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A comparative study of atmospheric pollen concentrations collected with Burkard and Cour samplers, Seville (Spain), 1992-1994

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A comparative study of atmospheric pollen concentrations collected with Burkard and Cour samplers, Seville (Spain), 1992–1994

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A comparative study has been carried out of the relative efficiency of a Burkard sampler and Cour trap, by taking samples from the air of Seville (SW Spain) for two consecutive years (July 1992 to July 1994). The devices were subjected to identical conditions of installation. 16 specific pollen types were studied either because of their high presence in the regional atmosphere or because of their allergenicity. With both methods, the variations in weekly concentrations throughout the year were analysed. Then the data from the two traps was compared in order to compare the efficiency of the two methods.

The Burkard sampler collects 1.42 times more total pollen than the Cour trap. Certain pollen types are found more frequently in the Burkard trap (*Casuarina*, *Mercurialis*, *Olea*, *Platanus*, *Rumex* and *Urticaceae*); some are approximately equal in the two traps (*Amaranthaceae*/*Chenopodiaceae*, *Cupressaceae*, *Fraxinus*, *Pinaceae*, *Plantago*, *Poaceae* and *Quercus*); and others are found more frequently in the Cour trap (*Artemisia*, *Compositae* and *Myrtaceae*). Qualitatively, the Cour trap (with 80 different pollen types identified) is more efficient than the Burkard (with 44 different pollen types identified), although the analysis with the Burkard is quicker, and therefore more practical for allergy studies.

A Spearman correlation analysis between the two methods was carried out. It showed that there were no large statistical differences in the weekly concentrations through the year for 15 out of the 16 pollen types considered.

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In just over a century many pollen samplers have been introduced to estimate pollen composition and concentration in the atmosphere. Among this large variety of sampling devices, we can single out the following, as being probably the most used and best known in aerobiology: Durham (O'Rourke 1990), modified Durham (Belmonte & Roure 1991), Tauber (Borromei & Quattrocchio 1990) rotary arm impactors (Chapman 1986, Fountain & Confort 1991), membrane filtration methods (Roses-Codinachs et al. 1992), Cour (Candau & González Minero 1992), MK-Samplair (Banks & Di Giovanni 1994) and Hirst in either the Burkard or Lanzoni versions (Galán et al. 1989, Jäger et al. 1991, Hicks et al. 1994, among others).

Since such a large array of samplers are available it is interesting to make comparative studies between them to see whether the results obtained by two different samplers simultaneously sampling the same geographical area are comparable, and if so, to determine the degree of correlation between them. Some works of this kind are found in the literature: comparisons between Burkard and Cour (Durand & Comtois 1989), Burkard and Durham (O'Rourke 1990), Burkard, Durham and Rotorod (Gagnon & Comtois 1992) and Rotorod and Samplair (Banks & Di Giovanni 1994).

The present work aims to add to these, and reports the results of two years of sampling the air of Seville simultaneously with a Burkard sampler and a Cour trap.

A comparison between these two methods was carried out some years ago in the air of Montréal (Durand & Comtois 1989), and more recently jointly in rural sites in France and Italy by the Louis Pasteur Institute, the CNRS of Montpellier and the Plant Biology department of Perugia University, and co-ordinated by Cemagref (Bordeaux). The latter study aimed to establish whether, for grape and olive harvests, these two methods gave the same crop prediction results.

MATERIAL AND METHODS

We used one Burkard sampler and one Cour trap at the same site, at a height of 15 metres on the roof of the Pharmacy Faculty, Seville (37° 23'N and 5° 58'W). These sampled the air of the city for two successive years, from the 32nd week of 1992 (beginning of August) to the 32nd week of 1994 (end of July).

The Cour trap was designed in 1973 (Cour 1974). It consists of two vertical filters supported on a rod 3 metres above ground level. These are protected from the rain and continuously face into the wind under the action of a vane incorporated on the back of the device. The device does not need electrical power: the particles found in the air are pushed by the wind into the mesh of the filters. Each filter consists of five sterile gauzes overlaid in the form of a net and fitted into a plastic frame, giving a surface area of 400 cm². The filters are normally exposed for a week, although they can be changed two or three times weekly if, for example, the aim is to make crop prediction studies (González Minero & Candau 1995).

At least two days are required for the chemical treatment of the filters and the microscope analysis of the preparations. The method has already been described partially or totally in previous works (Cour 1974, Cambon 1981, Rajeriarison 1983, Richard 1985, Belmonte 1988, Durand & Comtois 1989, González Romano et al. 1992 and González Minero et al. 1993). The two procedures can be summed up in five stages:

- The gauze is dissolved and the sand and organic particles retained with the pollen are removed. This is achieved with successive treatment of sulphuric acid, 70% hydrofluoric acid and hydrochloric acid.
- The resulting pollen is acetolyzed and coloured with basic fuchsin.
- The volume of pollen collected is quantified. This operation is carried out by adding a known volume of glycerine and collecting the resulting volume (pollen + glycerine) with a micropipette.
- A large part of the total pollen recovered will be counted. For this purpose, the microscopic preparations are mounted in 50 μ l aliquots of the above volume.

Both the amount and diversity of the pollen collected on the filter are determined microscopically. The wind speed is known from a totalling anemometer located beside the sampler, so that the pollen count from the analysis can be expressed as grains/ m^3 of air.

Aerobiologists are quite familiar with the Burkard sampler. The device runs by electricity, and sucks 10 litres of air per minute through a small opening permanently turned into the wind by its built-in vane. The particles contained in the sucked-in air impact upon a strip located next to the opening. The strip is a transparent plastic film, covered with a thin, uniform layer of filamentous cellulose, and fixed around a drum which is rotated by a 7-day clockwork mechanism at a speed of 2 mm/hr. After (in our case) a week of exposure, the strip is cut into seven pieces (one for each day of the week). Each piece is mounted on a slide and, after adding a staining solution, is analysed under the microscope. This method enables the results to be known very rapidly, and can give pollen concentrations per hour, day or week because the amount of air sucked in every unit of time is known (0.6 m^3 /hr, 14.4 m^3 /day and 100.8 m^3 /week).

In our study, the Burkard tape and the Cour filter were changed weekly (every Monday at 12.00 noon) during the 104 weeks for which the study lasted. Therefore, with the Cour method we obtained 104 preparations, while with the Burkard one 728 slides (104 weeks $\times$ 7 days/week) were needed. To enable comparisons of the results from the two samplers, the Burkard daily concentrations were totalled for the seven days from Monday 12.00 midnight to the following week at the same hour, to coincide with the weekly exposure of the Cour filter.

We chose to study 16 different pollen types, either because of their abundance or, in the case of *Artemisia*, because of their allergenicity. Seventeen figures have been drawn showing the weekly variation through the year for the total pollen concentration and for the 16 most abundant pollen types by the two methods. (These weekly concentrations are arithmetic means of the weekly concentrations for the two years of sampling).

In each graph, the x axis indicates the months and weeks of the year, and the y axis the range of concentrations (expressed as grains/ m^3 of air) obtained with either the Burkard or the Cour sampler. In order to improve the graphical comparison of the results the scales of the ordinates are different for each pollen type.

The weekly results for each pollen type were summed to give the total pollen collected through the year (from week 32 to week 31 of the following year). We also calculated Spearman's coefficient of correlation (r_s), to reveal any significant correlation between the weekly concentrations obtained with the two samplers (These weekly concentrations are arithmetic means of the weekly concentrations for the two years of sampling).

RESULTS AND DISCUSSION

During the two years of sampling, 80 different pollen types were identified with the Cour trap while only 44 were collected from the Burkard sampler (Table I). A similar result was reported by Durand & Comtois (1989). Those workers gave two reasons (with which we agree) for this qualitative difference:

- the Cour method yields acetolyzed grains, making their later identification easier and reducing the number of unknown types.
- the Cour trap probably collects pollen from a larger geographical area, due to its large capture surface (400 cm^2) – which makes it especially useful for biogeographical studies (Cambon 1981).

The number of additional types identified with the Cour forms a very small proportion of the total pollen collected, and is of little or no importance from the clinical point of view.

According to our research, the Burkard sampler collects on average 1.42 times the total pollen estimated by the Cour trap (Table II). Similar results are being produced by ongoing studies of the Cemagreff-CNRS-Dpt (Vegetal Biology of Perugia University 1993).

In the study carried out by Durand & Comtois (1989), the amount of total pollen is four times greater in the Burkard than in the Cour, when those authors compare the weekly concentrations obtained using the Cour with the sum of the seven daily concentrations obtained from the Burkard.

The Burkard sampler collects more pollen for some specific types (Amaranthaceae/Chenopodiaceae, *Casuarina*, Cupressaceae, *Mercurialis*, *Olea*, *Plantago*, *Platanus*, Poaceae, *Rumex* and Urticaceae). We believe that this is a direct consequence of the regular intake of air produced with this method (100.8 m^3 /week). Therefore situations of high pollen concentrations combined with aeolian calm can only be seen by volumetric sampling. However, with some other pollen types, such as *Artemisia*, Compositae, *Fraxinus*, Myrtaceae, Pinaceae and *Quercus*, the pollen concentrations were higher when estimated by the Cour method. This is probably because in situations of low pollen concentration, pollen which has been transported over long distances, or refloated pollen, both of which have a more constant presence in the air are sampled more extensively with the Cour trap.

Table II groups the 16 taxa studied into three groups, in accordance with the level of pollen concentration they reached in each trap:

- Taxa for which the pollen concentrations were higher with the Burkard method ($B/C > 1.42$): *Casuarina*, *Mercurialis*, *Olea*, *Platanus*, *Rumex* and Urticaceae
- Taxa whose concentrations were about the same with both methods ($B/C = 0.58 - 1.42$): Amaranthaceae/Chenopodiaceae, Cupressaceae, *Fraxinus*, Pinaceae, *Plantago*, Poaceae and *Quercus*.
- Taxa for which the concentrations were higher using the Cour method ($B/C < 0.58$): *Artemisia*, Compositae and Myrtaceae.

Table I. List of the different taxa identified with Burkard (B) and Cour (C) traps.

Taxa	Sampler	Taxa	Sampler
<i>Abies</i>	C	<i>Mercurialis</i>	C+B
<i>Acacia</i>	C+B	<i>Morus</i>	C+B
<i>Acer</i>	C+B	<i>Myoporum</i>	C
<i>Alnus</i>	C+B	<i>Myrtaceae</i>	C+B
Amaranthaceae/Chenopodiaceae	C+B	<i>Nerium</i>	C+B
<i>Anagallis</i>	C	<i>Olea</i>	C+B
<i>Anchusa</i>	C	<i>Palmae</i>	C+B
<i>Arbutus</i>	C	<i>Papaver</i>	C
<i>Artemisia</i>	C+B	<i>Papilionaceae</i>	C+B
<i>Berberis</i>	C	<i>Pinus</i>	C+B
<i>Betula</i>	C+B	<i>Pistacia</i>	C+B
<i>Brachychiton</i>	C	<i>Plantago</i>	C+B
<i>Castanea</i>	C+B	<i>Platanus</i>	C+B
<i>Casuarina</i>	C+B	<i>Polygonum</i>	C
<i>Cestrum</i>	C+B	<i>Prunus</i>	C+B
<i>Celtis</i>	C	<i>Quercus</i>	C+B
<i>Cistaceae</i>	C+B	<i>Ranunculus</i>	C
<i>Citrus</i>	C	<i>Rhamnus</i>	C
<i>Corrigiola</i>	C	<i>Ricinus</i>	C
<i>Corylus</i>	C+B	<i>Rosaceae</i>	C
<i>Cruciferae</i>	C+B	<i>Rubiaceae</i>	C
<i>Cupressaceae</i>	C	<i>Rumex</i>	C+B
<i>Cyperaceae</i>	C+B	<i>Salix</i>	C+B
<i>Ecballium</i>	C	<i>Sambucus</i>	C
<i>Echium</i>	C	<i>Sanguisorba</i>	C
<i>Emex</i>	C	<i>Scrophularia</i>	C
<i>Ericaceae</i>	C+B	<i>Schinus</i>	C
<i>Erinus</i>	C	<i>Silene</i>	C+B
<i>Firmiana</i>	C	<i>Solanum</i>	C
<i>Fraxinus</i>	C+B	<i>Tamarix</i>	C
<i>Fumaria</i>	C	<i>Thymelaea</i>	C
<i>Geranium</i>	C	<i>Tilia</i>	C
<i>Helianthus</i>	C+B	Compositae-Tubuliflorae	C+B
<i>Herniaria</i>	C	Typhaceae	C+B
<i>Juglans</i>	C	<i>Ulmus</i>	C+B
Labiatae	C+B	Umbelliferae	C+B
Compositae-Liguliflorae	C+B	Urticaceae	C+B
<i>Ligustrum</i>	C+B	<i>Viburnum</i>	C+B
<i>Liliaceae</i>	C+B	<i>Vitis</i>	C+B
<i>Lythraceae</i>	C	<i>Xanthium</i>	C+B

The main characteristic of the first of the three groups is that it includes generic pollen types (except Urticaceae); pollen types in this group have a seasonal presence in the air, and can reach extremely high concentrations (*Casuarina*, Fig. 4; *Olea*, Fig. 10; and *Platanus*, Fig. 13). In the case of Urticaceae, the size and habitat of this plant, together with the size and concentration of its pollen, favour the spreading of the pollen by upward moving warm air streams (convection), in which conditions the Burkard method of trapping is extremely efficient.

The second group, which is also the most numerous, has two main characteristics: on one hand it comprises many species, and on the other, these species are those which usually stay in the atmosphere for long periods during the year (Poaceae, Amaranthaceae/Chenopodiaceae, *Quercus*, *Plantago*). The *Fraxinus*-type, is an exception since it comprises few species with intense pollination at a precise time of the year. It has normally been included in the first group mentioned (Candau et al. 1994). After the long periods of drought concomitant with our two years of study, the

pollination of *Fraxinus* was severely affected, and as a result, *Fraxinus* is artificially included in the second of our taxa groups (Fig. 7).

The third group (*Artemisia*, Compositae and Myrtaceae) comprises those taxa that usually appear when the temperature in Seville rises above 40°C. Under these circumstances, the Burkard sampler has a very low performance and efficiency (Figs. 3, 5, 9). The pollen type known as Compositae is formed mostly of pollen coming from the sunflower (*Helianthus*), a large, heavy pollen pushed into the trap by the effect of the turbulence produced during the August harvesting of certain crops surrounding the traps. The action of many combine-harvesters makes the Cour trap more efficient than the Burkard one. Finally, the case of *Artemisia* is a clear example of a better performance of the Cour trap over the Burkard when we are dealing with pollen types of little prevalence and abundance in the atmosphere.

Figures 1 to 17 also show that most of the pollen types are captured earlier with the Cour trap than with the Burkard one, and this may be especially true in cases of very low

Table II. Sum of the annual concentrations obtained with Burkard and Cour. traps.

Ratio of these concentrations B/C

Taxa	Burkard grains/m ³	Cour grains/m ³	G m ⁻³ B/G m ⁻³ C
Amar/Chen	247.07	201.87	1.22
Artemisia	1.14	6.17	0.18
Casuarina	25.43	15.54	1.64
Compositae	60.86	122.04	0.50
Cupressaceae	719.43	568.20	1.27
Fraxinus	41.36	68.50	0.60
Mercurialis	49.07	30.49	1.61
Myrtaceae	155.00	417.79	0.38
Olea	800.86	394.08	2.03
Pinaceae	49.50	85.42	0.58
Plantago	142.14	105.57	1.35
Platanus	1843.93	973.10	1.89
Poaceae	473.71	436.99	1.08
Quercus	816.93	997.52	0.82
Rumex	87.79	55.67	1.58
Urticaceae	428.14	165.57	2.58
Total pollen	7127	5026.84	1.42

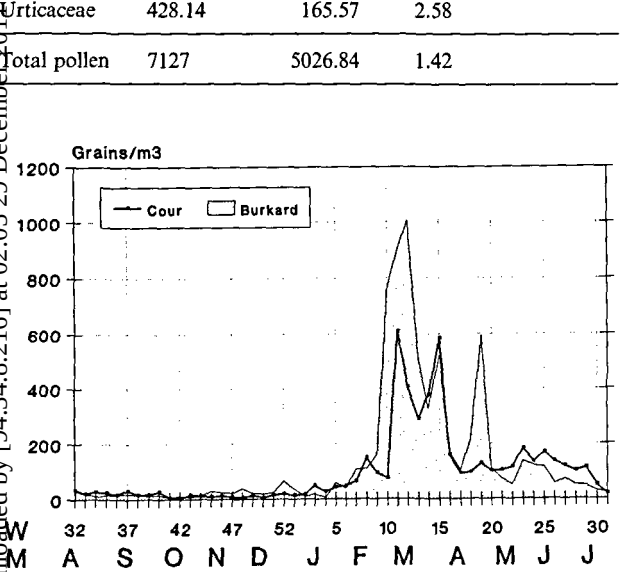


Fig. 2

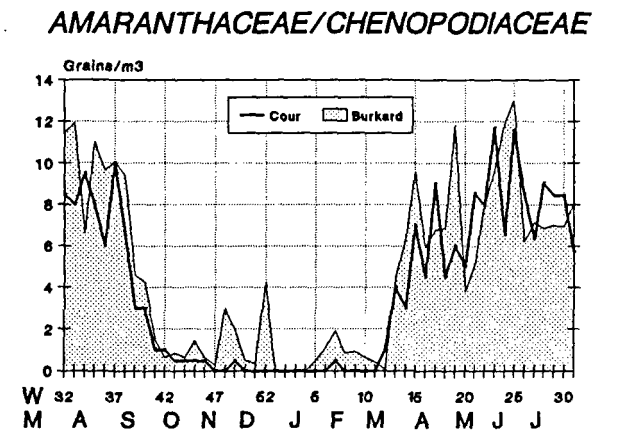


Fig. 3

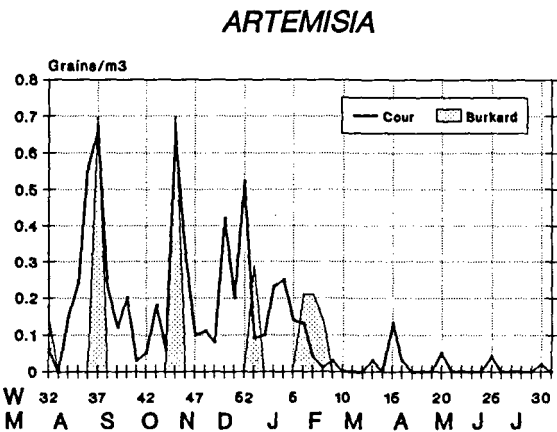


Fig. 4

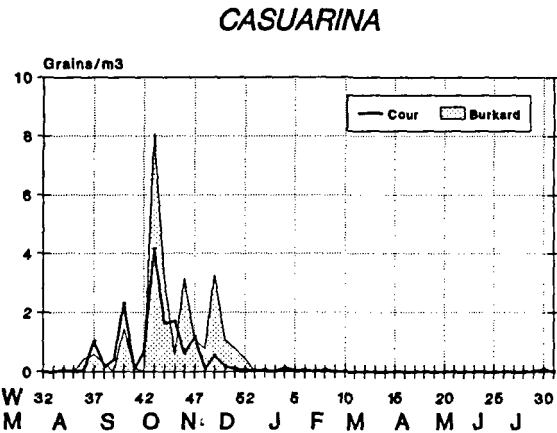


Fig. 5

pollen concentrations (as mentioned above). In this respect, we would like to emphasise that the Cour trap is rather sensitive to situations of low pollen concentration, and for that reason, the pollen of anemophilous plants may be detected by it just at the very beginning of flowering.

Spearman's correlation test was applied to discover whether there are statistically significant differences between the weekly pollen concentrations (of total pollen and the 16

CUPRESSACEAE

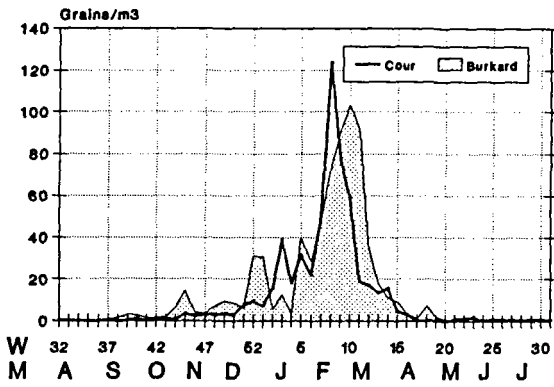


Fig. 6

MYRTACEAE

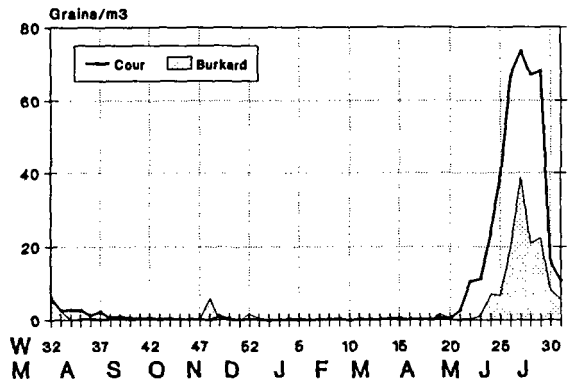


Fig. 9

FRAXINUS

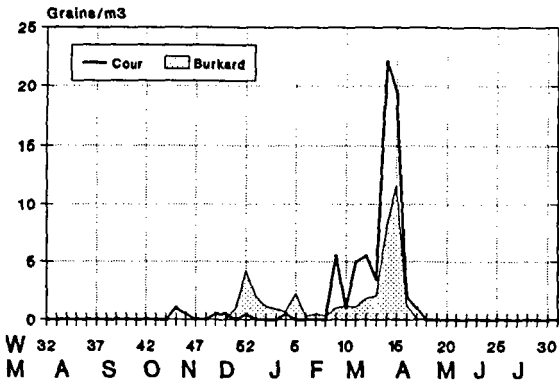


Fig. 7

OLEA

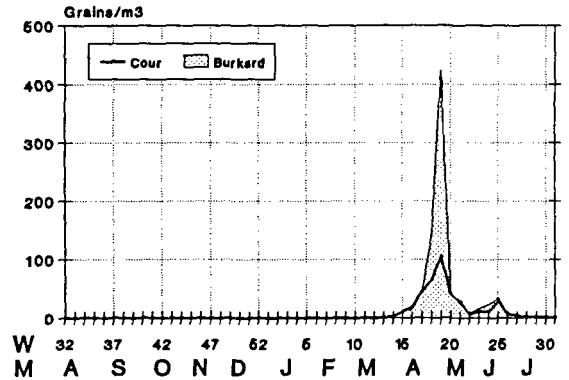


Fig. 10

MERCURIALIS

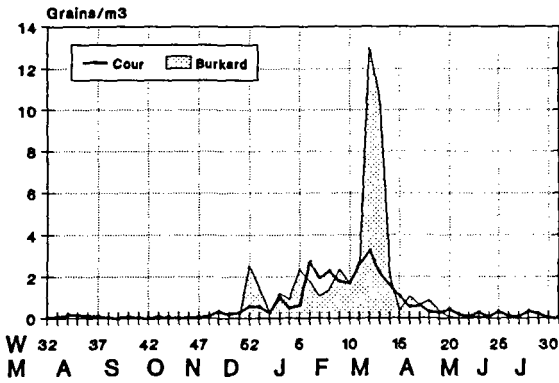


Fig. 8

PINACEAE

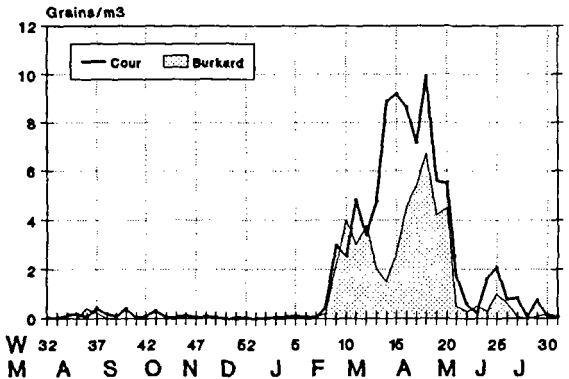


Fig. 11

pollen types) found using each method. This non-parametric test was chosen since the concentrations do not have a normal distribution. Table III shows the correlation coefficients and their levels of significance. In all cases the correlation coefficients are different from zero and are higher than the critical value (0.274), except in the case of *Artemisia*. According to these results, apart from *Artemisia*, there are no statistically significant differences between the weekly

pollen concentrations obtained using the Cour trap and those obtained using the Burkard trap.

CONCLUSIONS

The running of the Burkard trap is not costly, and the amount of pollen collected with it is slightly higher than that obtained using the Cour trap. However, if specific pollen

PLANTAGO

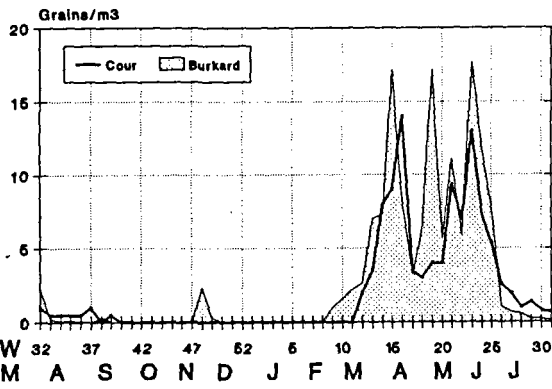


Fig. 12

QUERCUS

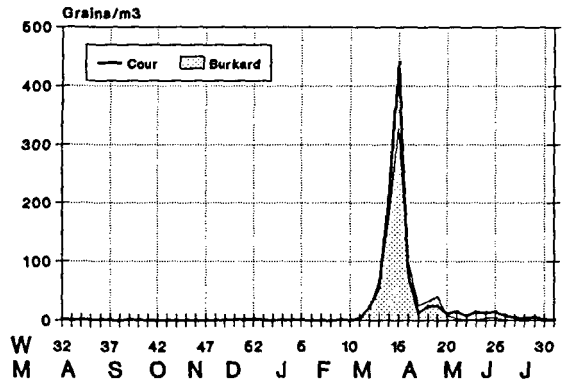


Fig. 15

PLATANUS

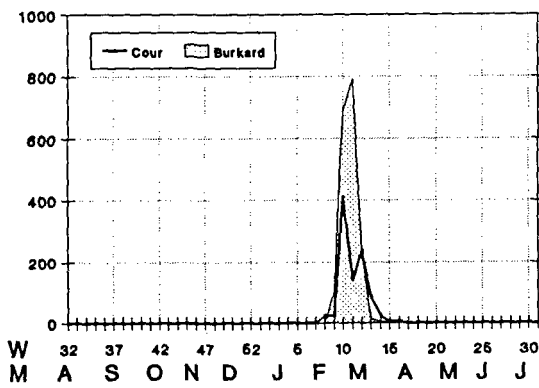


Fig. 13

RUMEX

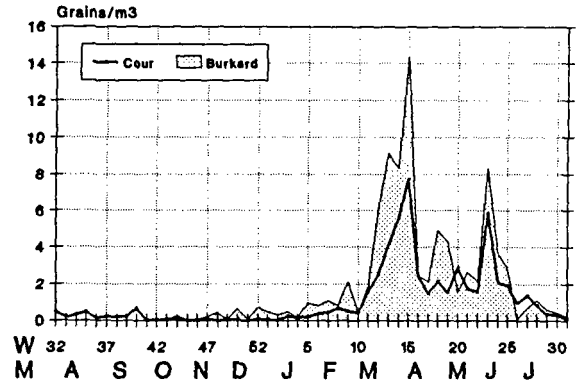


Fig. 16

POACEAE

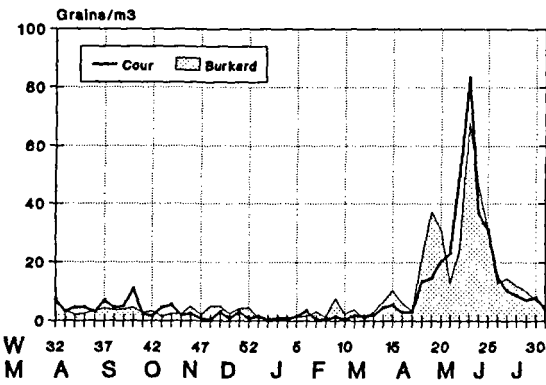


Fig. 14

URTICACEAE

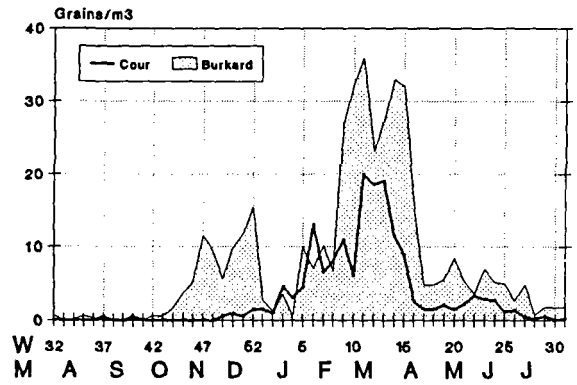


Fig. 17

types are considered, our results are inconclusive, since we found different levels of concentration for the same pollen type with the two traps. Nevertheless, the use of a Burkard sampler enabled us to deliver the results of the sampling almost immediately after collection. The main disadvantage of the use of this trap is that it uses electricity, and that the analysis has to be done with seven preparations instead of one.

The Cour trap is more efficient for small pollen concentrations showing also a high diversity of pollen types. Nevertheless, this superiority in quality has very little effect on the total amount of pollen collected, and any possible interest of this trap for further clinical studies can be ruled out. In addition, its maintenance is too costly, the processing of the filters too laborious, and the results cannot be known immediately. Therefore the choice of a Cour would

Table III. Spearman coefficients of correlation (r_s), performed to reveal statistically significant differences between the variation throughout the year in the weekly concentrations found in each pollen type with Burkard and with Cour traps. (***) p significant correlation.

Critical value: $(r_s)_{0.05, (2), 52} = 0.274$

*** $p < 0.001$

** $p < 0.01$

* $p < 0.05$

(rs) 0.05 (2), 52 = 0.274

Taxa	rs
Amar/Chen	0.843***
Artemisia	0.199
Casuarina	0.809***
Compositae	0.602***
Cupressaceae	0.810***
Fraxinus	0.571***
Mercurialis	0.813***
Myrtaceae	0.530***
Olea	0.900***
Pinaceae	0.776***
Plantago	0.803***
Platanus	0.687***
Poaceae	0.742***
Quercus	0.778***
Rumex	0.725***
Urticaceae	0.703***
Total pollen	0.792***

not be judicious for the carrying out of clinical studies. It would however be satisfactory for pollination or agronomy studies.

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