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METEOROLOGY IN PORTUGAL.*

OUR notice of the present state of meteorology in Portugal naturally divides into two parts—(1) Places and methods of observation; (2) Results.

The chief observatory, that of the Infante D. Luiz, at Lisbonne, is about a mile from the Tagus, and 300 feet above the sea, and is under the personal direction of Senor J. C. de Brito Capello. It is provided with photographically recording barometer and hygrometer, with two recording anemometers (one a Robinson for velocity, and the other a Cator for pressure), also with a recording rain gauge on the top of the observatory, of which we should be glad to receive a detailed description. There is also a Thomson's photographic electrometer, a set of magnetographs, and a full set of ordinary meteorological instruments. There appears, however, to be one omission: we do not see mention of any thermometers for observing the temperature of the earth at different depths. We trust that a set for this purpose will soon be added.

The second-order stations are—

COAST.

Porto..... Lat. 41°8′ N., Lon. 8°37′ W., Altitude 279 ft.
Lagos..... Lat. 37°8′ N., Lon. 8°48′ W., Altitude 43 ft.

INLAND.

Guarda..... Lat. 40°32′ N., Lon. 7°20′ W., Altitude 3409 ft.
Campo Maior. Lat. 39° 2′ N., Lon. 6°56′ W., Altitude 945 ft.
Evora..... Lat. 38°40′ N., Lon. 7°39′ W., Altitude 1027 ft.

Each of these stations is provided with standard barometer, hygrometer, max. and min. thermometer, rain gauge, evaporimeter, Robinson's anemometer and ozone papers. (Similarly equipped sta-

* *Résumé Météorologique du Portugal.* Par M. DE BRITO CAPELLO. Large 8vo. 1879.

La Pluie à Lisbonne. Par M. DE BRITO CAPELLO. Large 8vo. 1879.

Pression Atmosphérique à Lisbonne, 1856-75. Par M. DE BRITO CAPELLO. Large 8vo. 1879.

Détermination de la Température de l'Air. Par M. DE BRITO CAPELLO. Large 8vo. 1879.

Postos Meteorologicos, 1876. SEGUNDO SEMESTRE. Folio. 1878.

Annaes do Observatorio do Infante D. Luiz. VIGESIMO TERCEIRO ANNO. Folio. 1878.

tions are maintained by the Portuguese Government in Madeira, and at St. Thomas, Gulf of Guinea.)

Observations are made at all stations at 9 a.m., noon, and 3 p.m., and at some of them a 9 p.m. observation is added. The observations are printed very fully, almost *in extenso*, in the Postos Meteorologicos.

The results will be most handily given in the form of a table.

Stations.	Altitude	Pressure.		Temperature.					Rain.
		Mean at Sea Level.	Mean diff. 9 am-3 pm	Absolute Max.	Absolute Min.	Mean Max.	Mean Min.	Mean.	
	ft.	in.	in.	°	°	°	°	°	in.
Porto	279	30·013	·029	99·3	30·6	67·6	52·7	60·2	59·96
Guarda	3409	30·071	·007	94·3	19·2	58·0	45·2	51·6	39·34
Campo Maior..	945	30·069	·047	111·7	25·5	73·9	50·8	61·3*	21·81
Lisbonne	335	30·050	·039	100·0	29·3	66·6	55·2	60·9	30·04
Lagos.....	43	30·063	·028	100·9	32·7	71·3	55·5	63·4	23·03

We may translate a few sentences respecting temperature as a comment upon the above table :—

"The mean annual temperature at the three coast stations decreases from south to north, in accordance with the general law.

"At the two stations in the interior great anomalies result from their orographical and topographical position.

"At Guarda (altitude 3,409 ft.), in lat. 40½ N., the mean annual temperature is nearly identical with that of Paris, and, what is still more singular, the mean temperatures of the various seasons, and even those of the various months, are very much like those of Paris.

"The decrease of mean temperature with altitude is about 1° F. for 329 feet.

"At Campo Maior, although in a latitude slightly north of Lisbonne, and at an altitude of 945 feet, the mean temperature exceeds that of Lisbonne.

"This anomaly is entirely due to its inland position. [It is near Badajoz, and about 116 miles from the coast.]

"Campo Maior is in a district which is very dry, and consequently greatly heated during the summer.

"There are there, during summer, periods of ten and fifteen consecutive days with the temperature at 9 a.m. exceeding 86°, and during this period daily maxima often exceeding 108°.

"On the coast during the warm season there is almost always a sea breeze, beginning between 11 a.m. and noon. Although on many occasions this breeze is feeble and of short duration, it always lowers the temperature and increases the humidity. But this cooling and softening influence never reaches the inland stations."

The following table gives the monthly rainfall on the mean of the nine years 1864–1872.

* The mean of the max. and min. gives 62°·3, but a correction varying from 0°·5 to 1°·3 has been applied, for some reason not stated by Señor Capello.

Mean Rainfall in Portugal, 1864–72.

MONTHS.	PORTO.	GUARDA.	CAMPO MAIOR.	LISBONNE.	LAGOS.
	in.	in.	in.	in.	in.
January ...	9·49	5·00	2·60	4·14	3·18
February ...	5·07	3·40	2·28	3·21	2·74
March	5·98	4·69	2·40	3·69	3·57
April.....	3·42	2·67	1·42	1·63	·80
May	5·04	4·30	2·25	2·53	1·84
June.....	1·43	1·43	1·06	·39	·45
July	·94	·60	·13	·14	·00
August.....	·87	1·04	·58	·32	·18
September .	5·12	3·10	1·78	1·93	1·28
October ...	6·85	4·68	2·40	3·54	1·70
November .	8·66	4·38	2 67	4·12	3·66
December ..	7·09	4·05	2·45	4·40	3·63
TOTAL ...	59·96	39·34	22·02*	30·04	23·03

We are rather surprised at the number of fogs. There being on an average 67½ days in a year with fog at Guarda is not remarkable considering the elevation, but that there should be 19 at Lisbonne, and 37½ at Porto, does seem excessive. Thunder is very rare at Porto; on an average it is only heard on three days in a year.

The observations of rainfall at Lisbonne scarcely seem as good as those of other meteorological elements.

There are now two rain gauges at the observatory—one, which was erected about 20 years since, on the top of the observatory, 75 ft. above the ground, and the other 5 ft. above the ground; but they collect nearly identical amounts. This is such an unusual fact that we should be glad to know whether the lower gauge is quite fully exposed. We have not been able to find any statement upon this point.

The earliest observations quoted in the works before us are some made by M. Franzini, respecting the diameter, height and position of whose gauge not a word is said; information on these points would double the value of the observations. However, we convert and give here the annual totals :—

RAIN AT LISBONNE.

According to M. Franzini.				*According to gauge on roof of the Observatory of the Infante D. Luiz.*	
	in.		in.	in.	in.
1836.....	15·83	1846.....	29·25	1856..... 34·65	1866..... 25·10
7.....	13·54	7.....	25·51	7 ..... 29·85	7..... 26·31
8.. ...	34·57	8.....	21·54	8..... 37·40	8 ..... 26·38
9.....	22·05	9.....	20·24	9 .. .. 27·60	9..... 18·87
1840.....	21·14	1850.....	19·17	1860..... 28·23	1870..... 24·86
1	29·45	1.....	19·41	1..... 32·17	1..... 36·12
2.....	21·38	2.....	30·75	2..... 32·93	2..... 36·50
3.....	23·98	3.....	30·08	3..... 18·95	3..... 27·34
4.	30·59	4.....	18·19	4..... 37·42	4..... 17·22
5.....	32·17	5.....	51·02	5 ..... 38·82	5..... 18·33
	24·47		26·52	31·80	25·70
Mean of 20 years = 25·50 inches.				Mean of 20 years = 28·75 inches.	

* There is an error of 6 mm. either in the months of Dec., Jan. or Feb., or in the total given on the previous page, and there is no means of ascertaining which is correct.

AN ANTICIPATION FULFILLED.

To the Editor of the Meteorological Magazine.

SIR,—On May 4th I addressed you as follows:—"I cannot get at any satisfactory data for supporting my theory, that cold winters are followed by cold summers;" but, at all events, my theory has been justified by the Arctic temperature of the past summer six months, which read as follows:—

May.....	46°·5	.....	only two colder in 30 years.
June	54°·9	.....	only one ,, ,, ,,
July.....	56°·5	.....	only one ,, ,, ,,
August	57°·6	.....	only three ,, ,, ,,
September ...	52°·8	.....	only four ,, ,, ,,
October	46°·2	.....	only six ,, ,, ,,

Average of six months, 52°·3.
Do. of do. 30 years, 55°·1.

The month ended yesterday was colder than the same month last year, and there have been only three colder in the last 30 years. I fear we are in for a frightful winter, the only hopeful sign at present is the absence of fieldfares, which are generally harbingers of cold, and of which I have seen none.

Yours truly,

W. LUCAS.

Hitchen, 1st Dec., 1879.

THE FROST OF 1795.

To the Editor of the Meteorological Magazine.

SIR,—I send you a very curious extract from the diary of Margaret Woods, which has lately been brought to my notice. My mother, who knew about Mrs. Woods, stated that she lived after 1795 at Stoke Newington, and that if she was not living there in 1795 she was certainly living within a few miles of London, where her husband was in business.

"On the 25th January, 1795, the thermometer was only $2\frac{1}{2}^{\circ}$ out of doors, and on the 27th of the same 43° out of doors. A rapid thaw had taken place in the preceding night, and the difference of climate within and without doors was so remarkable, that the rain and melted snow which overflowed the gutters and ran through the ceilings, froze as it ran down the bed curtains and formed icicles at the bottom, and cakes of ice on the floor; neither of which completely thawed till after the admission of outward air in the morning: the following day it froze again."—*Diary of Margaret Woods.*

Yours very truly,

ROGERS FIELD.

5, *Cannon Row, Westminster, S. W.*
20th November, 1879.

[The above reading of 2°·5 on January 25th, 1795, agrees very well with what might have been expected for the neighbourhood of

Stoke Newington, which at that date was a country village. The following list of temperatures for that day may be of interest: it must be remembered that few minimum thermometers were in use. Most of the following are 8 a.m. temperatures.

LONDON.—Paternoster Row.—Thermometer, outside a window 15 ft. above ground facing N., was 12°; but outside an attic window (? 40 ft. above ground) it was 9°.
„ Somerset House, Strand. 7°.
„ Norfolk Street, Strand. 7°.
„ Beaumont Street, Marylebone. 4°.
SOUTH LAMBETH. 0°.
„ „ .—4°.
CLAPHAM.—6°.
EDMONTON.—1°.
ST. ALBAN'S. 5°.
MANSFIELD, NOTTINGHAMSHIRE. 12°.
MAIDSTONE.—On a post 5 feet above the snow, —10°; on the snow, —14°.—ED.]

THE WEATHER IN NOVEMBER.

LITTLE change from the weather which had prevailed during the last few days of October was experienced during the first seven days of this month. During the greater part of the period pressure increased and readings became uniform and unusually high in the western part of W. Europe, while the lowest bar. was found in Scandinavia. N. to N.W. winds consequently prevailed over these Islands, and N.E. winds in France, while the weather was cloudy but fair and dry; temperature, however, was nowhere low. On the evening of the 7th the change began, the bar. began to fall everywhere, most in the west, and the area of high readings moved eastward over England and Central Europe, so that while very light breezes blew in the south-east, S. winds began in the west, the weather becoming dull and misty.

Conditions very different from the above were experienced during the week following. On the 9th a large anticyclone lay over the south-eastern part of W. Europe, and a large depression lay to the northward of Scotland, so that breezes from S.W. to W. prevailed, with cloudy, mild weather. Next day an area of high readings was developing in the west, and the wind veered to N. with fair weather and rather low temp. On the following day, however, a brisk decrease of pressure had occurred in the north, the anticyclone was shewn over the Channel and France, and W. breezes blew generally; temp., however, shewing a fall, except in the north. During the day a rather deep depression passed east-south-eastwards over our northern coast, and N.W. gales were experienced in some districts.

The centre of the depression had reached Denmark by the 12th, and N. winds and gales prevailed in these Islands, the weather being fair and cold. On the 13th the bar. had risen quickly, and a large area of high pressure lay over our west coast and the north of France, and N. breezes with a further decrease of temp. were reported. On the 14th and 15th pressure was highest over the north of Scandinavia, but a band of high readings stretched in a southerly direction across the North Sea and these Islands to the north of France. Within this band light airs with sharp frost and fair, but misty or foggy, weather prevailed, while N. breezes were reported over and to the eastward of the North Sea, with S. winds and warm cloudy weather on our western coast.

Important changes occurred in the weather during the next week. At first a large area of high pressure lay over the south of England and the greater part of France, while a low bar. was reported from our northern coasts and over the Baltic. These conditions, with some modifications, held good during the 16th and 17th, so that while S.W. to W. breezes prevailed, with moderately high temp., in the west and north, but sharp frost in the south on the 16th, which was, however, immediately followed by mild weather on the 17th. On the 18th the highest pressures were reported from our south-western coast, but a second area of high readings was in course of formation over the Baltic, and during the day a broad band of high pressure was developed, extending from the west coast of these Islands as far as Sweden, the weather over these Islands being fine and warm, with breezes from N.W.

On the 19th a brisk fall of the bar. occurred in France, while the high pressures were firmly established over Scandinavia, the North Sea, and Scotland, so that E. breezes became general. During the whole of that day and until the evening of the 21st the bar. fell over France and these Islands, while it rose for some time over Scandinavia; consequently steep gradients were formed, the E. wind increased in strength to a gale on some coasts, and the weather became snowy, cold, and most inclement. On the 21st a well-marked depression was shown over England, but on the 22nd, when this disturbance was moving slowly northwards, the bar. rose over S. England, the wind shifted to S, the snow ceased, and the weather improved.

The weather during the remainder of the month was either unsettled or variable, mostly the former. On the 23rd the depression above mentioned as lying over the north of England on the 22nd, suddenly changed its direction, and passing to the eastward reached Denmark, while pressure decreased very rapidly over Scandinavia, and a fresh fall began in the south-west of Ireland. Little change was shewn in temp., but it appeared to have an inclination to fall.

On the 26th an anticyclone lay over the west and north of these Islands, while areas of low pressure lay over the north of Sweden and south of France, and showers of snow or hail were reported from many places in these Islands. Next day pressure was increasing over Scandinavia and Scotland, but was falling slowly elsewhere, and on the following day a general fall of the bar. took place, the fall in these Islands being slight, but in Scandinavia considerable. On the 29th pressure increased over Scandinavia, but continued to fall in other parts (readings being highest off our west coast), and well-defined areas of low pressure over the Baltic and south of France. Temperature was low on the Continent generally, but higher in these Islands, the highest temp. being in the north-west of Ireland.

Lowestoft. H. E. M.

THE SANITARY INSTITUTE AT CROYDON.

(Continued from page 165*).*

Lastly, I come to the rain—and here the points of contact with everyday life and with sanitary matters are so numerous that it is hard to know where to begin and harder still to know when to stop. Fortunately for us all, I need say very little to-day on the relation between rainfall and national water supply, because I stated fully my views upon that subject in my address upon Water Economy at your anniversary meeting; and it is for others either to refute my statements or to carry out the course suggested. Unfortunately there is another course, which is so easy that it is generally preferred— I mean the ruinously costly one of *laissez faire*. The question of national water supply in its broad features is epitomized on page 21 of the address just mentioned,* and

* Sanitary Institute of Great Britain. Address upon Water Economy, by G. J. Symons, F.R.S. Stanford, Charing Cross.

the longer the time before action is taken, the greater will be both the confusion and the cost.

I leave the question of national water economy where I left it before: ripe for the action of our legislators.

The amount of rain is, I need hardly say, a most important element in all sewage questions; I say *all* advisedly, because even where attempts are made to exclude rain water from the sewers, no one claims to have succeeded perfectly, and even if he did, the rain question would very likely come in again as affecting the administration of a sewage farm.

By the bye, I trust that Mr. Rogers Field will try to apply his recent researches upon syphons to the flushing of drains by cumulative discharges of rain water.

The remarkable absence of some classes of disease during the period in 1879 when summer was expected to occur, may have been partly due to low temperature, partly to the absence of the usual supply of unwholesome fruit; but I think part must also be ascribed to the scouring of the streets and drains by the superabundant rains. And there is something else washed by the rain, greatly to the Sanitary advantage of residents in towns—I mean the air. Those who have leisure and inclination can follow this subject up by perusing Dr. Angus Smith's book on "Air and Rain." I will merely call attention to one proof of its important action, which is patent to everybody who uses his eyes—it is an almost invariable action, but I will take a strong though not over-coloured illustration. It is a summer evening, close and thundery, the air is thick partly with moisture, but chiefly with extremely fine dust, particles of almost endless variety, fibres of cotton and of wool, soot, pollen from flowers, granite, road dirt, &c. No thunder occurs, but there is a downrush of colder air; rain begins, and in an hour it is over, and has carried with it to the ground an enormous proportion of the miscellaneous compound which the inhabitants had previously been breathing. If you ask for proof of this, I merely refer you to the street lamps; watch them regularly, and you will find them nearly as good at revealing the dust motes in the air, as the beam of light from Prof. Tyndall's lamp. Under the conditions I have described, they shine with a brilliancy rarely seen. Metropolitan air wants washing, it is wonderfully better for the process, and I suspect that that is one reason for the low mortality in 1879.

Rain as a supply of drinking-water will be considered in one of the papers to-day; and in two or three others we shall have rain before us in its relation to the yield of wells. On those two points, therefore, I need say nothing.

* * * * * * *

RAIN COLLECTED FROM ROOFS CONSIDERED AS A DOMESTIC WATER SUPPLY.

By H. Sowerby Wallis, F.M.S.

Meteorology and Sanitary Science are very closely connected. Meteorology deals with all the properties and changes of the atmosphere which surrounds our earth; and Sanitary Science has to arrive at the best means of keeping that air pure, and in a satisfactory state for respiration, and to deal with the deposits from it, not only to prevent them injuring man, but also to obtain the greatest advantage from them in all ways.

One of the chief points of connection between the two sciences is rainfull; meteorologists study the moisture in the atmosphere, its various forms and conditions, the causes which deposit it on the earth as rain, and the quantity deposited at various places. Then the sanitarian has to take up the question of how it shall be dealt with? which naturally divides into two branches—Water Supply and Drainage, making use of the water, and preventing it doing mischief; and his chief object is so to balance the two as to get rid of it without its doing any harm, and yet to get all the good he can out of it.

We are entirely dependent on rain for our supply of water; for whether we

catch the water which falls on our roofs, or obtain it from shallow or deep wells, or from streams and rivers, it is nothing more nor less than rain. The subject of water supply has many branches, and perhaps the most important is plenty of good water for domestic use, though the supply for manufacturing and general purposes, and for power is of vast importance, and the different interests are generally very conflicting. The agriculturist, to prevent the water standing on his land, drains it into the water-courses, which receiving it quicker than would naturally be the case, overflow and cause mischief by floods; he also manures his fields, and some of the manure is washed down the drains, and instead of enriching the soil, pollutes the water. Then the manufacturer not only wants to receive the water clean and to send it away dirty, but, to get power out of it, he backs up the stream with dams and weirs, and causes floods above him; in short, every riparian owner wishes to receive the water pure and to empty into it all superfluous water, sewage, and refuse of all kinds, and to have absolute control over the river; not caring whether those above and below him are flooded, or deprived of water altogether.

When a supply of water is wanted for a large town, the first question is where is there a large rainfall within reasonable distance? Then geology plays an important part, the structure and natural products of the gathering ground affecting not only the quality and quantity of water that can be made available, but also the cost of the necessary works and reservoirs. For the use of towns the water can be brought in bulk, and having only to be distributed over a small area, the cost though great can be easily met, but in small villages and rural districts the cost of distribution would be so great that a supply in this manner is altogether out of the question. In these districts, however, the importance of a sufficient quantity of pure water for domestic purposes is very great, and seems to be only equalled by the difficulty of obtaining it. The usual sources of supply are the small streams and shallow wells; the streams are scarcely ever pure enough for drinking, and the wells are very frequently much too near cesspools and house-drains, to say nothing of the miscellaneous organic matter with which surface water must necessarily be polluted. This is not all; one well generally supplies several cottages, and the distance which the water has to be carried, prevents it being used in anything like sufficient quantity for thorough cleanliness; and in hot and dry weather, when a plentiful supply is more than ever needed, the well often runs dry, or at least, the scarcity of water causes frequent quarrels.

Perhaps the simplest solution of the difficulty is storing the water which falls on the roofs of houses, if a sufficient quantity can be obtained in this manner, and the object of my paper is to consider this question.

The average rainfall over the British Isles varies from about 20 inches to about 200 inches per annum. The largest amounts being recorded in the English Lake district, and in the mountainous districts of Wales and Scotland; and the smallest in the eastern and midland counties of England. I have selected four fairly representative stations, with average rainfalls of approximately 22, 25, 35, and 45 inches, on which I have based my calculations. Stations where the fall is much above 45 inches are only found in mountainous districts which are generally rocky, and consequently there is no difficulty in obtaining a supply of water from the streams which are numerous, and in such districts usually sufficiently pure. The two average falls, 22 inches and 25 inches, may appear rather near each other in amount; my reason for adopting them was that the 22 inches was the lowest satisfactory average I knew of, obtained from a sufficiently large number of years, and 25 inches represents the fall over a larger part of the country than any other amount.

In dealing with my subject, I shall consider more particularly the supply of labourers' cottages; for although pure water is as necessary to the middle and upper classes of the community, they have the matter more in their own hands, and can, as a rule, meet the necessary expense of procuring a good supply.

Taking the average size of a cottage as 15 ft. by 20 ft., which I think is not far from correct, the average yield of water for a year, with a mean rainfall of twenty-five inches, would be 3,900 gallons, or nearly 10·7 gallons per day,

but this is without allowing anything for loss in collecting, which is considerable. From measurements of the flow of water from a tiled roof in average condition, I find that about twenty per cent. is lost. First, there is the water absorbed by the tiles; then a considerable quantity is held between the tiles by capillarity; and, lastly, some is lost by splashing off the edges of the roof, and out of the gutters. On a slated roof, I believe the loss might be reduced to between five and ten per cent.

Then, also, we must not calculate the supply only from the average rainfall, but from the fall in a dry year. Thus, at a station with a mean annual rainfall of twenty-five inches, the amount in the driest year is about seventeen inches. This would yield 2,653 gallons. Deducting twenty per cent. for loss, 531 gallons; leaves as available supply 2,122 gallons, or little more than 5·8 gallons per day, which would be altogether inadequate for the use of four or five persons—the presumed number of the inhabitants of the cottage.

With a mean rainfall of thirty inches, we should have an average supply of 10·3 gallons per day, and in the driest year 6·9 gallons.

With a 35 in. rainfall 12·0 gallons, and 7·7 gallons per day.
,, 40 ,, ,, 14·5 ,, ,, 10·8 ,, ,,
,, 45 ,, ,, 16·4 ,, ,, 13·1 ,, ,,

I have not been able to find anywhere a statement of the quantity of water per head, per day requisite in rural districts. In towns the quantity varies from about twelve gallons to about fifty gallons; but there can be no comparison, as in towns a large proportion goes for trade supply and for general sanitary purposes; a great deal is wasted by bad fittings; and the amount used for water-closets, which are almost unknown in country cottages, is, I believe, considerably more than half the quantity delivered to each house.

I think there can be little doubt, that a cottage with an average supply of twelve gallons per day of pure water close to the house, would be considerably better off than nine-tenths of the English cottages in their present condition; but this could only be obtained from a tiled roof in places where the mean rainfall was thirty-five inches and upwards. In places where the rainfall was less, this method could only be adopted with satisfaction as a supplemental supply, or for potable water where there was another supply for cleansing purposes.

It is of considerable importance that the water collected on roofs be properly stored. A gread deal might be said about the objection to storing in wooden butts, or cisterns of any kind above ground which are often exposed to the sun, and are liable to receive various impurities, the water becoming unfit for consumption after a very short time, and I believe it is from this cause that a great deal of the prejudice against rain-water as a beverage has arisen, for if properly stored it is probably the most wholesome of all waters. The best receptacle is an underground tank or well, bricked at the sides and bottom, and lined with about half an inch of Portland cement, to prevent any possibility of loss from leakage or pollution from the infiltration of impure water from the surrounding ground; the top should be domed over, leaving a man-hole, so that the tank may be occasionally cleaned; the man-hole should be covered with a slab of paving stone laid in mortar, to prevent worms or other insects getting in and polluting the water. The pipes from the roof to the tank where they pass underground should he of glazed earthenware, and the joints made of cement, so as to be both watertight and impregnable to insects and other polluting matter from the outside. They should not go straight into the tank, but into a small receptacle beside it, in which any dead leaves or other matter carried down from the roof would be intercepted, so as not to reach the tank and decay in the water. This receptacle should be made with a closely-fitting movable cover, so that it could be occasionally cleaned, which would aid materially in keeping the water pure. The tank should also have a waste-pipe to allow any surplus water to escape, the end of which should be covered with a piece of perforated zinc or copper wire gauze, to prevent frogs, mice, or other vermin having access to the water. A tank carefully constructed in this manner will not require cleaning more than once in two or three years.

The size of the tank is perhaps the next point for consideration; to insure a regular daily supply proportionate to the yearly fall, the tank must be of sufficient capacity to store all the water that falls during the wet periods of the year, for if during the spring some of the heavy rains run to waste, the water kept in store will not be adequate to meet the daily demand during the dry summer weather, for it is evident that anything deducted from the yearly amount of rain even during the wettest season must of necessity reduce the average daily supply that it is capable of yielding. I have, therefore, calculated the requisite capacity of the tank from the surplus yield of water during the three wettest months, and find that for a cottage 15 ft. by 20 ft.—the size on which I have based all my calculations—with a rainfall of 20 inches, the tank would require a capacity of 150 cubic feet, or 5 months' supply

with a rainfall of	25	inches,	200	,,	5	,,	,,
,,	,,	35	,,	235	,,	4	,,	,,
,,	,,	45	,,	250	,,	3	,,	,,

The decrease in the proportionate size of the tank with larger rainfalls is due to the different relation which the wet periods in dry districts bear to those periods in wet districts; that is to say, that where the average rainfall is 20 inches, the fall during the wettest three months will be about 75 per cent. of the mean annual fall; while at stations where the mean rainfall is 45 inches, the wettest three months will be only about 50 per cent. of the annual fall. Or, to put it very simply, at wet stations the fall is more evenly distributed over the year.

The cost of tanks such as I have described is not great, and would not exceed one shilling for each cubic foot of capacity, that is a tank holding 100 cubic feet would cost £5, and so on. When a storage capacity of more than 200 cubic feet is required, it will be found advantageous to make two or more tanks rather than one large one.

In the foregoing I have worked on an average condition of things, and of course the results are averages, and there are various disturbing elements; as before stated, I have taken as my basis a cottage having an area of 300 square feet with a tiled roof in fair condition, the inclination of the roof being about 35°. I do not think the inclination of the roof has much effect, for though a steep roof would catch rather less water it would run off more freely and less would be held between the tiles by capillarity; of course with a very flat roof the conditions would be reversed. On a slated roof there can be no doubt that the loss would be less, and, as before mentioned, need not exceed 10 per cent.

I think the most important element is the position and bearing of the house, for if a house has a large expanse of steep roof facing a wet wind, it will, undoubtedly, catch more than the average, especially if it is in an exposed situation. I believe, as a general rule, a flat roof will catch most water in a sheltered position, and a steep roof in an exposed position, if it presents a fair proportion of roof to the wet winds.

It is hardly necessary to state that in calculating the yield of water from any roof, the area of the ground covered by the roof should be taken, and not the area of the roof itself.

The question of Water Supply is perhaps engaging more attention now than it has ever done before, and I hope the few facts I have given on what appears to me one of its most difficult bracnhes, and at the same time one that seems most likely to be overlooked—the supply of country cottages—have not been altogether useless or uninteresting.

In conclusion, I should like to express my thanks to the President, Mr. Symons, for allowing me the free use of his rainfall records, which were so essential for the compilation of this paper.

[The tables accompanying this paper will be printed *in extenso* in the Transactions of the Sanitary Institute.]

THE INFLUENCE OF WEATHER ON DISEASE.

Mr. Corden began by saying that, having contributed the meteorological

element in the Croydon mortality returns for some years, he ventured to submit a short paper on the influence of weather on certain classes of disease in the district. The diseases illustrated were those of the zymotic class, and to facilitate the study of the subject he drew up a table calculated to show at a glance the annual and quarterly death-rates from those diseases, together with the mean temperature and rainfall for the same time, and extending from 1865 to 1878, a period of 14 years. Having divided the period of time into two portions of seven years each, and calculated the averages, he found that the general death-rate from all causes for the first period was 20·51 per 1,000 living, and for the second only 18·62, thus showing a gain of 2 per 1,000. He next took the seven principal zymotic diseases, and found that the death-rate from them for the first period was 3·6, and for the second 2·8 per 1,000, showing another improvement. In comparing the quarterly averages, he found that for the third quarter of the year for the second period there was a slight increase in the number of zymotic deaths, but in the remaining quarters a decrease. The annual mean temperature of the first period was 49°·97, and of the second 50°·67. The average rainfall per annum for the first period was 26·61 inches, and for the second 28·52 inches. The mean temperature of the first and fourth quarters was, in the second period, as much as 2°, and 10° respectively, higher than in that of the first; the mean of the second and third quarters remaining nearly stationary. The first and third quarters in the second period showed a diminution in the rainfall, but the second and fourth a large increase, the fourth to the extent of 2¼ inches. The mean temperature for the whole period of 14 years was 50°·3, which is about the usual figure. The annual average rainfall for the whole period was 27·56, or 1·5 in. above the average of a large number of years. After examining the results given by various years, he came to the conclusion that the years mostly prevalent with zymotic disease were those in which there have been long periods of dry weather interspersed with occasional heavy rains, as in 1865 and 1870. In the case of 1865, although the total rainfall for the year was large, being over 30 inches, still it was remarkable for the irregularity of its distribution, and for the smallness in number of rainy days; for instance, there were but three days' rain in April, giving only 0·17 of an inch, whilst 11 days in May gave 3·40 inches, one day of which had a fall of 1·20 in., and another of 1·10 of an inch during thunderstorms. Again, in September there was but one day on which it rained to the amount of 0·27 of an inch, whilst in October there were 23 days of rain to the amount of 7 inches. The year began with a very low zymotic death-rate, viz., 1·56 in the first quarter, and ended with a very high one, 8·80 in the fourth quarter; such a high zymotic death-rate in any one quarter has not been equalled since. The rainfall of the next year (1866) was very large, over 32 inches, with a much larger number of days, and as the year went on it showed a rapidly-decreasing death-rate from zymotic diseases, the rate per 1,000 in the fourth quarter being only 2·18.

(To be Continued.)

THE FROST OF DECEMBER, 1879, IN ENGLAND AND ITALY.

To the Editor of the Meteorological Magazine.

SIR,—The following figures may be interesting:—

	Aysgarth Vicarage. 660 ft.		Pasture near stream, ½ mile distant. 480 ft.
	Min. at 4 ft.	Exposed ther. on snow.	Min. at 4 ft.
December 4th	+ 2·7	—2·0	—4·7
,, 5th	12·2	—1·0	—1·8
,, 7th	9·2	+6·0	—0·5

The 4th uncommonly severe. Thermometer as low as +2°·7 at

this height shows great *general* depression of temperature. The 7th was the coldest at Thirsk, Ripon, &c., where it is said to have been from 6° to 8° below zero, but here rapid fluctuations and a relatively high radiation thermometer indicated as early as 8 p.m. on the 6th that a change was setting in, and *had set in above.*

F. W. STOW.

Aysgarth, Bedale.

To the Editor of the Meteorological Magazine.

SIR,—It may interest you to hear that the usually favoured shores of the Mediterranean have not escaped their share of the recent severe cold. A heavy thunderstorm on December 1st has been followed by a succession of frosts of a severity unprecedented in this district. On December 2nd a thermometer by Casella registered 25° in a very sheltered part of Mentone, the snow both there and at Bordighera lying for two days close to the edge of the sea.

The gardens all along the coast are terribly disfigured, and the olives and lemons, both of which promised an exceptionally heavy crop, are sadly cut up. In the Mentone valley the lemon trees seem all but killed, and various estimates put the loss of olives round San Remo at from half to three-quarters of the crop.

Yours faithfully,

PERCY BICKNELL.

San Remo, Italy, Dec. 10th.

[If our readers will favour us with the minimum readings of accurate thermometers properly mounted, we shall be happy to classify them for our next number.—ED.]

CLIMATOLOGICAL STATIONS.

[The following circular has been issued to all the Fellows of the Meteorological Society. We reprint it here because some of our readers who are not yet Fellows of the Society may be interested in it, and willing to furnish observations.—ED.]

METEOROLOGICAL SOCIETY,
30, Great George Street, Westminster,
November, 1879.

SIR,—The Council have decided upon establishing a number of stations especially intended for elucidating the peculiarities of the Climates of different Health Resorts. They wish that these stations should be numerous rather than elaborately equipped, and consequently the instruments required are merely the following :—

Maximum Thermometer divided on the stem and verified.
Minimum ,, ,, ,, ,,
Dry Bulb ,, ,, ,, ,,
Wet Bulb ,, ,, ,, ,,
Rain Gauge.

The thermometers must be mounted in a Stevenson stand, and read once daily at 9 a.m.

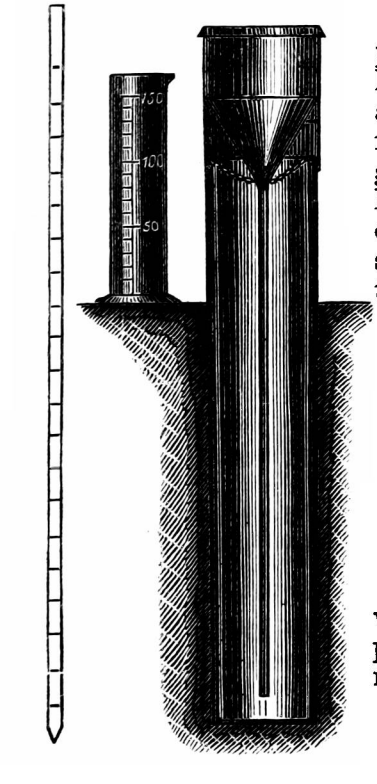
The Council are desirous that there should be a wide distribution of stations furnishing these data, and also that the differences of climate due to the varieties of physical configuration even in such small distances as, for instance, the higher and lower parts of Torquay, should be represented by separate returns.

It is intended that this system, which will be concurrent, and in no way clash, with the Society's present series of Second Order Stations, should commence on January 1st, 1880; the Council will therefore be glad if all those Fellows who are prepared to comply with the above conditions, will communicate with the Assistant Secretary as soon as possible, so that the requisite forms may be issued forthwith.

We are, Sir, your obedient servants,
G. J. SYMONS,
JOHN W. TRIPE, M.D., } *Hon. Secs.*

CHEAP MOUNTAIN RAIN GAUGE.

To the Editor of the Meteorological Magazine.



SIR,—With reference to your recent plea for additional rain-gauge stations, it has occurred to us that possibly you will allow us to call attention to a slight modification of our indestructible rain-gauge, whereby it is rendered suitable for holding a month's rainfall, even in a wet district. The only alterations, as you will see by the specimen sent herewith, are the following:—

(1) The receiving can is so lengthened as to hold 20 inches of rain.

(2) The measurement can be taken by inserting a graduated dipping rod, or by—

(3) The measuring jar, which is larger than usual, holds an inch and a half of rain, and is graduated to 0·05 in.

Of course we do not specify price, but we may say that it is moderate as compared with any gauge of equal capacity now in the market.

Yours truly,
NEGRETTI & ZAMBRA.

NOVEMBER, 1879.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32°. In shade.	On grass.
			inches	inches.	in.								
I.	ENGLAND.	Camden Square	·73	— 1·68	·27	21	8	55·2	18	23·0	16	15	22
II.		Maidstone (Hunton Court)	1·38	— 1·65	·49	21	13	...	...	...	...	...	...
,,		Selborne (The Wakes)	2·32	— 1·22	1·00	21	6	55·0	18	15·0	23	14	19
III.		Hitchen	·75	— 1·39	·19	20	12	50·0	17†	21·0	14	17	...
,,		Banbury	·75	— 1·45	·21	20	14	53·5	18	20·5	15	18	...
IV.		Bury St. Edmunds (Culford)	1·47	— ·92	·42	23	15	51·0	18	18·0	15	19	24
,,		Norwich (Cossey)	2·25	...	·44	23	19	51·0	5‡	23·5	22	11	16
V.		Bridport	·21	— 2·95	·11	9	3	...	...	...	...	...	...
,,		Barnstaple	·80	— 3·34	·31	20	5	56·0	20	27·0	14¶	...	...
,,		Bodmin	1·15	— 3·83	·32	30	12	56·0	19	26·0	30	11	16
VI.		Cirencester	·38	— 2·34	·15	20	3	...	...	...	...	...	...
,,		Shifnal (Haughton Hall)	·86	— ·71	·34	20	11	54·0	18	19·0	15	18	19
,,		Tenbury (Orleton)	·99	— 1·48	·35	20	15	58·7	18	17·2	22	16	16
VII.		Leicester (Town Museum)	1·09	...	·37	20	16	55·2	18	23·5	15	13	23
,,		Boston	1·15	— ·99	·27	20	12	52·0	5	25·0	16**	13	...
,,		Grimsby (Killingholme)	1·89	...	·63	20	17	52·0	6	26·0	22	5	...
,,		Mansfield	1·59	...	·56	20	12	56·3	18	18·9	22	15	20
VIII.		Manchester (Ardwick)	1·27	— 1·36	·53	12	13	53·0	7, 18	...	...	11	...
IX.		York	1·20	— ·78	·25	1, 20	14	57·0	5	24·0	23	12	14
,,		Skipton (Arncliffe)	2·66	— 3·79	1·04	11	15	57·0	7	23·0	13	11	...
X.		North Shields	3·82	+ 1·12	1·02	1	21	55·0	7	26·5	30	8	10
,,		Borrowdale (Seathwaite)	3·87	—12·80	1·70	11	14	...	...	...	...	...	...
XI.	WALES.	Cardiff	·43	...	·18	20	8	60·4	18	24·2	30	8	...
,,		Haverfordwest	1·66	— 4·01	·75	30	8	58·0	19	22·5	21	15	16
,,		Lampeter (St. David's Coll.)	...	...	...	...	...	...	...	...	...	...	...
,,		Llandudno	·98	— 2·18	·26	23	11	54·2	19	32·0	14	1	...
XII.	SCOTLAND.	Cargen	1·01	...	·38	11	6	57·0	7	22·6	...	13	...
,,		Hawick (Silverbut Hall)	1·98	...	·65	21	11	...	...	...	...	...	...
XIV.		Annanhill	1·28	...	·53	9	13	54·8	20	24·0	30	12	17
XVI.		Kilmory	2·27	...	·58	9	10	...	...	23·0	30	11	...
,,		Mull (Quinish)	2·45	...	5·6	8	15	...	...	...	...	...	...
,,		Loch Leven	1·80	— 1·85	·60	10*	7	...	...	...	...	...	...
,,		Loch Long (Arddaroch)	2·31	...	...	...	...	...	...	...	...	...	...
XVII.		Arbroath	1·96	— ·93	·78	21	9	57·0	18	28·0	30	...	5
,,		Braemar	2·75	— ·07	·66	21	17	57·8	18	16·0	14	15	23
XVIII		Aberdeen	2·76	...	·43	21	21	57·5	17	29·0	30	4	15
,,		Portree	5·31	— 5·17	1·53	16	23	...	...	...	...	...	...
,,		Inverness (Culloden)	2·74	+ ·15	1·07	24	9	56·0	17	25·9	26	6	15
XIX.		Dunrobin	3·00	+ ·69	·54	11	16	53·0	9	28·0	30	6	...
,,		Sandwick	3·62	— ·38	·52	16	27	53·0	9	28·8	30	3	10
XX.	IRELAND.	Caherciveen DarrynaneAbbey	·75	...	·18	9	9	...	...	...	...	...	...
,,		Cork	...	...	...	...	...	...	...	...	...	...	...
,,		Waterford	·45	— 3·50	·15	9	8	58·0	18	29·0	30	7	...
,,		Killaloe	·99	— 3·90	·39	9	10	58·0	18§	28·0	13	8	...
XXI.		Portarlington	·78	— 3·14	·19	9	10	57·0	19	29·0	29	8	...
,,		Monkstown, Dublin	1·31	— 1·58	·32	9	11	...	...	...	...	...	...
XXII.		Galway	·88	...	·45	9	10	57·0	28	28·0	2, 27	6	...
XXIII		Waringstown	1·29	...	·57	9	15	59·0	18	20·0	30	11	16
,,		Edenfel (Omagh)	1·36	...	·55	9	20	56·0	17‖	22·0	30	12	...
,,		Ballinfull	...	...	...	...	...	...	...	...	...	...	...

* And 22. † And 18. ‡ And 6, 7. § And 19. ‖ And 18. ¶ And 30. ** And 23.

+ Shows that the fall was above the average; — that it was below it.

METEOROLOGICAL NOTES ON NOVEMBER.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; T S for Thunderstorm; R for Rain; H for Hail S for Snow.

ENGLAND.

HITCHEN.—Only two drier and three colder Novembers for 30 years.

CULFORD.—A month of exceedingly cold and winterly weather, S falling more or less on 11 days. Heavy fogs on and about the 24th. Mean temp. 37°·3, below the average. Swallows left here about the middle of October, but a solitary one was seen on the 2nd. North-westerly winds prevailed during the greater part of the month.

COSSEY.—S about 5 inches deep on the level on the 30th.

BODMIN.—Mean temp. 40°·2. There is no remembrance here of so little R in November, nor of so low a temperature.

CIRENCESTER.—An unusually dry month; cold towards the end.

SHIFNAL.—One of the driest and coldest Novembers we have had for years, only two drier for 44 years—Nov., 1855, when ·57 in. fell, and 1858, ·61 in. First S fell on the 20th. Wind persistently from N.W., N. and N.E. Ice would bear on 16th. A fine wheat seed time.

ORLETON.—The first half of the month was generally cloudy and dry, with an even temperature and high bar. On the 14th frost set in, and, with the exception of the 17th, 18th and 19th, which were very warm, continued till the end of the month, with frequent light falls of S. The mean temp. of the month was about 2° below the average, and the fall of R and S was very small, not being one half of the average. Great darkness for about an hour occurred on the 20th, 21st and 26th, and there were only a few clear days.

GRIMSBY.—Very cold month; the first half dry, the second wet.

YORK.—First S on 1st. Ice bore on 15th.

ARNCLIFFE.—Violent TS at 5 p.m. on 11th; bar. fell rapidly.

WALES.

HAVERFORDWEST.—This November is remarkable for its high bar., absence of R, for the dry condition of the air, and the absence of storms of wind; it was the driest November during the past 31 years, the next to it being 1871, when 1·81 in. fell. Bar. pressure very high. I have no remembrance of so fine a November; its value to the farmers cannot be fully estimated.

LLANDUDNO.—Month dry, but deficient in sunshine. Mean temp. about a degree and a half below the average, though only one night's frost. A gale of wind from N. on the 12th, and another still heavier from E.N.E. on the 21st.

SCOTLAND.

CARGEN.—The driest November recorded here for 20 years.

ANNANHILL.—Mean temp. 40°·8. Prevailing winds N.E. and N.W., usually light to moderate. W.S.W. gale on 11th.

QUINISH.—A very fine, dry month, and particularly calm, the 11th and 12th being the only rough days. Hard frost from 24th to 30th.

BRAEMAR.—Hurricane of wind from 9 p.m. on 11th to noon on 12th.

PORTREE.—On the whole, a mild month. N.W. gale on 11th. Four last days of month frosty, with showers of S. Crops all secured; cattle and sheep in good condition.

CULLODEN.—Month generally fine; no severe frost. Heavy rainfall on night of 23rd and 24th.

SANDWICK.—The weather was open until 29th, when a snowstorm began and still continues (Dec. 2nd). There was a gale of 60 miles an hour from 1 to 2 a.m. on 12th, and another on 11th.

IRELAND.

DARRYNANE.—The driest month since Jan., 1870. The dryness of this and last month has been of the greatest service to the farmers, &c., as the turf (peat) cut for fuel has dried, a thing which the oldest inhabitant cannot remember to have happened so late in the year.

KILLALOE.—An extremely small rainfall in this district for any month of the year, especially so for November. The month was also remarkable for a greater number of bright sunny days than any of the ten preceding months.

MONKSTOWN.—A fine, bright, and comparatively mild November. Smart frosts on several nights, but nothing approaching November, 1878. Bar. very high.

WARINGSTOWN.—Very fine and dry. Wheat got in, in good order.

SUPPLEMENTARY TABLE OF RAINFALL IN NOV., 1879.

[For the Counties, Latitudes, and Longtitudes of most of these Stations, see *Met. Mag.*, Vol. XIV., pp. 11 & 10.]

Div.	STATION.	Total Rain.	Div.	STATION.	Total Rain.
		in.			in.
II.	Margate, Acol	·94	XI.	Port Madoc	1·24
,,	Littlehampton	·74	,,	Douglas.....	1·29
,,	Dorking, Abinger	1·32	XII.	Carsphairn	1·36
,,	Hastings, Manor House	1·12	,,	Melrose, Abbey Gate...	2·46
,,	Hailsham	1·35	XIV.	Douglas Cas., Newmains	1·20
,,	I. of W., St. Lawrence.	·59	XV.	Islay, Gruinart School..	1·81
,,	Strathfield Turgiss	·82	XVI.	St. Andrew's, Cambo...	...
III.	Great Missenden.....	·51	,,	Aberfeldy H.R.S.	1·12
,,	Winslow, Addington ...	·76	XVII.	Tomintoul.....	3·16
,,	Oxford, Magdalen Col...	·67	,,	Keith H.R.S.	3·85
,,	Northampton	1·16	,,	Forres H.R.S.	1·82
,,	Cambridge, Merton Vil.	·89	XVIII.	Strome Ferry H.R.S....	3·38
IV.	Harlow, Sheering	·72	,,	Lochbroom	3·56
,,	Diss	1·83	,,	Auchnasheen H.R.S. ...	...
,,	Swaffham	1·91	,,	Tain, Springfield.....	1·70
,,	Hindringham	1·86	,,	Loch Shiel, Glenfinnan.	6·43
V.	Salisbury, Alderbury...	·42	,,	Dalwhinnie H.R.S.....	...
,,	Calne, Compton Bassett	·42	XIX.	Lairg H.R.S.	3·02
,,	Beaminster Vicarage ...	·40	,,	Altnabreac H.R.S.	3·35
,,	Dartmoor Prison.....	·48	,,	Watten H.R.S.	2·43
,,	Langtree Wick	·63	XX.	Fermoy, Glenville	·74
,,	Lynmouth, Glenthorne.	1·17	,,	Tralee, Castlemorris ...	·50
,,	St. Austell, Cosgarne...	1·39	,,	Cahir, Tubrid	·53
,,	Taunton	·45	,,	Tipperary, Henry St....	·58
VI.	Bristol, Ashleydown ...	...	,,	Newcastle West	·66
,,	Wem, Sansaw Hall.....	1·10	,,	Kilrush	·75
,,	Cheadle, The Heath Ho.	1·40	,,	Corofin	·79
,,	Bickenhill Vicarage ...	1·09	XXI.	Kilkenny, Butler House	·40
VII.	Coston Rectory	1·60	,,	Carlow, Browne's Hill..	·77
,,	Horncastle, Bucknall...	1·43	,,	Kilsallaghan.....	1·19
VIII.	Walton-on-the-Hill.....	1·12	,,	Navan, Balrath	·77
,,	Broughton-in-Furness ..	1·36	,,	Athlone, Twyford	·65
IX.	Wakefield, Stanley Vic.	·96	,,	Mullingar, Belvedere ...	·67
,,	Ripon, Mickley	1·30	XXII.	Ballinasloe	·66
X.	Gainford	·98	,,	Clifden, Kylemore	1·54
,,	Haltwhistle, Unthank..	1·78	,,	Crossmolina, Enniscoe..	2·21
,,	Shap, Copy Hill	1·40	,,	Carrick-on-Shannon ...	·91
XI.	Llanfrechfa Grange	·85	,,	Dowra	1·53
,,	Llandovery	·71	XXIII.	Rockcorry.....	1·11
,,	Solva	1·08	,,	Warrenpoint	1·16
,,	Castle Malgwyn	1·91	,,	Newtownards	1·09
,,	Rhayader, Nantgwillt..	1·51	,,	Larne, Carnlough	1·43
,,	Carno, Tybritle	1·53	,,	Bushmills	1·58
,,	Corwen, Rhug	1·07	,,	Buncrana, Rockfort ...	1·96