weather station of the National Meteorological Institute for the period 1922–1989).

The vegetation of the zone consists of (i) a dense, varied ornamental flora in the city, dominated by members of the families Pinaceae, Cupressaceae, Moraceae, Ulmaceae, Platanaceae, Leguminosae, Myrtaceae, Rosaceae, Rutaceae, Oleaceae, and Palmae (Andrés Camacho 1991), (ii) a natural vegetation severely reduced by agricultural use, although there are still considerable enclaves of well-preserved Mediterranean forest (above all, different species of *Quercus*), and (iii) large areas devoted to agriculture, with groves of *Olea europaea* as the most important woody element.

Airborne pollen was collected using a Burkard sampler located at a height of 20 metres on the roof terrace of the School of Pharmacy. The sampler was in operation uninterruptedly from August 1992, although the data presented here are for the five calendar years from 1993 to 1997, both inclusive. The samples were processed according to the protocol proposed by the Spanish Aerobiology Network (Dominguez Vilches et al. 1991).

The meteorological data (daily mean temperature values) were supplied by the regional centre of the National Meteorological Institute, located in the María Luisa Park 1 km from the sampler as the crow flies.

The start of pollen emission coincided with the start of the main pollination periods (MPP). For each pollen type, four main pollination periods were established, their starting days being when 1%, 2.5%, 5%, and 10% of the accumulated annual total pollen had been collected.

Pearson coefficients were calculated to relate the starting dates of the main pollination periods (expressed as number of days from

Jan 1) with the mean of the mean temperatures of the preceding months (in some cases, a fortnightly period was also used). Given the small number of years of observation, the level of significance was taken as $p < 0.1$, which although not indicating statistical significance, is a guide that there may be a relationship between prior temperature and starting day of pollen emission. The sums of daily mean temperature $> 0^{\circ}\text{C}$, $> 5^{\circ}\text{C}$ and 10°C recorded between the first day of the months preceding pollen emission and the starting day of the main pollination periods (1%, 2.5%, 5% and 10%) were also calculated.

Similar sums were calculated for the period between the hypothetical end of dormancy and the start of pollen emission. The hypothetical end of dormancy was estimated retrospectively by analyzing the variation in 10-day mean temperatures from 1st November to February. For *Alnus glutinosa* and *Ulmus* (types with winter flowering), the hypothetical end of dormancy was taken as that 10-day period in November or December when the lowest mean temperatures were recorded, while for the other four types (with later flowering), the hypothetical end of dormancy was taken as that 10-day period from the end of January or beginning of February with lowest mean temperatures. This criterion to determine the hypothetical end of the dormancy period and calculate the accumulated daily mean temperatures above a certain value is that followed in similar studies carried out for ash (Candau et al. 1994) and olive (González Minero & Candau 1996) trees, and is based on the woody plant property of accumulating temperature once vegetative repose has finished. It directly and positively affects

maturation of the floral buds, and thus flowering and start of pollen emission (Richard 1985, Rallo 1994). The accumulated temperatures are presented as 5-yearly means with their corresponding standard deviations. We have considered that there is some kind of relationship between the accumulated daily mean temperature and the starting day of pollen emission when the standard deviation is lower than 10% of the accompanying mean.

RESULTS AND DISCUSSION

Table I presents the starting days (from January 1) of the main pollination periods for each pollen type and year of study. The types are arranged in order of their appearance in the air. The differences between the years with earliest and latest start of MPP are also shown. In *Alnus glutinosa* and *Ulmus*, these differences were small (< 20 days), while in the other four, the differences ranged between 17 (*Quercus*, MPP 2.5%) and 30 days (*Quercus*, MPP 10%, and *Olea europaea*, MPP 5%). The interannual variations in the start of the main pollination periods can be seen graphically from the variation in prior 10-day temperatures (from 1st

Table I. Starting days (expressed as number of days from January 1) of the main pollination periods.

(1%, 2.5%, 5% and 10%).

	Date of beginning of MPP: Days from 1st January					
Taxa	1993	1994	1995	1996	1997	Difference
<i>Alnus glutinosa</i>						
1%	10	13	13	5	6	8 days
2.5%	10	13	13	5	9	8 days
5%	10	14	14	6	9	8 days
10%	10	18	15	7	10	11 days
<i>Ulmus</i>						
1%	47	60	44	48	43	17 days
2.5%	47	60	44	48	43	17 days
5%	48	62	44	49	43	19 days
10%	48	62	44	49	43	19 days
<i>Moraceae</i>						
1%	70	61	55	79	51	24 days
2.5%	76	63	63	73	56	20 days
5%	82	66	68	74	56	26 days
10%	88	65	68	75	58	20 days
<i>Platanus hispanica</i>						
1%	65	62	66	81	57	24 days
2.5%	69	65	67	82	58	23 days
5%	70	66	67	82	59	23 days
10%	70	67	67	82	59	21 days
<i>Quercus</i>						
1%	81	76	80	89	65	24 days
2.5%	81	77	81	95	68	17 days
5%	87	80	87	109	71	18 days
10%	87	80	87	103	73	30 days
<i>Olea europaea</i>						
1%	108	95	100	107	80	28 days
2.5%	109	100	103	114	85	24 days
5%	115	104	103	118	85	30 days
10%	112	114	103	117	88	29 days

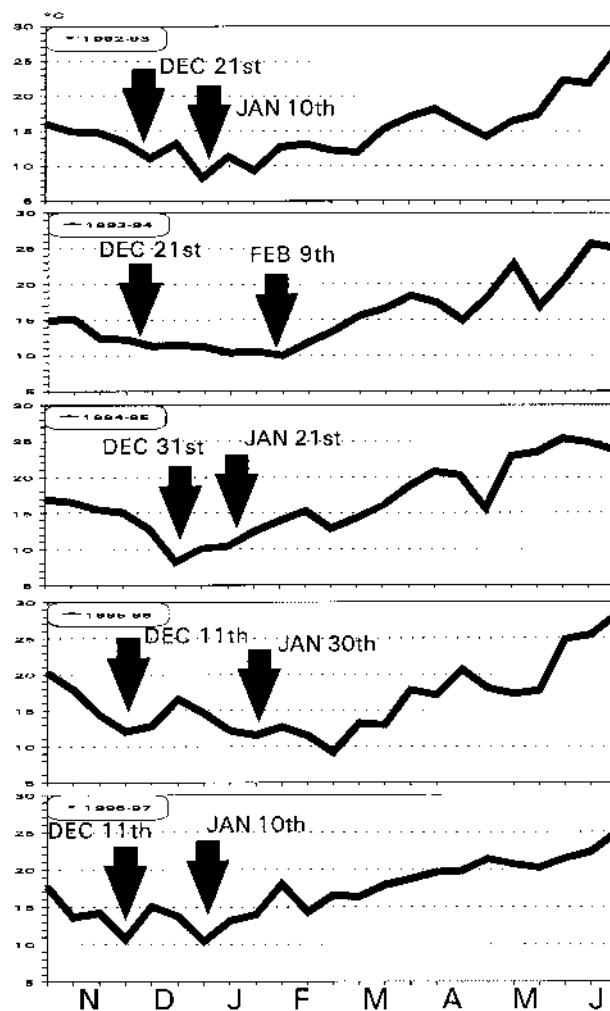


Fig. 1. Variation in ten-day mean temperatures during the inter-annual periods from 1st November to June. The days of the hypothetical end of dormancy release are shown by an arrow.

Table II. Pearson correlation coefficients between mean temperature of the months preceding pollen emission and the starting day of the main pollination periods.

(1%, 2.5%, 5% and 10%). * = $p < 0.05$, ° = $p < 0.1$.

Mean Temp.	ALNUS GLUTINOSA				ULMUS				MORACEAE			
	1%	2.5%	5%	10%	1%	2.5%	5%	10%	1%	2.5%	5%	10%
NOV	-.361	-.493	-.405	-.133	-	-	-	-	-	-	-	-
DEC	-.978**	-.973**	-.980**	-.886*	-.705	-.0712	-.696	-.697	-	-	-	-
NOV+DEC	-.675	-.767	-.707	-.474	-	-	-	-	-	-	-	-
JAN	-	-	-	-	-.911*	-.910*	-.891*	-.917*	-.859°	-.685	-.637	-.638
DEC+JAN	-	-	-	-	-.833°	-.830°	-.821°	-.831°	-	-	-	-
FEB	-	-	-	-	-	-	-	-	-.164	-.251	-.315	-.309
JAN+FEB	-	-	-	-	-	-	-	-	-.586	-.721	-.726	-.725

Mean Temp.	PLATANUS				QUERCUS				OLEA EUROPAEA			
	1%	2.5%	5%	10%	1%	2.5%	5%	10%	1%	2.5%	5%	10%
JAN	-.392	-.274	-.269	-.303	-.097	-.135	-.175	-.192	-	-	-	-
FEB	-.713	-.872°	-.841°	-.831°	-.358	-.225	-.330	-.272	-.701	-.791	-.791	-.956*
JAN+FEB	-.697	-.823°	-.814°	-.795	-.906*	-.815°	-.746	-.735	-	-	-	-
JAN+FEB+ 1/2MAR	-	-	-	-	-.720	-.580	-.474	-.451	-	-	-	-
FEB+1/2MAR	-	-	-	-	-	-.823°	-.767	-.650	-.628	-	-	-
MAR	-	-	-	-	-	-	-	-	-.936*	-.930*	-.930*	-.748
FEB+MAR	-	-	-	-	-	-	-	-	-.885*	-.936*	-.936*	-.948*

November) (Fig. 1). In *Alnus glutinosa*, the main pollination periods were earliest in 1996 and 1997, and latest in 1994. Parallely, the months of December in 1995 and 1996 were the warmest of the period, with 10-day temperatures above 15°C, with the coldest December (10°C) in 1993 (Fig. 1). In *Ulmus*, 1997 had the earliest main pollination periods (Table I), related to a warm previous December, and a January when the 10-day temperatures rose uninterruptedly from 10 to 15°C (Fig. 1). The latest main pollination periods were in 1994 (Table I), following the coldest preceding December and January of the study years (Fig. 1). In the other four types (*Moraceae*, *Platanus hispanica*, *Quercus* and *Olea europaea*), the earliest main pollination periods were in 1997, with the highest February and March temperatures recorded (> 15°C). The latest main pollination periods were in 1996 (Table I), when the February temperatures fell to below 10°C, an unusual phenomenon not found in the other years (Fig. 1).

These relationships between prior temperatures and starting date of the main pollination periods are seen in the Pearson correlation coefficients (Table II). The most noteworthy features of this Table are the following:

1. the negative value of all the coefficients, whether significant or not, confirming the commonly accepted idea that high prior temperatures bring forward the start of the main pollination periods, and low prior temperatures delay it.
2. in *Alnus glutinosa*, there is a good level of significance between the mean temperature of December and the start of the main pollination periods (1, 2.5, 5, and 10%), the highest level being for the 5% period.
3. in *Ulmus*, the effect is similar to that in *Alnus* (although with somewhat lower levels of significance), taking the

temperatures of January. The mean temperatures of December and January also seem to have an effect. These results are in accord with the correlations between temperature and start of pollen emission found for *Alnus* and *Ulmus* in northern and central Europe (Andersen 1991, Frenguelli et al. 1991).

4. in *Moraceae*, *Platanus hispanica* and *Quercus*, the present data show little correlation. The mean temperatures of January and February in *Platanus* and *Quercus*, and those of February in *Platanus*, could affect the start of pollen emission. Significant relationships have been found between the mean temperatures of February and the start of the main pollination period (for 5%) of *Platanus hispanica* in Seville in an 8-year study carried out using the Cour method (González Minero & Candau 1997b).
5. in *Olea europaea*, a good correlation was found with the mean of the mean temperatures of February and March, and the mean temperatures of March, in agreement with the reports of Frenguelli et al. (1989) and González Minero & Candau (1996).

Table III shows the accumulated temperatures above a threshold and from a determinate date before the start of pollen emission. The results most in accord with the criterion described in Material and Methods are underlined. In *Alnus glutinosa*, acceptable results were obtained from the accumulated temperatures above zero and 5°C from the first day of the two months (November and December) before flowering (January). In *Ulmus*, the accumulated daily temperatures above zero from the beginning of January (the month preceding flowering) determined the start of the main pollination periods for 1 and 2.5%. In *Moraceae*, the accumulated temperatures above zero from January 1 also had an effect. In *Platanus hispanica* and *Quercus*, the effect

Table III. Sum of the daily mean temperatures $>0^{\circ}\text{C}$, 5°C and 10°C for different periods prior to the start of the main pollination periods. Mean values and standard deviations for the years 1993–97.

EnD=Hypothetical end of dormancy period. We have considered that there is some kind of relationship between the accumulated daily mean temperature and the starting day of pollen emission when the standard deviation is lower than 10% of the accompanying mean (underlined).

		<i>Alnus</i>	<i>Ulmus</i>	<i>Moraceae</i>	<i>P. hispanica</i>	<i>Quercus</i>	<i>Olea</i>
Accum. Temp. $>0^{\circ}\text{C}$ from 1st Nov-to:	MPP 1%	953 $\pm$ 52.3	—	—	—	—	—
	MPP 2.5%	961 $\pm$ 47.9	—	—	—	—	—
	MPP 5%	968 $\pm$ 53.8	—	—	—	—	—
	MPP 10%	986 $\pm$ 63.9	—	—	—	—	—
Accum. Temp. $>5^{\circ}\text{C}$ from 1st Nov-to:	MPP 1%	601 $\pm$ 59.7	—	—	—	—	—
	MPP 2.5%	606 $\pm$ 58.3	—	—	—	—	—
	MPP 5%	610 $\pm$ 61.9	—	—	—	—	—
	MPP 10%	621 $\pm$ 65.9	—	—	—	—	—
Accum. Temp. $>10^{\circ}\text{C}$ from 1st Nov-to:	MPP 1%	226.6 $\pm$ 112	—	—	—	—	—
	MPP 2.5%	244 $\pm$ 72.5	—	—	—	—	—
	MPP 5%	247 $\pm$ 72.6	—	—	—	—	—
	MPP 10%	256 $\pm$ 75.4	—	—	—	—	—
Accum. Temp. $>0^{\circ}\text{C}$ from 1st Dec-to:	MPP 1%	485 $\pm$ 24.8	950 $\pm$ 138.7	—	—	—	—
	MPP 2.5%	493 $\pm$ 19.7	950 $\pm$ 138.7	—	—	—	—
	MPP 5%	501 $\pm$ 25.2	961 $\pm$ 147.8	—	—	—	—
	MPP 10%	519 $\pm$ 35.6	961 $\pm$ 147.8	—	—	—	—
Accum. Temp. $>5^{\circ}\text{C}$ from 1st Dec-to:	MPP 1%	285 $\pm$ 23.9	553 $\pm$ 107.6	—	—	—	—
	MPP 2.5%	290 $\pm$ 23.3	553 $\pm$ 107.6	—	—	—	—
	MPP 5%	295 $\pm$ 26.6	502 $\pm$ 113	—	—	—	—
	MPP 10%	298 $\pm$ 108.8	502 $\pm$ 113	—	—	—	—
Accum. Temp. $>10^{\circ}\text{C}$ from 1st Dec-to:	MPP 1%	83.2 $\pm$ 37.9	165 $\pm$ 72.5	—	—	—	—
	MPP 2.5%	84 $\pm$ 39.1	165 $\pm$ 72.5	—	—	—	—
	MPP 5%	85 $\pm$ 41.8	167 $\pm$ 65.5	—	—	—	—
	MPP 10%	86 $\pm$ 45.7	167 $\pm$ 65.5	—	—	—	—
Accum. Temp. $>0^{\circ}\text{C}$ from 1st Jan-to:	MPP 1%	—	507 $\pm$ 29.6	742 $\pm$ 104.5	808 $\pm$ 119.9	1003 $\pm$ 175	1364 $\pm$ 123.6
	MPP 2.5%	—	507 $\pm$ 29.6	808 $\pm$ 79.8	833 $\pm$ 101.6	107 $\pm$ 94.8	1441 $\pm$ 123.5
	MPP 5%	—	564 $\pm$ 111.6	817 $\pm$ 81.7	833 $\pm$ 101.6	1102 $\pm$ 150.5	1441 $\pm$ 123.5
	MPP 10%	—	564 $\pm$ 111.6	848 $\pm$ 76.7	849 $\pm$ 99.5	1121 $\pm$ 124.3	1448 $\pm$ 190.2
Accum. Temp. $>5^{\circ}\text{C}$ from 1st Jan-to:	MPP 1%	—	283 $\pm$ 31.2	436 $\pm$ 57.4	475 $\pm$ 86.8	613 $\pm$ 129	871 $\pm$ 82.5
	MPP 2.5%	—	283 $\pm$ 31.2	478 $\pm$ 48.4	493 $\pm$ 71.4	614 $\pm$ 63.6	930 $\pm$ 79.3
	MPP 5%	—	329 $\pm$ 85.8	483 $\pm$ 50.8	493 $\pm$ 71.4	683 $\pm$ 106.3	930 $\pm$ 79.3
	MPP 10%	—	329 $\pm$ 85.8	504 $\pm$ 48.7	505 $\pm$ 70.8	706 $\pm$ 103.1	980 $\pm$ 67.6
Accum. Temp. $>10^{\circ}\text{C}$ from 1st Jan-to:	MPP 1%	—	63 $\pm$ 40.9	168 $\pm$ 81.3	144 $\pm$ 65.9	23 $\pm$ 52.9	343 $\pm$ 62.6
	MPP 2.5%	—	63 $\pm$ 40.9	188 $\pm$ 89.7	154 $\pm$ 58.9	223 $\pm$ 92.5	420 $\pm$ 56.4
	MPP 5%	—	84 $\pm$ 57.9	191 $\pm$ 92.7	154 $\pm$ 58.9	264 $\pm$ 76.2	420 $\pm$ 56.4
	MPP 10%	—	84 $\pm$ 57.9	202 $\pm$ 91.8	160 $\pm$ 59.5	277 $\pm$ 75	446 $\pm$ 49.1
Accum. Temp. $>0^{\circ}\text{C}$ from 1st Feb-to:	MPP 1%	—	—	396 $\pm$ 94	455 $\pm$ 96.4	652 $\pm$ 145	1010 $\pm$ 134
	MPP 2.5%	—	—	458 $\pm$ 88.4	482 $\pm$ 80.4	656 $\pm$ 86	1090 $\pm$ 124.5
	MPP 5%	—	—	466 $\pm$ 93.2	482 $\pm$ 80.4	751 $\pm$ 130.5	1090 $\pm$ 124.5
	MPP 10%	—	—	497 $\pm$ 85.6	499 $\pm$ 73.6	784 $\pm$ 127	1163 $\pm$ 120.9
Accum. Temp. $>5^{\circ}\text{C}$ from 1st Feb-to:	MPP 1%	—	—	241 $\pm$ 49	267 $\pm$ 66.5	417 $\pm$ 95.5	695 $\pm$ 57.2
	MPP 2.5%	—	—	282 $\pm$ 52.3	297 $\pm$ 43.8	417 $\pm$ 47.2	754 $\pm$ 49.3
	MPP 5%	—	—	387 $\pm$ 56.3	297 $\pm$ 43.8	489 $\pm$ 79.8	754 $\pm$ 49.3
	MPP 10%	—	—	308 $\pm$ 53.9	309 $\pm$ 40.5	510 $\pm$ 78.5	804 $\pm$ 20
Accum. Temp. $>10^{\circ}\text{C}$ from 1st Feb-to:	MPP 1%	—	—	86 $\pm$ 20.3	103 $\pm$ 34.8	182 $\pm$ 27.5	340 $\pm$ 44.3
	MPP 2.5%	—	—	106 $\pm$ 31.3	112.6 $\pm$ 29.3	182 $\pm$ 56.6	395 $\pm$ 39.3
	MPP 5%	—	—	108 $\pm$ 33.6	112.6 $\pm$ 29.3	223 $\pm$ 44.3	395 $\pm$ 39.3
	MPP 10%	—	—	119 $\pm$ 36.8	119 $\pm$ 26.9	236 $\pm$ 43.6	418 $\pm$ 92.9
Accum. Temp. $>0^{\circ}\text{C}$ from 1st EnD.-to:	MPP 1%	250 $\pm$ 140.2	365 $\pm$ 79.1	556 $\pm$ 95.5	625 $\pm$ 74.5	804 $\pm$ 124.8	1180 $\pm$ 119.8
	MPP 2.5%	268 $\pm$ 149	365 $\pm$ 79.1	609 $\pm$ 88.3	634 $\pm$ 61.7	830 $\pm$ 73.1	1260 $\pm$ 85.9
	MPP 5%	282 $\pm$ 98.4	353 $\pm$ 66.8	617 $\pm$ 92	634 $\pm$ 61.7	921 $\pm$ 89.7	1260 $\pm$ 85.9
	MPP 10%	298 $\pm$ 108.8	353 $\pm$ 66.8	649 $\pm$ 91.2	650 $\pm$ 56.3	954 $\pm$ 90.2	1333 $\pm$ 60.6
Accum. Temp. $>5^{\circ}\text{C}$ from 1st EnD.-to:	MPP 1%	159 $\pm$ 94.9	221 $\pm$ 81	337 $\pm$ 56.3	375 $\pm$ 63.7	505 $\pm$ 99.8	772 $\pm$ 76.5
	MPP 2.5%	159 $\pm$ 103	221 $\pm$ 81	369 $\pm$ 66.4	385 $\pm$ 57.9	514 $\pm$ 52	830 $\pm$ 56.3
	MPP 5%	166 $\pm$ 74.1	229 $\pm$ 83.3	374 $\pm$ 69	385 $\pm$ 57.9	583 $\pm$ 71.8	830 $\pm$ 56.3
	MPP 10%	176 $\pm$ 81.1	229 $\pm$ 83.3	396 $\pm$ 71.8	296 $\pm$ 54.4	606 $\pm$ 71.2	880 $\pm$ 18.9
Accum. Temp. $>10^{\circ}\text{C}$ from 1st EnD.-to:	MPP 1%	50 $\pm$ 51.4	43 $\pm$ 24	108 $\pm$ 43.2	125 $\pm$ 61.9	204 $\pm$ 52.8	427 $\pm$ 40.1
	MPP 2.5%	53 $\pm$ 52.9	43 $\pm$ 24	119 $\pm$ 36.7	136 $\pm$ 56.5	206 $\pm$ 77.6	400 $\pm$ 56.5
	MPP 5%	54 $\pm$ 55.3	44 $\pm$ 25	131 $\pm$ 54.3	136 $\pm$ 56.5	244 $\pm$ 65.9	400 $\pm$ 56.5
	MPP 10%	58 $\pm$ 59.5	44 $\pm$ 25	143 $\pm$ 57.8	142 $\pm$ 55.3	251 $\pm$ 66.2	595 $\pm$ 249.6

was from the accumulated temperatures above zero from the hypothetical end of dormancy. In *Olea europaea*, various accumulations of temperature were of importance: above zero and 5°C from January 1, above 5°C from February 1, and above zero and 5°C from the end of dormancy. The 754 ± 49.3 degrees above 5°C accumulated from February 1, two months before flowering, are noteworthy, since that value is very similar to those established by other authors following the same criterion (Frenguelli et al. 1989).

CONCLUSIONS

The present results are from a limited number of years of sampling, and will have to be completed and modified with further observations. Nevertheless, we think that five years are sufficient to give a notion of the effect of temperature on the start of pollen emission. The results are of interest both at local level and for other Mediterranean areas with vegetation and climate similar to those of SW Spain. In this sense, we have preferred to include a close or higher number of samples in order to elaborate a predictive model more reliable.

The relationship between prior mean temperatures and start of pollen emission can be shown in two ways: calculating the accumulated daily mean temperatures above a certain value and from a determinate date, and calculating the linear correlation coefficients between the mean of the mean temperatures of the preceding months and the starting day of the main pollination periods.

Our results suggest that forecasting models can be constructed using accumulated daily temperatures above zero and 5°C and the start of the main pollination period (for 2.5 and 5%). In northern regions of Europe, it is generally accepted that the temperatures significant for accumulating the heat necessary for flowering are above 4 or 5°C. In Mediterranean regions, with a lower latitude, it is quite likely that the lower limits for accumulating temperature will be higher.

The start of pollen emission best related to prior temperatures is that in the olive.

In types with winter pollination (*Alnus glutinosa* and *Ulmus*), it has not been possible to find a relationship with temperatures accumulated from the hypothetical end of dormancy, though such has been found in types with spring pollination (*Platanus hispanica*, *Quercus*, and *Olea*).

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