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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE
PERIOD: SECOND HALF OF 1990

Translated for

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PERIOD: Second Half of 1990

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CIEMAT/PRYMA/UGIA/M5A01/01/91

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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE

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RADIOLOGICAL MONITORING IN THE PALOMARES ZONE

PERIOD: Second Half of 1990

Radiological monitoring was carried out in the Palomares zone during the second half of 1990, in accordance with the planning established in the report "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE: PROGRAM FOR 1990". The following operations were conducted:

1. MONITORING OF PERSONS

The operations corresponding to this section were of two types:

a) Execution of the second part of the survey campaign programmed for 1990.

b) Obtaining of results corresponding to the 1990 survey campaign.

The following subparagraphs reflect the contents of each of the cited activities.

1.1 SURVEYS 1990: OPERATIONS

Following the plan set forth in the report: "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE: PROGRAM FOR 1990", referenced as CIEMAT/PRYMA/M5A01/PI002/91 and with the purpose of completing the survey of designated persons, the second part of the 1990 campaign has been conducted during this second half of the year.

This second campaign began on September 25, 1991 and ended on November 20 of that year, including a total of 89 persons distributed into the following previously defined and established priority groups:

	No. Persons
Group 1-A:	8
Group 1-B:	9
Group 1-C:	4
Group 2-A:	21
Group 2-B:	5
Group 2-C:	12
Companions:	30

completed in 50 years which, under the hypothesis of an acute inhalation in 1980, was calculated to be 87.9 mSv. The present result, 1.1 mBq/24 hours, confirms the calculated contamination and dose.

The third person is a child. In his first examination, in 1989, he gave a Pu-239+Pu-240 value of 1.45 mBq/24 hour urine. In view of the uncertainty of the determination as to time of contamination, it is considered appropriate to await some new information before proceeding to an evaluation of the case; he will therefore be re-examined in 1991.

The three remaining persons are presenting positive results for the first time. One of them had come to examination in previous years; this is the first examination for the others.

Obviously the radiological monitoring activation mechanisms of these people provide for subsequent or successive examination of persons who have given positive plutomium or americium results for the first time.

The percentage of persons with a positive result, 6 out of 149 in Pu (4%) and 0 out of 23 in Am (0%), does not exceed the order of appearances greater than the LID calculated for the period 1967-1985 of 7.7% (86 cases ouit of 1155). (See "Summarized Report of the Radiological Monitoring conducted in the Palmares (Almeria) Zone. JEN/PRYMA/M1/A--/7/1985, June 1985"). The distribution by ranges, and obviously the dose distribution as well, in this period corresponds to a normal logarithmic function.

The most useful parameter to evaluate the impact to which the Palomares population is being subjected is the collective dose ("de facto" situation and subgroups which cannot be correlated with the present risk). Obtainable parameters, however, are the median and the mean.

The median, which is that representing the most frequent effective dose equivalent completed in 50 years to the mean individual of the critical group, is below 5 mSv. Thus, the specific results in this report, in addition to being predictable, do not modify conclusions obtained or reflected previously

1.2 DOSIMETRY FOR 1990 (PARTIAL)

Of the total of 149 persons monitored in 1990, urinary Am-241 excretion analysis was completed during this six-month period on all for Pu-239+Pu-240, and for Am-241 on 23. The remaining results, still being obtained, will be reported in the report for the first half of 1991.

The results of the Pu-239+Pu-240 determinations made on the urine of the indicated 149 persons are:

- 6 persons had results of Pu-239+Pu-240 in the urine greater than the AMD of the analytical method. The values of radioactivity concentration were 0.74, 1.45, 1.88, 1.1, 1.85 and 2.4 mBq/24 hour urine.

These results were found in two men, two women and two children.

- The remaining 143 persons showed Pu-239+Pu-240 values below the AMD of the analytical method (0.7 mBq/ 24 hour urine).

The results of the determinations of Am-241 in the urine carried out on 23 of the 149 persons indicated are:

- The 23 persons examined showed Am-241 values lower than the AMD of the analytical method (0.7 mBq/24 hour urine).

Consequently, and as a summary of the results of the Pu-239+Pu-240 measurements taken in the 149 persons who were monitored during 1990, and from the results of Am-241 in 23 of them, it can be stated that positive plutonium values have been determined in the urine of six of these persons, and positive values of Am-241 have been determined in none of the 23 analyzed.

Of the six persons with Pu-239+Pu-240 results above the AMD, three had previously given positive results for Pu-239+Pu-240.

One of these three persons is a man. The effective dose equivalent completed in 50 years which, as a consequence of an acute inhalation at the time of the accident was calculated to be 70.7 mSv. The present result, 0.74 mBq confirms the calculated contamination and dose.

The second is a woman who was not present in the Palomares zone at the time of the accident. The effective dose equivalent

The direct determinations of pulmonary contamination, by means of a Pulmonary Radioactivity Counter, in the 24 persons examined in 1990 showed no contamination, as the measaurements carried out gave no values greater than the detection limit of the equipment utilized.

1.2.1 Medical Monitoring

In the second phase of the Radiological Monitoring Campaign in the Palomares Zone for 1990 (see Doc. M5A01/PI002/90), carried out during the period between 10/1/90 and 11/20/90, medical examinations were administered to 89 persons.

In these medical examinations, conducted in accordance with the directions contained in Safety Guide No. 7 "Bases for Medical Monitoring of Workers Exposed to Ionizing Radiation" and the recommendations of international organizations, no pathology was detected which might be attributable to the incorporation of transuranic elements coming from residual contamination of the zone.

We list below the significant findings:

Absence of alterations	26
Mild alterations	31
Presence of pathologies	32
1. INFECTIOUS AND PARASITIC DISEASES (001-139)*	
Simple Type I herpes	1
2. TUMORS (140-239)	
CA, Frontal spinocellular	1
3. DISEASES OF THE ENDOCRINE GLANDS, NUTRITION AND METABOLISM, AND IMMUNITY DISORDERS (240-279)	
Obesity	4
Hyperglycemia	4
Hypercholesterolemia	7
Mixed hyperlipoproteinemia	3
Type II diabetes mellitus	2
Gynecomastia	1

* ICD Code - 9th Revision.

Malnutrition	1

4. DISEASES OF THE BLOOD AND HEMATOPOIETIC ORGANS (280-289)

5. MENTAL DISORDERS (290-319)

Depressive neurosis	5
Pathological anxiety	1
Insomnia	1
Onicophagy	1

6. DISEASES OF THE NERVOUS SYSTEM AND SENSORY ORGANS (320-389)

Migraine	1
Presbyopia	15
Hypermetropia	4
Myopia	11
Astigmatism	14
Senile cataract	2
Detached retina	1
Pterygium	1
Parpebral ptosis	1
Strabismus	1
Unilateral visual acuity loss	1
Bilateral visual acuity loss	1
Hypoacusis	4
Impacted cerumen	4
Peripheral vertigo	1

Supurated semi-acute otitis	1
Hemiparesia	2

7. DISEASES OF THE CIRCULATORY SYSTEM (390-459)

Atrial fibrillation	1
Varicose veins of lower limbs	4
First degree A-V blockage	1
Right side cardiac insufficiency	1
Arterial hypertension	2
Orthostatic hypertension	1
Cerebral hemorrhage	1

8. DISEASES OF THE RESPIRATORY SYSTEM (460-519)

Polynosis	1
Allergic rhinitis	1
Chronic asthmatic bronchitis	2
Chronic bronchitis	2
Extrinsic asthma	1
Acute bronchitis	3
Amigdaline hypertrophy	2
Acute rhinopharyngitis	4
Acute pharyngitis	2
Chronic sinusitis	1
Amygdaline hypertrophy	1
Disphonia	1

9. DISEASES OF THE DIGESTIVE SYSTEM (520-579)

Inguinal hernia	3
Umbilical hernia	1
Acute pancreatitis	1
Lithiasis biliarisis	1
Gastric dyspepsia	3
Aerofagia	1
Gastric ulcer	1
Duodenal ulcer	1
Hiatal hernia	1
Irritable colon	2

10. DISEASES OF THE GENITOURINARY SYSTEM (580-629)

Microhematuria	17
Microscopic pyuria	11
Bacteriuria	1
Hypertrophy of the prostate	1
Prostatic syndrome	1
Matrorrhagia	1
Irregular menstrual cycles	1
Posthysterectomy urinary incontinence	1

11. PREGNANCY, CHILDBIRTH AND POST PARTUM COMPLICATIONS (630-676)

Ectopic pregnancy	1

12. DISEASES OF THE SKIN AND SUBCUTANEOUS CELLULAR TISSUE (680-709)

Contact dermatitis	1
Seborrheic dermatitis	1
Actinic hyperkeratosis	5
Friction dermatitis	2
Acne	1
Urticaria "a frigore"	1
Lipoma	1
Lingual mucous papilloma	1

13. DISEASES OF THE OSTEOMUSCULAR SYSTEM AND CONNECTIVE TISSUE (717-739)

Rheumatoid arthritis	1
Monoarthritis	1
Arthritis of the small joints	1
Arthralgia of the knees	2
Arthralgia of the hips	1
Constitutional scoliosis	2
Cervicalgia	2
Cervicobrachial syndrome	2
Dorsalgia	1
Lumbalgia	8
Cervical herniated disk	1

14. POORLY DEFINED SIGNS, SYMPTOMS AND DISEASED CONDITIONS (780-

799)

ECG. Sinus arrhythmia	3
ECG. VI hypertrophy	1
ECG. Incomplete branch blockage	3
ECG. Ventricular extrasystole	1
Spirometry. Diminished values	1
Gamma GT elevation	1
GPT elevation	1
Anorexia	1
Albuminuria	6
Glucosuria	1
Intentional tremor	1

15. TRAUMATISM AND POISONING (800-999)

Fracture of the calcaneus, tibia and fibula	1
Recto-anterior muscular tear of the femoral quadriceps	1
Postfracture unstable knee articulation	1
Postfracture unstable tibio/fibulo/ astragaline articulation	1
Tibial pseudoarthritis	1
Cervical sprain	1

The findings described correspond to the pathology which we find on a daily basis in periodic preventive examinations of

workers, both those who are, and are not exposed to ionizing radiation, and in our judgment there is no indication of any unhealthy condition specifically induced by radioactive agents.

2. MONITORING OF THE ENVIRONMENT

2.1 GROUND

The activities specified below have been conducted during this six month period with relation to the following ground contamination:

2.1.1 Plutonium determination

During this second half of 1990, Pu-239+Pu-240 analyses were carried out on soil surface samples taken at seven points located on the outer perimeter of the area identified as the "zero line" of initial contamination, at an approximate distance of 500m from the same. At each point a central sample and four samples at a distance of 150 meters in the four cardinal directions, were taken.

The sampling points are shown in Figure 1, which illustrates the original levels of contamination where the curve encircling the area is the so-called initial zero line.

The samples, which have been analyzed twice, for a total of 70 analyses, correspond to reference points 1, 12, 13, 18, 21, 22 and 23.

The values obtained are presented on Tables 1 and 2. These data reveal a movement of particles toward the exterior of the zero line or limit of the contamination line, following the 1966

accident. Obviously, the resuspension is one of the processes contributing to the redistribution of the initial contamination.

2.1.2 Determination of Am-241

The Am-241 concentration data will be delayed from the time frame specified in the report "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE: PROGRAM FOR 1990" due to problems in the measurement system which are being corrected.

2.2 AIR

The following activities have been accomplished during this second semester of 1990:

2.2.1 Sampling

Continuous air sampling, with a weekly filter change, has continued at the three stations which remain in operation, in the manner specified in report M5A01/PI002/90, "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE. PROGRAM FOR 1990" sent to the CSN. These three stations correspond to references 2-1, 2-2 and P (urban zone).

A total of 75 samples were taken, with an air volume of approximately 10 000 m^3 per sample.

2.2.2 Plutonium determination

The chemical treatments of the radioanalytical process were applied independently to each weekly sample, however, the electrodeposits and subsequent measurement by alpha spectrometry were conducted on compounded samples corresponding to four or eight weeks.

Building P (urban zone)

The samples were distributed by collection dates, in the following manner:

24 samples from 1988 (2nd half of 1988 complete)

49 samples from 1990 (year 1989 complete)

The values of the Pu-239+Pu-240 concentrations corresponding to the second half of 1988 are presented in Table 3. These data complement those already presented in report CIEMAT/PRYMA/M5A01/3/89 "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE. (Report for first half of 1989)", relative to the first half of 1988.

From the entirety of the readings obtained, it is inferred that:

- The mean value of the plutonium concentration in the Palomares urban area during the 2nd half of 1988 was 1.3 $\mu Bq/m^3$.

- The range of plutonium concentrations in this urban zone during this six-month period has fluctuated between < 0.2 and 2.0 $\mu Bq/m^3$.

- The mean value of the plutonium concentration in the Palomares urban area during 1988 was 4.4 $\mu Bq/m^3$.

- The range of plutonium concentrations in this urban zone during 1988 has fluctuated between < 0.2 and 98.9 $\mu Bq/m^3$.

- Both the mean value and the maximum concentration of plutonium during 1988 remained considerably below the derived concentration in air (5 900 $\mu Bq/m^3$) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish

legislation (3) for the limit of annual incorporation by inhalation.

Table 4 presents the data corresponding to building P in 1989.

From these readings, it is inferred that:

- The mean value of the plutonium concentration in the urban area of Palomares during 1989 was 2.58 $\mu Bq/m^3$.

- The weekly plutonium concentrations in this urban zone during 1989 lay within the range of 0.6 to 6.9 $\mu Bq/m^3$.

- Both the mean value and the maximum concentration of plutonium during 1989 remained considerably below the derived concentration in air (5 900 $\mu Bq/m^3$) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

Building 2-1

Analyzed during this six-month period were 24 samples corresponding to the second half of 1988.

The results obtained are shown on Table 3. These data complement those already submitted in report CIMAT/PRYMA/M5A012/1/90 "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE (Report for the second half of 1989)", relative to the first half of 1988.

From these readings it is determined that:

- The mean value of the plutonium concentration at Station 2-2-1 during the 2nd half of 1988 was 19.2 $\mu Bq/m^3$.

- The range of plutonium concentrations in this station's

zone during this six-month period has fluctuated between 5.7 and 40.1 μBq/m³.

- The mean value of the plutonium concentration at Station 2-1 during 1988 was 59.2 μBq/m³.

- The range of plutonium concentrations at this station during 1988 has fluctuated between 1.6 and 1575 μBq/m³.

- Both the mean value and the maximum concentration of plutonium during 1988 remained considerably below the derived concentration in air (5 900 μBq/m³) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

As indicated in report CIEMAT/PRYMA/M5A01/1/90 "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE (Report for the second half of 1989)" submitted to theCSN in February 1990, it appears that the construction of a water storage reservoir in the vicinity of this building during the period February 20 to May 7, 1988 provoked a clear increase in the concentrations, derived from the resultant displacement of soil with a maximum value of 1575 ± 165 μBq/m³, coinciding with the week during which condtruction of the reservoir was completed. This has logically produced an increase in the annual average at this point for 1988.

Building 2-2

The samples analyzed in this seconf half of 1990 are distributed as follows:

40 samples from '85

13 samples from '86

26 samples from '88 (second half complete)

52 samples from '89 (1989 complete)

Table 5 shows the data corresponding to 1985. This table includes data already presented in reports CIEMAT/PRYMA/M5A01/1/1987 "RADIOACTIVE MONITORING OF PALOMARES". Report for second half of 1986" and CIEMAT/PRYMA/M5A01/1/1988 "RADIOLOGICAL MONITORING OF PALOMARES. Report for second half of 1987", in order to provide an overview of the entire year.

From these readings it is determined that:

- The mean value of the plutonium concentration at Station 2-2-1 during 1985 was 64.4 $\mu Bq/m^3$.

- The range of plutonium concentrations in this station's zone during 1985 fluctuated between 1.1 and 326 $\mu Bq/m^3$.

- Both the mean value and the maximum concentration of plutonium during 1985 were below the derived concentration in air (5 900 $\mu Bq/m^3$) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

Table 6 shows the data corresponding to 1986. Like the previous table, this one includes data already presented in reports CIEMAT/PRYMA/M5A01/3/1987 "RADIOACTIVE MONITORING OF PALOMARES". Report for first half of 1987" in order to provide an overview of the entire year.

From these readings it is inferred that:

- The mean value of the plutonium concentration at Station 2-

2-1 during 1986 was 48.5 μBq/m³.

- The range of plutonium concentrations in this station's zone during 1986 fluctuated between <0.2 and 204 μBq/m³.

- Both the mean value and the maximum concentration of plutonium during 1986 were below the derived concentration in air (5 900 μBq/m³) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

Table 3 presents the results corresponding to the second half of 1988. These data complement those already submitted in report CIMAT/PRYMA/M5A012/1/90 "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE (Report for the second half of 1989)", relative to the first half of 1988.

From these readings it is inferred that:

- The mean value of the plutonium concentration at Station 2-2-2 during the 2nd half of 1988 was 34.9 μBq/m³.

- The range of plutonium concentrations in this station's zone during this six-month period has fluctuated between 15.7 and 91.0 μBq/m³.

- The mean value of the plutonium concentration at Station 2-2 during 1988 was 21.6 μBq/m³.

- The range of plutonium concentrations at this station during 1988 has fluctuated between < 0.2 and 91.0 μBq/m³.

- Both the mean value and the maximum concentration of plutonium during 1988 remained considerably below the derived concentration in air (5 900 μBq/m³) for Class Y plutonium

compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

Table 4 shows the data corresponding to Station 2-2 during 1989.

From these readings it is inferred that:

- The mean value of the plutonium concentration at Palomares Station 2-2 during 1989 was 2.51 $\mu Bq/m^3$.

- The range of plutonium concentrations in this station's zone during 1986 fluctuated between 0.6 and 6.9 $\mu Bq/m^3$.

- Both the mean value and the maximum concentration of plutonium during 1986 were well below the derived concentration in air (5 900 $\mu Bq/m^3$) for Class Y plutonium compounds, as can be inferred from the value specified by Spanish legislation (3) for the limit of annual incorporation by inhalation.

2.2.3 Americium determinations

Radiochemical analyses to determine the Am-241 concentration in air were conducted on the following samples:

- Station P: 52 samples from 1988 (1988 complete)
- Station P: 52 samples from 1989 (1989 complete)
- Station 2-2: 26 samples from 1988 (2nd half, 1988)
- Station 2-2: 52 samples from 1989 (1989, complete)

The chemical treatments of the radioanalytical process were applied independently to each weekly sample, however, the electrodeposits and subsequent measurement by alpha spectrometry were conducted on compounded samples corresponding to four or eight

weeks.

The results of the 52 samples fron 1988 from Station P (Palomares urban zone) analyzed during this second six-month period are shown on Table 7.

From these results it is inferred that:

- In 1988, the Am-241 concentration values at Station P (urban zone) have at all times been equal to or less than the detection limit of our analytical method, 0.2 $\mu Bq/m^3$, except for the period from July 2 to October 29, when the values were slightly above that limit.

The results of the 52 samples from Station P (Palomares urban zone) corresponding to 1989 which were analyzed during this second semester are shown on Table 8.

From these results, it is inferred that:

- During 1989 the Am-241 concentration values at Station P (urban zone) have at all times been equal or less than the detection limit of our analytical method (0.2 $\mu Bq/m^3$).

Table 7 shows the data corresponding to Station 2-2 during the second half of 1988. This table includes data already presented in report CIEMAT/PRYMA/M50A01/1/90 "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE (Report for the second half of 1989)", relative to the first half of 1988, in order to provide an overview of the entire year.

It is inferred from these data that:

- The mean value of the Am-241 concentration in the air of this zone during the second half of 1988 was 1.77 $\mu Bq/m^3$.

- The range of Am-241 concentrations during this six-month period has fluctuated between < 0.2 and 3.9 $\mu Bq/m^3$.

- The mean value of the Am-241 concentration in the air of this zone during 1988 was 1.25 $\mu Bq/m^3$.

- The range of Am-241 concentrations at this Station 2-2 during 1988 has fluctuated between < 0.2 and 3.9 $\mu Bq/m^3$.

- Both the mean value and the maximum value of the air concentration during this six-month period remained considerably below the limit of derived concentration in air for all Am-241 compounds, which, as specified by Spanish legislation (3), is 2.360 $\mu Bq/m^3$.

The results of the 52 samples from Station 2-2, corresponding to 1989, analyzed during this second six-month period are shown on Table 8.

It is inferred from these results that:

- The mean value of the Am-241 concentration in the air of this zone during 1989 was 0.36 $\mu Bq/m^3$.

- The range of Am-241 concentrations during 1989 has fluctuated between < 0.2 and 0.73 $\mu Bq/m^3$.

- Both the mean value and the maximum value of the air concentration during 1989 remained considerably below the limit of derived concentration in air for all Am-241 compounds, which, as specified by Spanish legislation (3), is 2.360 $\mu Bq/m^3$.

2.3 VEGETATION

Activities in this area have been as follows:

2.3.1 Sampling

In accordance with the provisions of report M5A01/PI001/90, "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE. PROGRAM FOR 1990", the following samples of vegetation and farm crops were taken during this second half of 1990:

- 5 tomato samples and 5 tomato plant samples coming from 1 parcel of Zone 2, 2 parcels of Zone 3, and 1 parcel each, of Zones 5 and 5-3B.
- 1 olive sample and 1 olive leaf sample coming from Zone 2.
- 2 pimiento samples and 2 samples of pimiento plants coming from one parcel each, of Zones 2 and 3.
- 1 sample of eggplant fruit and 1 sample from the plant itself, coming from one parcel of Zone 2.

The sampling was conducted during November.

2.3.2 Plutonium Determination

During this period plutonium analysis was made of 47 samples from 1990, of which the alpha spectrometry measurement was completed in 26.

The 1990 samples which were analyzed are classified as follows with regard to species and component:

- 8 tomato samples, 8 of washed tomatoes and 8 of tomato plants.
- 1 olive sample and 1 olive leaf sample.
- 6 water melon rind samples, 6 of the rest of the unwashed fruit and 1 of the plant itself.
- 1 muskmelon rind sample, 1 of the rest of the unwashed

fruit and 1 of the plant itself.

The results of the analysis of the 26 samples measured in this first [sic] semester are specified in Tables 9 - 11, according to the zone to which these crops belong.

The most important consideration which can be inferred from these results is that only 2 readings in excess of the LID are founf in the edible portion of unwashed tomatoes. These values of 0.1 and 0.04 Bq/kg are negligible from the point of view of the risk involved, since the official limit for annual incorporation by ingestion of Class Y plutonium compounds is 200 000 Bq.

2.3.3 Am-241 Concentration

The Am-241 concentration data will be delayed beyond the time frame contemplated in the report "RADIOLOGICAL MONITORING IN THE PALOMARES ZONE: PROGRAM FOR 1990" due to measurement system problems which are being corrected.

2.4 ANIMALS

2.4.1 Sampling

During 1990, two samples of milk were taken from goats which had foraged throughout the year in the Palomares area.

These milk samples were compounded weekly.

2.4.2 Plutonium Determination

The two samples of goat milk collected in 1990 and one from 1989 were analyzed radiochemically during this six-month period.

The values obtained are shown on Table 12. It is inferred from these data that none of the milk samples analyzed had

plutonium values in excess of the AMD of our analitical method.

3. METEOROLOGY

The weather station installed in Palomares was in operation during 1990. System problems have occasioned the loss of some data. A detailed report, "The Palomares (Almeria) Weather Station, January - December 1990", published as internal report "CIEMAT/IPRYMA/UMAC/M5A01/-1/91" is available. A summary of these activities follows.

The wind compass roses for the station are depicted graphically, differentiating them under the categories of daytime, nighttime and 24-hour periods.

Analysis of the wind data shows a pronounced differentiation in the prevailing directions, as can be seen in the compass roses corresponding to daytime (Figures C) [sic]. These are given by winds coming from the ENE-SSE and WNW-N sectors.

The observed meteorological process is perfectly defined, considering that the Palomares weather station is sited in a coastal zone. These strong flow changes in the "breezes" are due to the differences in physical properties between the sea and land. The prevailing directions from the ENE-SSE sectors correspond to the sea-to-land breeze, and those from WNW-N, the land-to-sea.

This behavior can be generalized to all months of the year studied, with the exception of days which probably correspond to the passage of fronts, which impedes the process of heating the soil, giving rise to nighttime-like conditions during the day, with

wind directions coming from the WNW-N. This situation is clearly observed in the non-summer months.

For a better interpretation of the process, a comparative study has been made of the monthly wind compass roses between day and night (Figures A and B), which reveal this pronounced difference between the incoming flows during the daytime, which takes in the ENE-SSE sector, and the nighttime outflowing in the WNW-N sectors. A slight asymmetry can also be bserved in the range taken in by the wind directions in the day and at night. The coastline profile orientation determines these directions of inflow, probably disturbed by the topography and orientation of the Almanzora River which channelizes the return flow during the night.

During the summer, when the percentage of days when local conditions prevail [missing words? --is high? --is low?], the daytime windspeeds are higher than those of the night.

During the winter months, nightime-typical conditions occur during the day; this is due to the fact that in the winter, there are a greater number of days in which synoptic conditions prevail.

Another aspect to note is very high nighttime (Figures B) frequencies between the NW and N sectors during all months of the year studied. In February high frequencies from the NNW are observed, but the fan extends from the W to the NNE, and in April, from the WNW to the N with more equalized frequencies.

4. PARTICIPANTS

The following CIEMAT persons participated in the activities

which have led to obtaining the data, specifications and conclusions set forth in this report.

Senior technicians: José Gutierrez, C. Emma Iranzo, Angel Bellido, Santiago Castaño, María Asunción Espinosa, Begoña Aceña and Emilio Iranzo.

Technicians: Camila Blanco, Ludivina Borrega, María del Carmen Guzman, Francisco Moreno, Mariano Moya and Carmen Barros, responsible for transcription and preparation of this manuscript.

5. REFERENCES

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TABLE 1. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN SURFACE SOIL SAMPLES. OUTER O LINE (Bq/g)

1	North	0.08 ± 0.02
1′	North	0.02 ± 0.09
1	South	0.04 ± 0.008
1′	South	0.10 ± 0.02
1	East	< LID
1	West	0.05 ± 0.009
1′	West	0.03 ± 0.006
1	Center	0.02 ± 0.005
1′	Center	0.04 ± 0.008
12	Center	< LID
12′	Center	< LID
12	Center	0.033 ± 0.0066
12	West	< LID
12	North	< LID
12′	North	< LID
13	South	< LID
13′	South	< LID
13	West	< LID
13′	West	< LID
13	East	< LID
13′	East	< LID
13	Center	< LID
13′	Center	< LID
13	North	0.0118 ± 0.0017
13′	North	0.016 ± 0.0041
18	West	0.0324 ± 0.00608
18′	West	0.1036 ± 0.0175
18	Center	0.0038 ± 0.0014
18′	Center	0.0256 ± 0.0053
18	East	0.0282 ± 0.0045
18	South	< LID
18′	South	< LID
18	North	0.00572 ± 0.00085
18′	North	0.02372 ± 0.00384

TABLE 2. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN SURFACE SOIL SAMPLES. OUTER 0 LINE (Bq/g)

21	North	< LID
21′	North	0.027 ± 0.005
21	South	0.047 ± 0.009
21′	South	0.115 ± 0.02
21	East	
21′	East	1.01 ± 0.15
21	West	0.027 ± 0.006
21′	West	0.037 ± 0.006
21	Center	0.028 ± 0.006
21′	Center	0.059 ± 0.011
22	North	0.07416 ± 0.011
22′	North	0.0118 ± 0.0224
22	South	0.0311 ± 0.0049
22′	South	≤ LID
22	East	
22′	East	≤ LID
22	West	≤ LID
22′	West	≤ LID
22	Center	≤ LID
22	Center	≤ LID
23	East	≤ LID
23′	East	≤ LID
23	West	≤ LID
23′	West	≤ LID

TABLE 3. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF PLUTONIUM 239 + 240 $\mu Bq/m^3$

PERIOD	BUILDING 2-1	BUILDING 2-21	BUILDING P (Urban Zone)
02-07-88 al 30-07-88	5.7 ± 0.95	2.0 ± 0.34	8.5 ± 2.9
30-07-88 al 10-09-88	31.2 ± 5.4	1.8 ± 0.29	15.7 ± 2.5
10-09-88 al 01-10-88	11.0 ± 1.9	1.5 ± 0.25	21.3 ± 3.6
01-10-88 al 29-10-88	19.6 ± 3.2	1.0 ± 0.17	34.3 ± 5.5
29-10-88 al 03-12-88	7.1 ± 1.1	≤ LID	91 ±15
03-12-88 al 31-12-88	40.1 ± 7.3	1.0 ± 0.19	28.7 ± 8.8

KEY: 1) to.

TABLE 4. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF PLUTONIUM 239 + 240 $\mu Bq/m^3$

PERIOD	BUILDING 2-1	BUILDING 2-21	BUILDING P (Urban Zone)
31-12-88 al 28-01-89		2.7 ± 0.53	7.5 ± 1.2
28-01-89 al 25-02-89		1.8 ± 0.38	1.4 ± 0.25
25-02-89 al 01-04-89		2.2 ± 0.37	8.7 ± 1.36
01-04-89 al 29-04-89		5.2 ± 1.00	
29-04-89 al 03-06-89		0.6 ± 0.12	6.7 ± 1.1
03-06-89 al 01-07-89		2.1 ± 0.54	17.4 ± 2.8
01-07-89 al 29-07-89		1.1 ± 0.31	
29-07-89 al 02-07-89		3.2 ± 0.60	14.0 ± 2.3
02-09-89 al 30-09-89		1.7 ± 0.40	3.6 ± 0.58
30-09-89 al 28-10-89		6.9 ± 1.16	35.0 ± 5.4
28-10-89 al 02-12-89		1.2 ± 0.29	6.2 ± 0.98
02-12-89 al 16-12-89		1.0 ± 0.28	
02-12-89 al 30-12-89			≤ 0.2

KEY: 1) to.

TABLE 5. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF PLUTONIUM 239 + 240 μBq/m³

PERIOD	BUILDING 2-1	BUILDING 2-21	BUILDING P (Urban Zone)
05-01-85 al 26-01-85		51.0 ± 8.2	
26-01-85 al 02-02-85		3.1 ± 0.3	
02-02-85 al 23-02-85		51.0 ± 8.2	
23-02-85 al 02-03-85		1.1 ± 0.2	
02-03-85 al 30-03-85		4.0 ± 0.7	
30-03-85 al 06-04-85		189.0 ± 3.0	
06-04-85 al 27-04-85		4.0 ± 0.7	
27-04-85 al 04-05-85		3.3 ± 0.4	
04-05-85 al 25-05-85		13.8 ± 2.5	
25-05-85 al 01-06-85		4.2 ± 0.3	
01-06-85 al 29-06-85		13.8 ± 2.5	
29-06-85 al 06-07-85		19.2 ± 1.1	
06-07-85 al 27-07-85		123.0 ± 19	
27-07-85 al 03-08-85		46.0 ± 1.1	
03-08-85 al 31-08-85		123.0 ± 19	
31-08-85 al 07-09-85		107.0 ± 20	
07-09-85 al 05-10-85		156.0 ± 24	
05-10-85 al 12-10-85		77.7 ± 8.3	
12-10-85 al 02-11-85		156.0 ± 24	
02-11-85 al 09-11-85		326.0 ± 49	
09-11-85 al 07-12-85		25.8 ± 4.2	
07-12-85 al 14-12-85		7.4 ± 0.9	
14-12-85 al 04-01-86		25.8 ± 4.2	

KEY: 1) to.

TABLE 6. CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF PLUTONIUM 239 + 240 $\mu Bq/m^3$

PERIOD	BUILDING 2-1	BUILDING 2-2	BUILDING P (Urban Zone)
04-01-86 al 11-01-86		16.3 ± 1.8	
11-01-86 al 01-02-86		86.7 ± 13	
01-02-86 al 08-02-86		13.3 ± 1.6	
08-02-86 al 01-03-86		86.7 ± 13	
01-03-86 al 08-03-86		6.8 ± 0.9	
08-03-86 al 15-03-86		115.0 ± 17	
15-03-86 al 22-03-86		7.4 ± 0.9	
22-03-86 al 05-04-86		115.0 ± 17	
05-04-86 al 12-04-86		16.7 ± 1.3	
12-04-86 al 15-04-86		12.2 ± 1.1	
15-04-86 al 19-04-86		7.4 ± 0.7	
19-04-86 al 23-04-86		141.0 ± 14	
23-04-86 al 26-04-86		38.5 ± 4.0	
25-04-86 al 29-04-86		8.1 ± 0.8	
29-04-86 al 03-05-86		10.4 ± 1.1	
03-05-86 al 06-05-86		13.3 ± 1.2	
09-05-86 al 13-05-86		24.8 ± 2.1	
13-05-86 al 16-05-86		8.1 ± 0.8	
16-05-86 al 20-05-86		13.3 ± 1.2	
20-05-86 al 23-05-86		7.4 ± 1.2	

KEY: 1) to.

TABLE 6 (CONT). CONCENTRATION OF Pu-239+Pu-240 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF PLUTONIUM 239 + 240 μBq/m³

PERIOD	BUILDING 2-1	BUILDING 2-2	BUILDING P (Urban Zone)
23-05-86 ① al 27-05-86		8.5 ± 0.8	
27-05-86 al 30-05-86		5.2 ± 0.5	
30-05-86 al 03-06-86		4.8 ± 0.5	
03-06-86 al 06-06-86		4.1 ± 0.5	
06-06-86 al 10-06-86		5.6 ± 0.6	
14-06-86 al 21-06-86		16.3 ± 1.4	
21-06-86 al 28-06-86		7.4 ± 0.8	
28-06-86 al 05-07-86		13.3 ± 1.4	
05-07-86 al 12-07-86		13.7 ± 1.4	
12-07-86 al 19-07-86		36.9 ± 3.6	
19-07-86 al 09-08-86		178.5 ± 28	
09-08-86 al 16-08-86		15.9 ± 1.6	
06-09-86 al 13-09-86		30.3 ± 3.1	
04-10-86 al 11-10-86		3.0 ± 0.3	
01-11-86 al 08-11-86		34.0 ± 3.4	
08-11-86 al 15-11-86		21.0 ± 3.4	
15-11-86 al 06-12-86		< 0.2	
06-12-86 al 13-12-86		204.0 ± 21	

KEY: 1) to.

TABLE 7. CONCENTRATION OF AMERICIUM-241 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF AMERICIUM- 241 $\mu Bq/m^3$

PERIOD ①	BUILDING 2-1	BUILDING 2-21	BUILDING P (Urban Zone)
02-01-88 al 30-01-88	< 0.2	0.15 ± 0.04	< 0.2
30-01-88 al 27-02-88	< 0.2	0.79 ± 0.15	< 0.2
27-02-88 al 12-03-88		0.82 ± 0.19	< 0.2
12-03-88 al 09-04-88	< 0.2	1.00 ± 0.17	< 0.2
02-04-88 al 30-04-88	< 0.2	0.96 ± 0.16	< 0.2
30-04-88 al 04-06-88	< 0.2	0.62 ± 0.12	< 0.2
04-06-88 al 02-07-88	< 0.2	0.78 ± 0.14	< 0.2
02-07-88 al 10-09-88	1.50 ± 0.27	1.20 ± 0.21	0.22 ± 0.05
10-09-88 al 29-10-88	0.79 ± 0.17	3.90 ± 0.74	0.28 ± 0.05
29-10-88 al 31-12-88	0.49 ± 0.12	< 0.2	< 0.2

KEY: 1) to.

TABLE 8. CONCENTRATION OF AMERICIUM-241 RADIOACTIVITY IN PALOMARES AIR SAMPLES

CONCENTRATION OF AMERICIUM- 241 $\mu Bq/m^3$

PERIOD	BUILDING 2-1	BUILDING 2-21	BUILDING P (Urban Zone)
31-12-88 al 25-02-89		< 0.2	< 0.2
25-02-89 al 29-04-89		0.61 ± 0.14	< 0.2
29-04-89 al 01-07-89		< 0.2	< 0.2
01-07-89 al 02-09-89		< 0.2	< 0.2
02-09-89 al 28-10-89		0.73 ± 0.17	< 0.2
28-10-89 al 30-12-89		< 0.2	< 0.2

TABLE 9. PLUTONIUM-239 CONTENT IN VEGETATION OF AREA 2 DURING 1990

SAMPLING DATE	FARM	VEGETABLE		ACTIVITY CONC. Bq/kg
		Species	Part	
17-01-90	2-2 M.S.N	Tomato	Unwashed	< LID
"	"		Washed	< LID
"	"		Plant	0.48 ± 0.08
"	Parcela cemen.	Tomato	Unwashed	0.10 ± 0.02
			Washed	< LID
"	"		Plant	0.09 ± 0.014
15-1-90	2-2	Olive	Fruit	< LID
"	"		Leaves	0.63 ± 0.10

TABLE 10. PLUTONIUM-239 CONTENT IN VEGETATION OF AREA 3 DURING 1990

SAMPLING DATE	FARM	VEGETABLE Species	VEGETABLE Part	ACTIVITY CONC. Bq/kg
17-1-90	J.A:L.	Tomato	Unwashed	<LID
"	"		Washed	< LID
"	"		Plant	< LID
"	F:F:G.	Tomato	Unwashed	< LID
"	"		Washed	< LID
"	"		Plant	< LID
"	D.S.C.		Unwashed	< LID
"	"		Washed	< LID
"	"		Plant	0.28 ± 0.007

TABLE 11. PLUTONIUM-239 CONTENT IN VEGETATION OF AREA 5 DURING 1990

SAMPLING DATE	FARM	VEGETABLE Species	VEGETABLE Part	ACTIVITY CONC. Bq/kg
17-1-90	B.A.S.	Tomato	Unwashed	< LID
"	"		Washed	< LID
"	"		Plant	< LID
"	J.F.G.	Tomato	Unwashed	0.04 ± 0.008
"	"		Washed	< LID
"	"		Plant	
"	5-3B		Unwashed	< LID
"	"		Washed	< LID
"	"		Plant	1.81 ± 0.37

TABLE 12. PU-239 + PU-240 CONCENTRATION IN GOAT MILK SAMPLES

DATE COLLECTED	TOTAL VOLUME	CONCENTRATION mBq/liter
29-05 al 04-06-89	670 ml	< 3.28
09-07 al 17-07-90	2130 ml	< 2.29
17-07 al 25-07-90	2050 ml	< 4.19

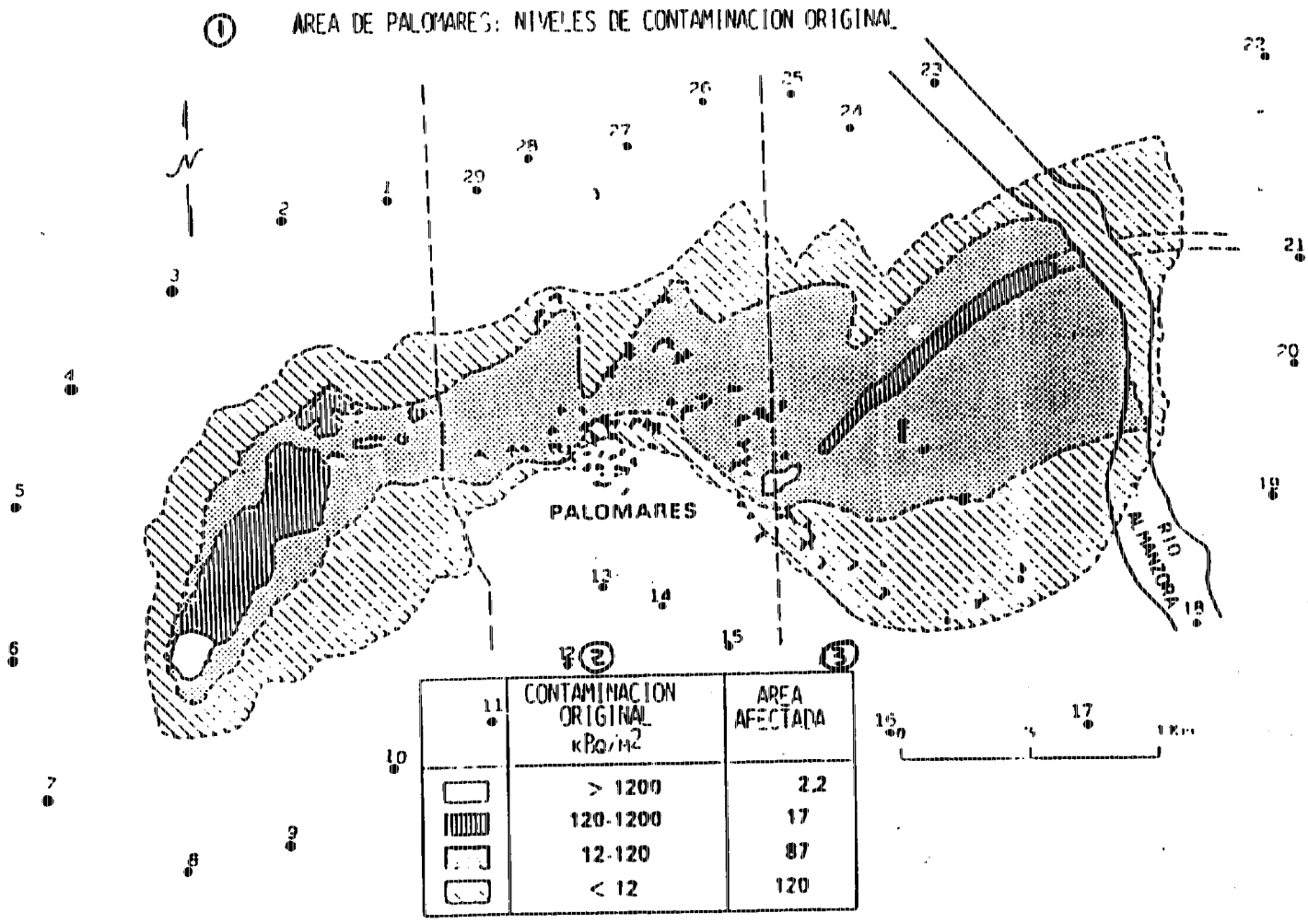

Figure 1. Surface Soil (5 cm) Sampling Sites

Key: 1) Palomares area: Original Contamination Levels; 2) Original Contamination; 3) Affected Area.

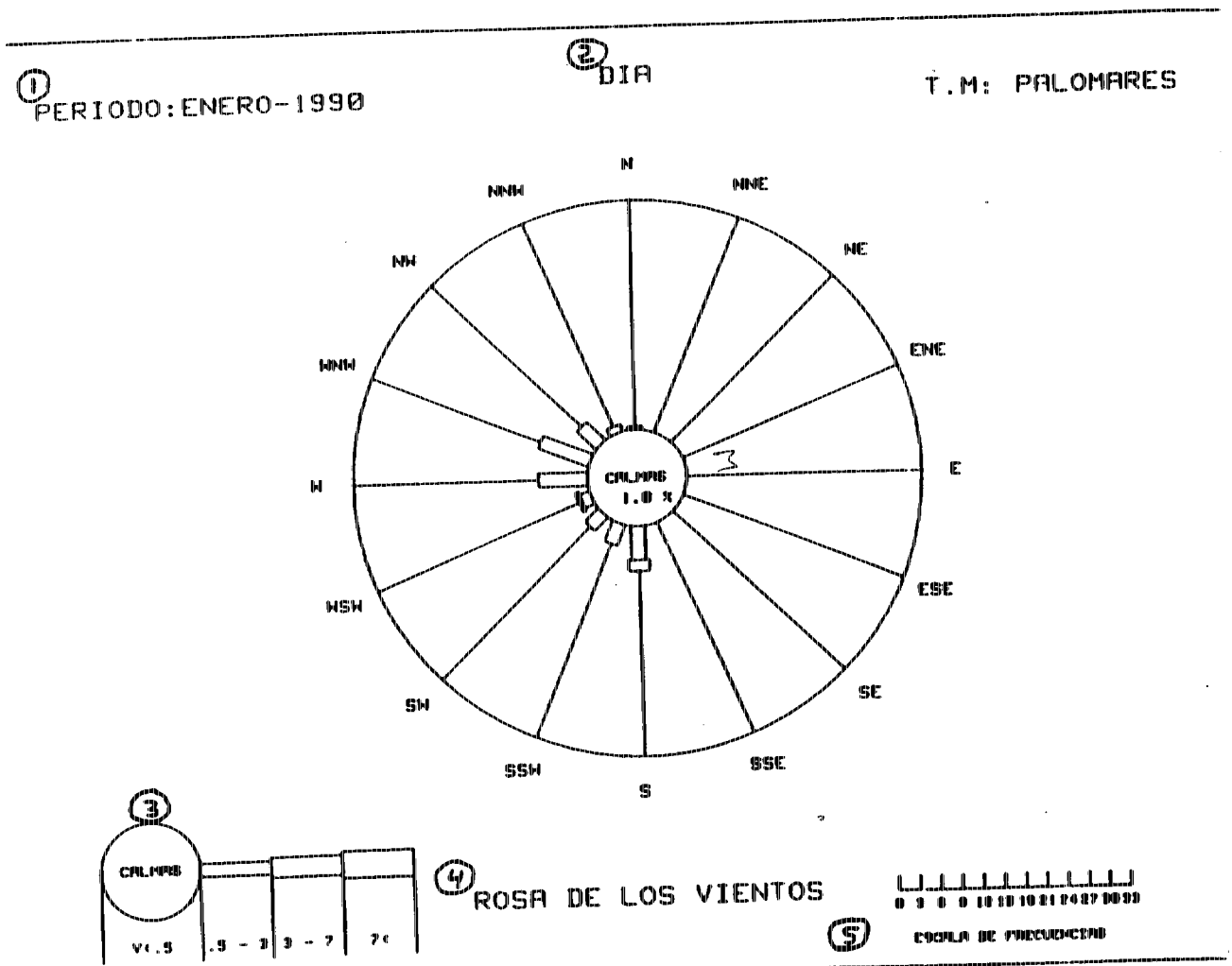

Figura A.1

Figure A.1.

Key: 1) Period: January - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

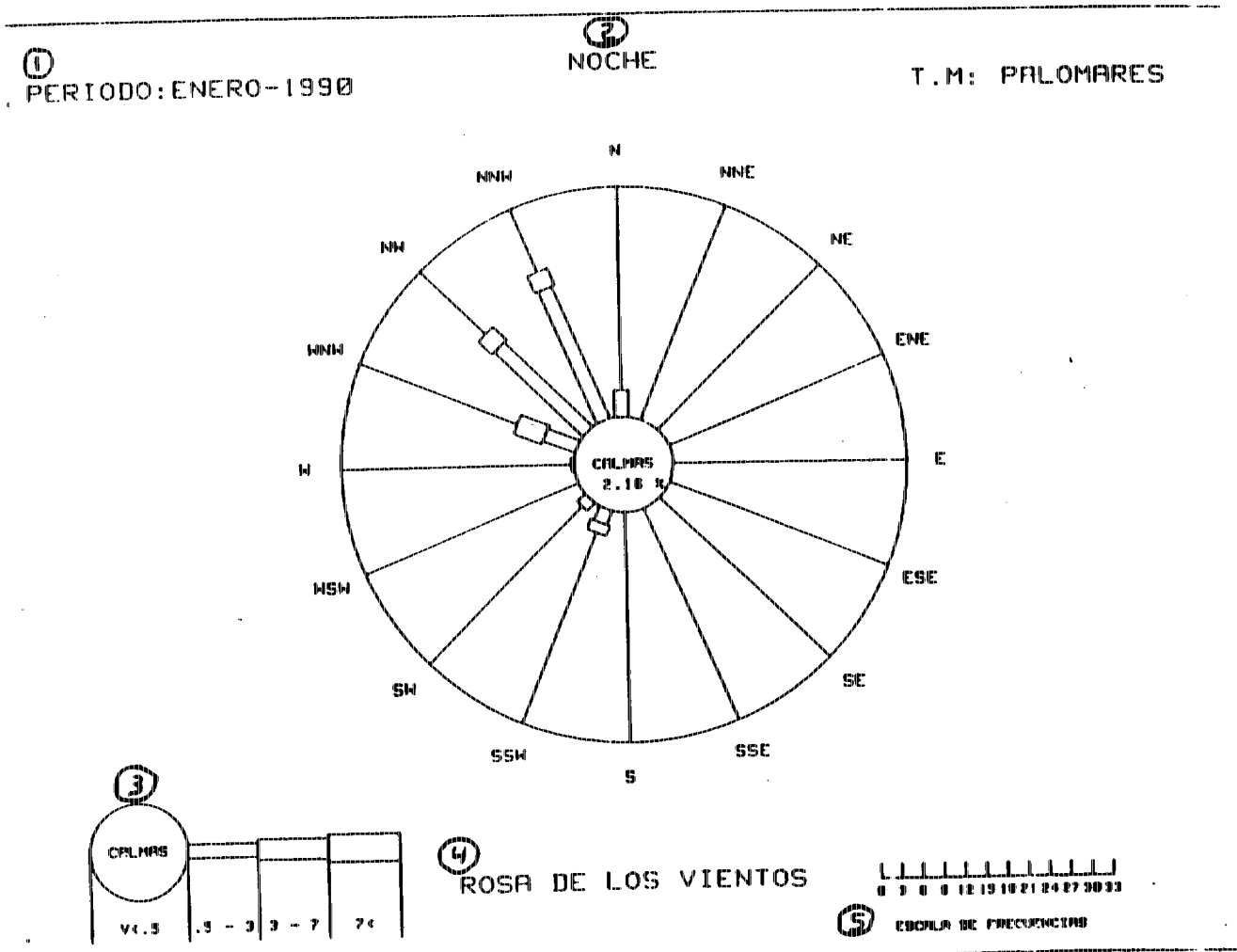

Figura B.1

Figure B.1.

Key: 1) Period: January - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

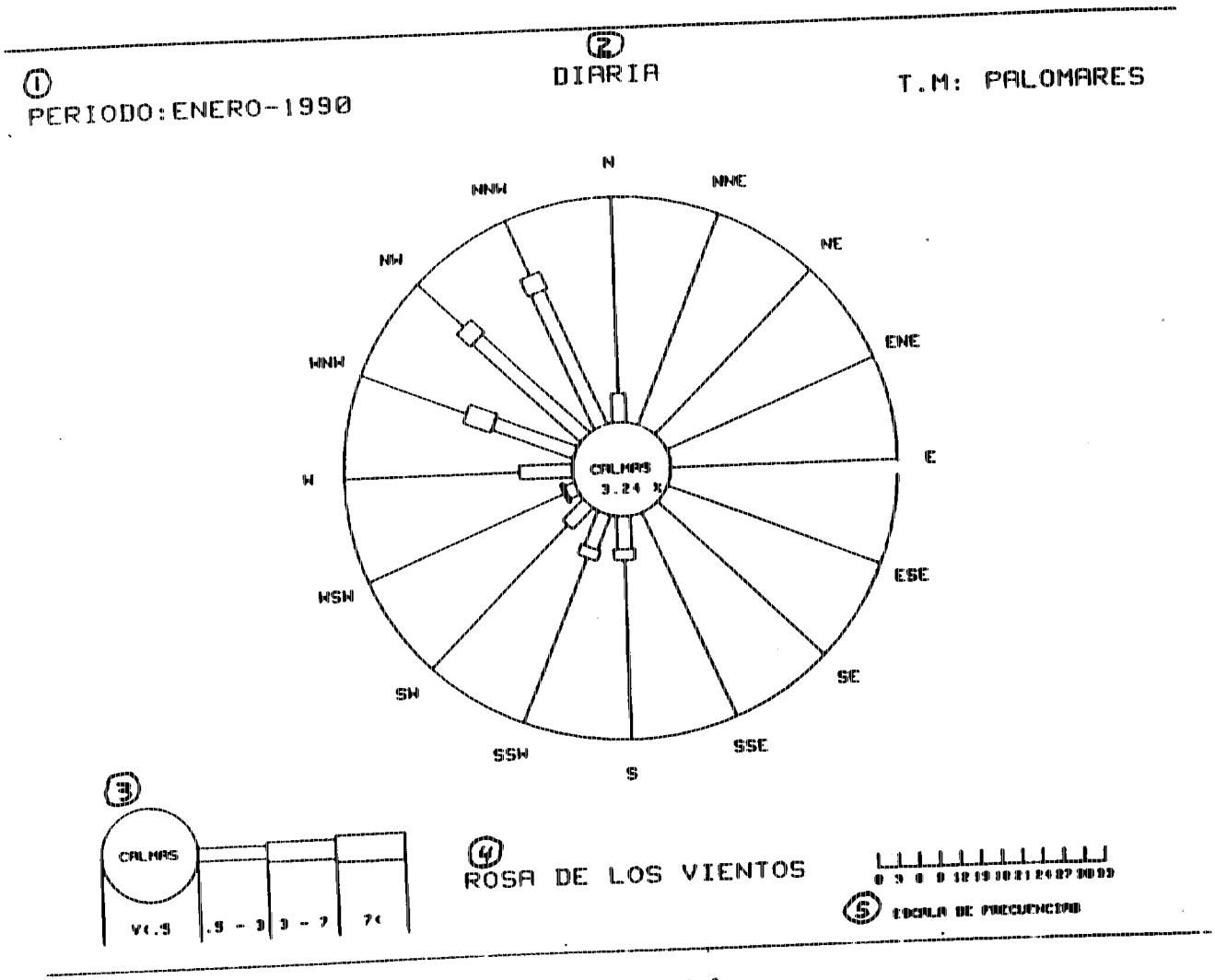

Figura C.1

Figure C.1.

Key: 1) Period: January - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

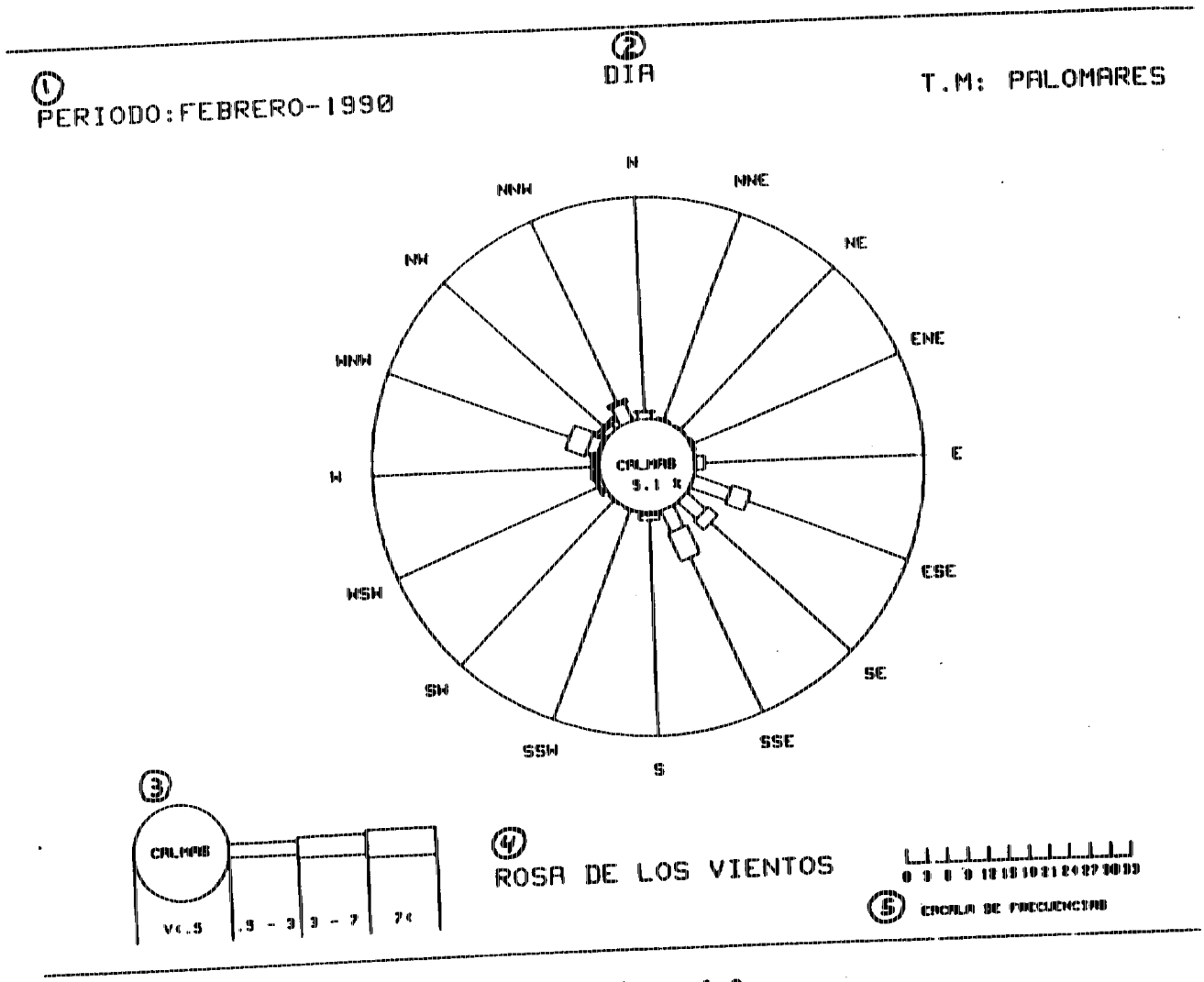

Figura A.2

Figure A.2.

Key: 1) Period: February - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

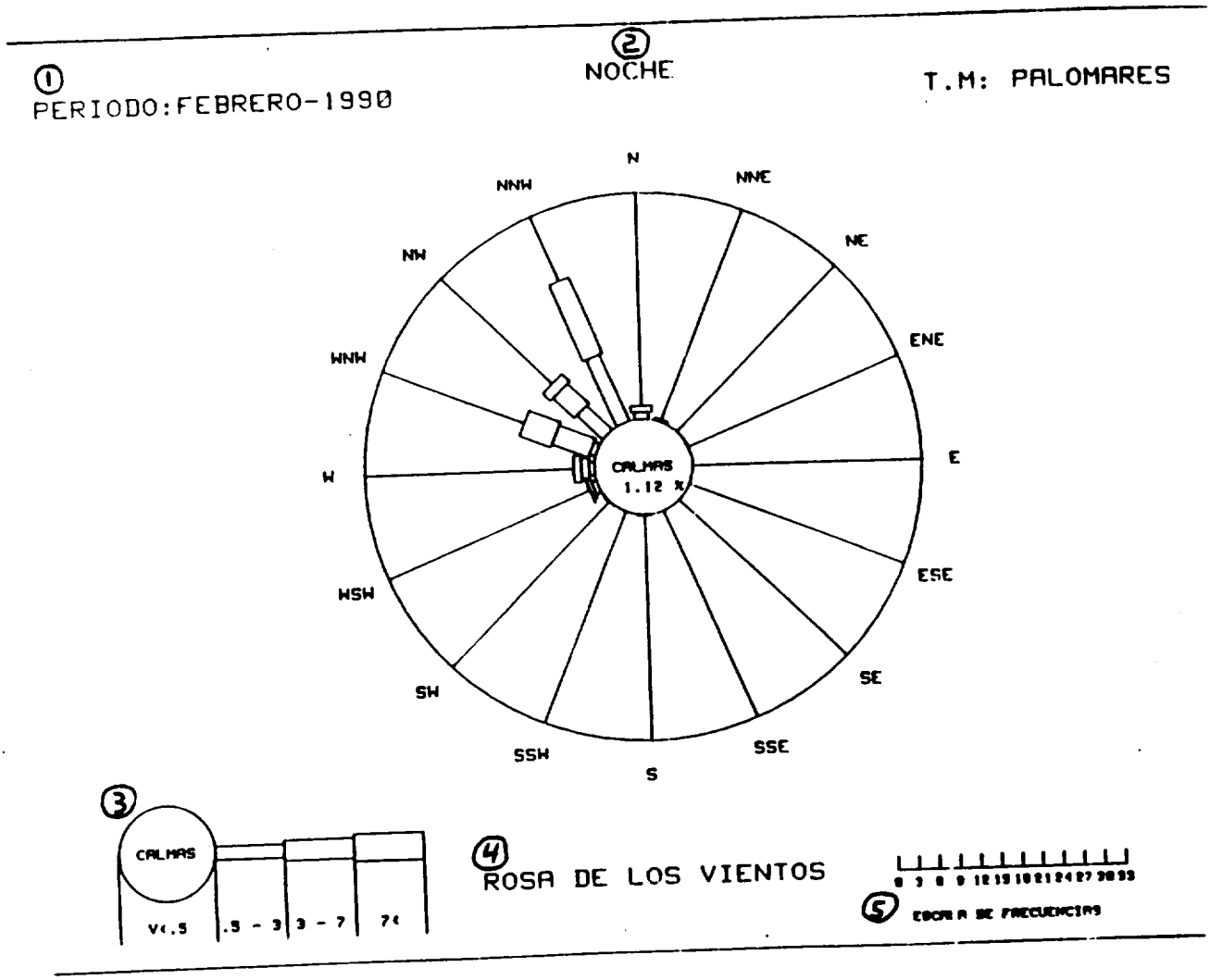

Figura B.2

Figure B.2.

Key: 1) Period: February - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

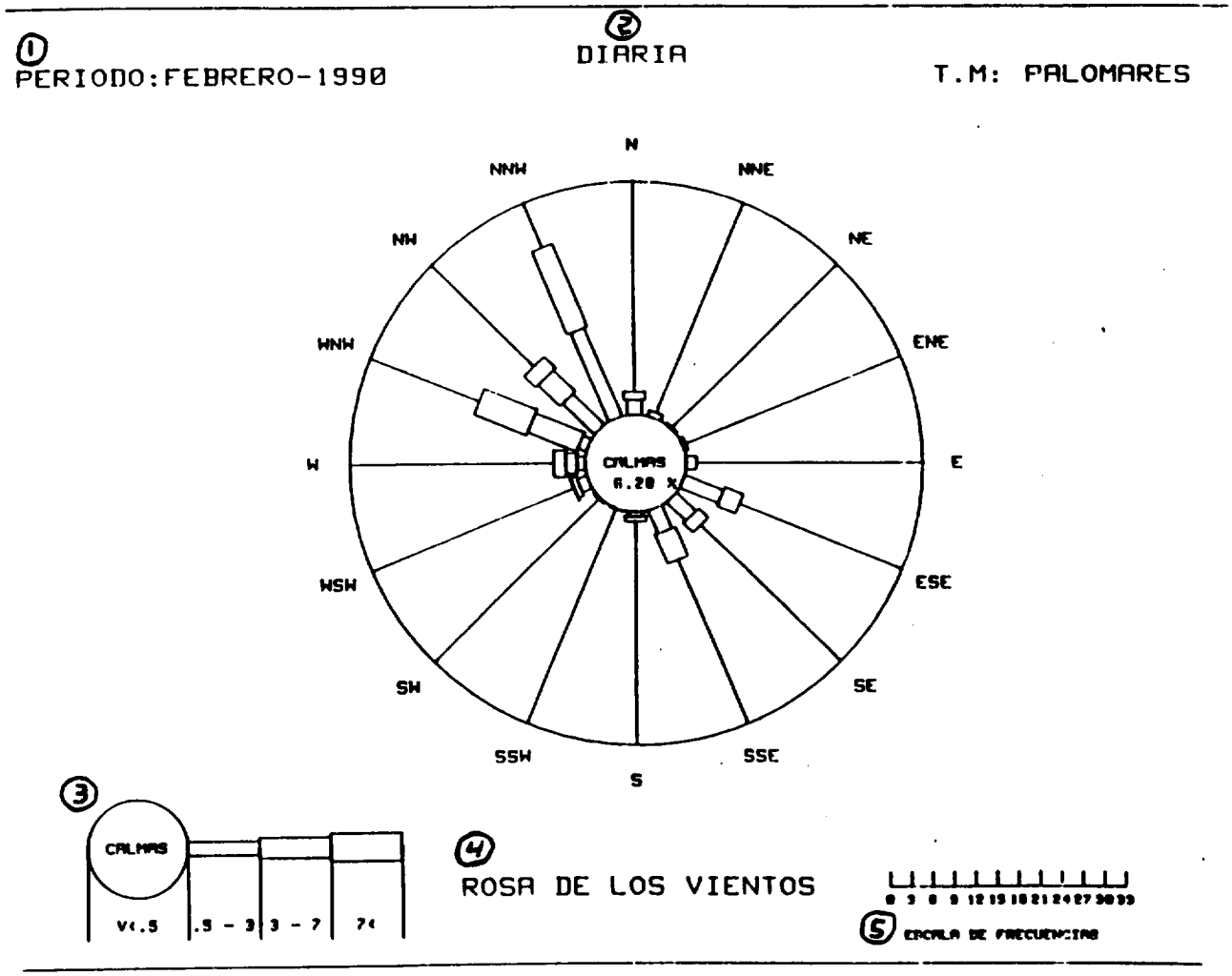

Figura C.2

Figure C.2.

Key: 1) Period: February - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

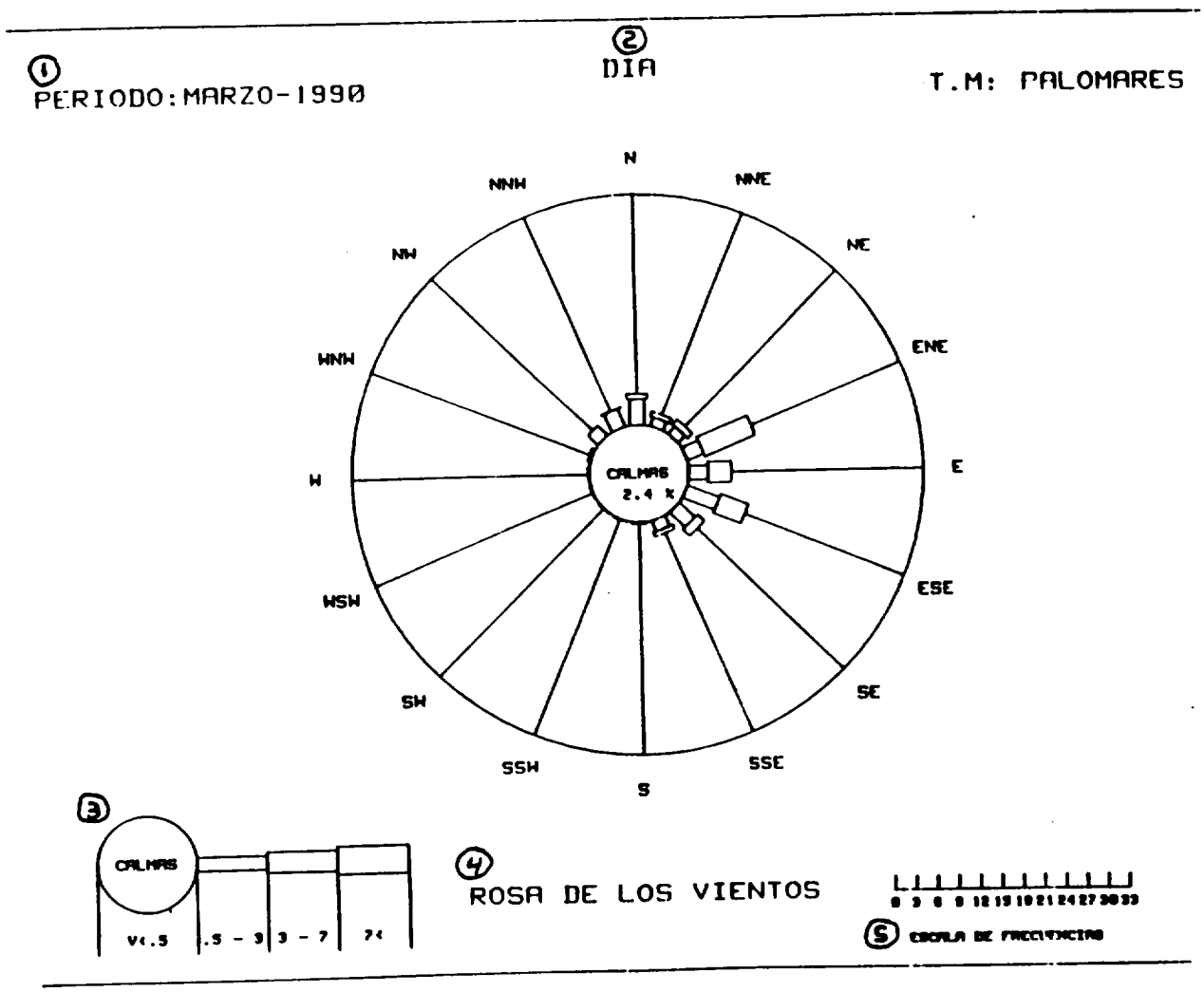

Figura A.3

Figure A.3.

Key: 1) Period: March - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

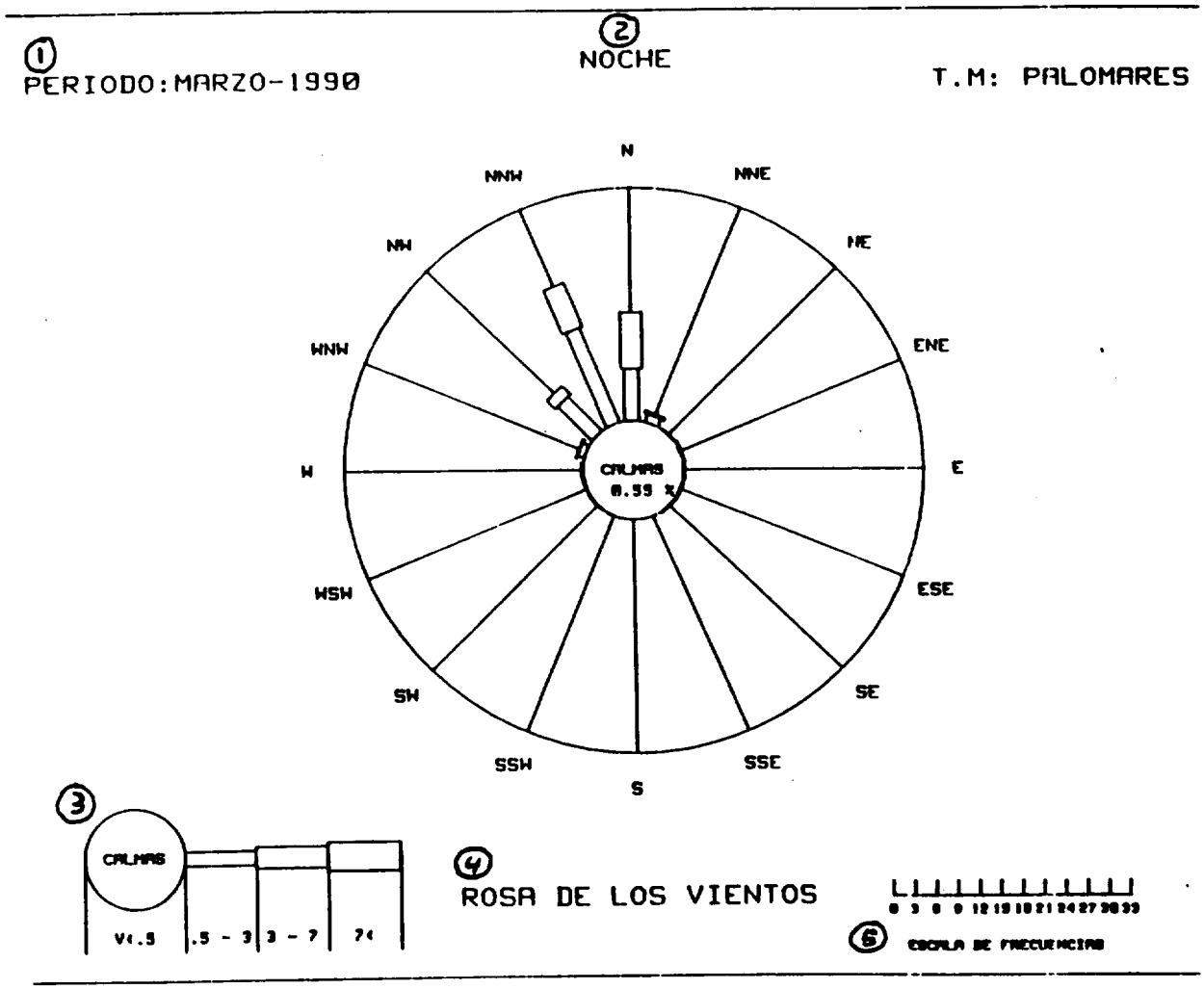

Figura B.3

Figure B.3.

Key: 1) Period: March - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

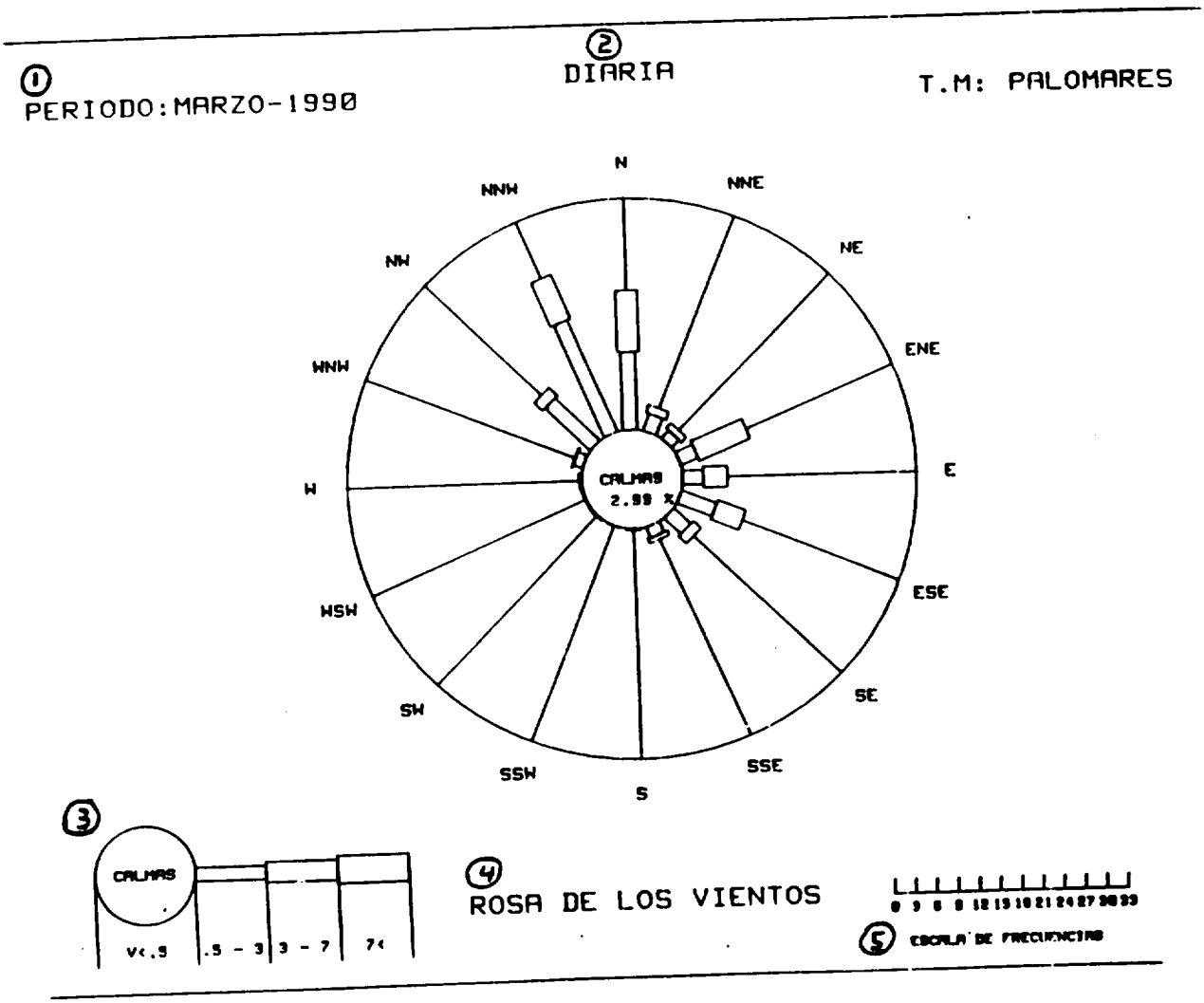

Figura C.3

Figure C.3.

Key: 1) Period: March - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

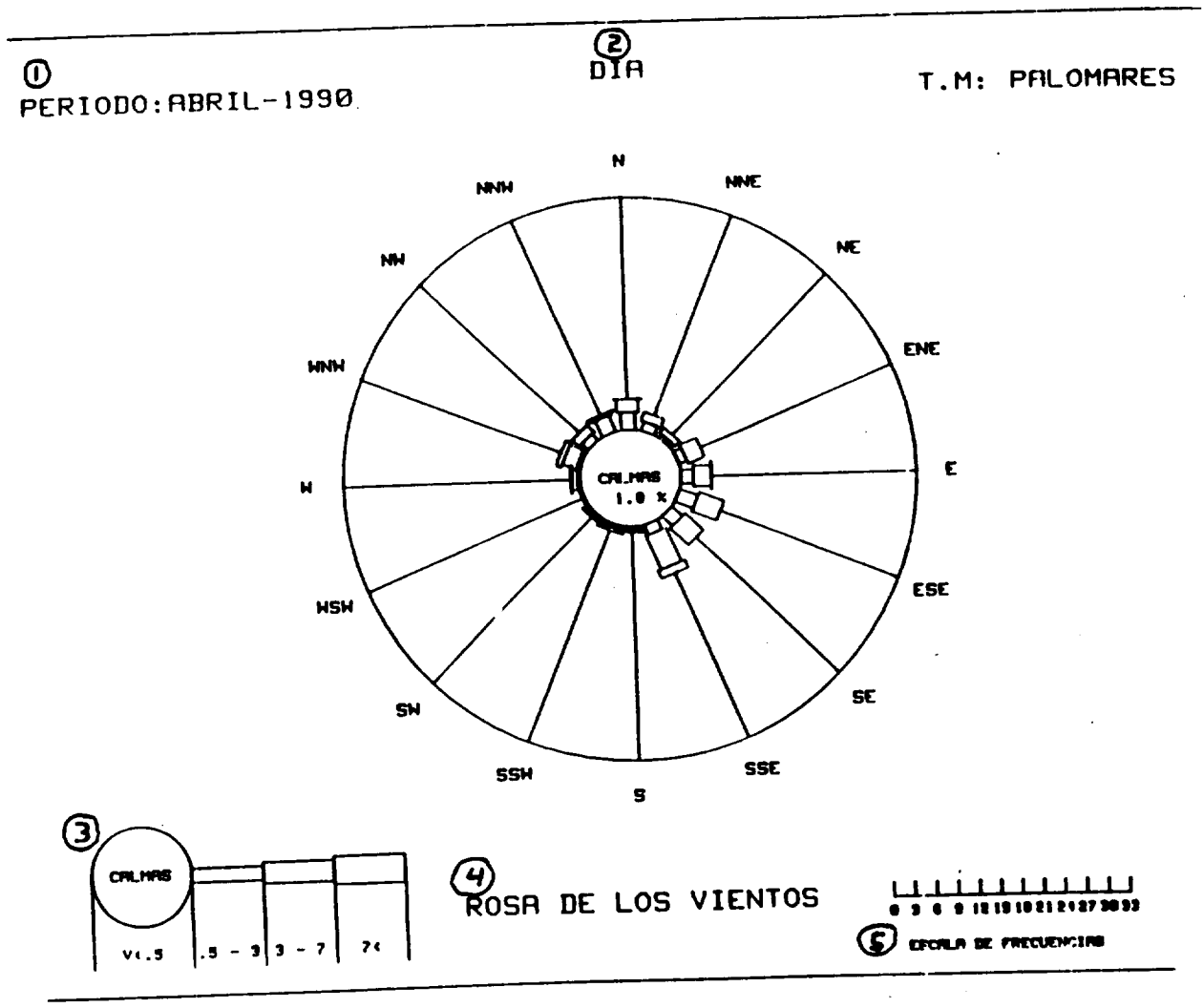

Figura A.4

Figure A.4.

Key: 1) Period: April - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

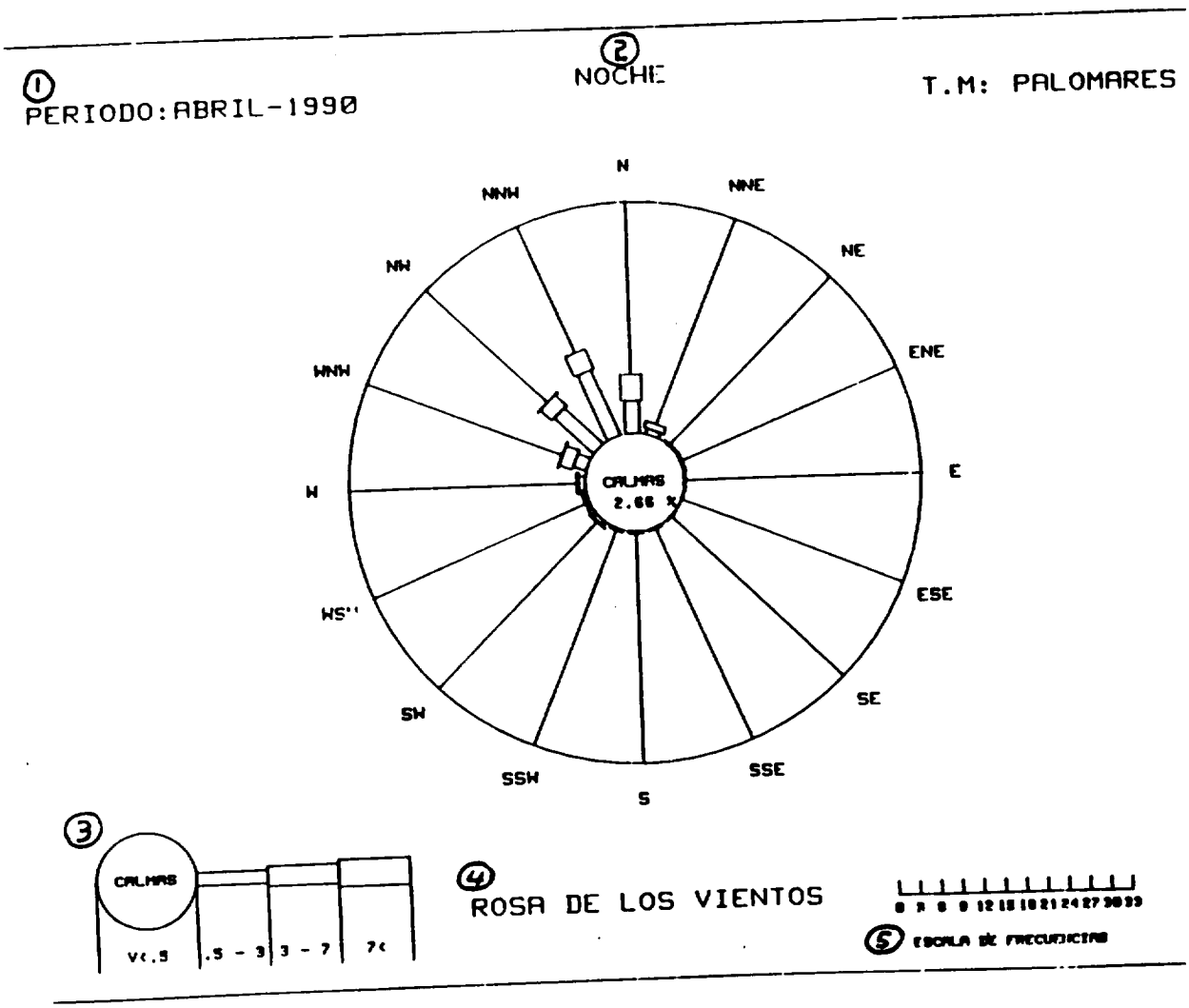

Figura B.4

Figure B.4.

Key: 1) Period: April - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

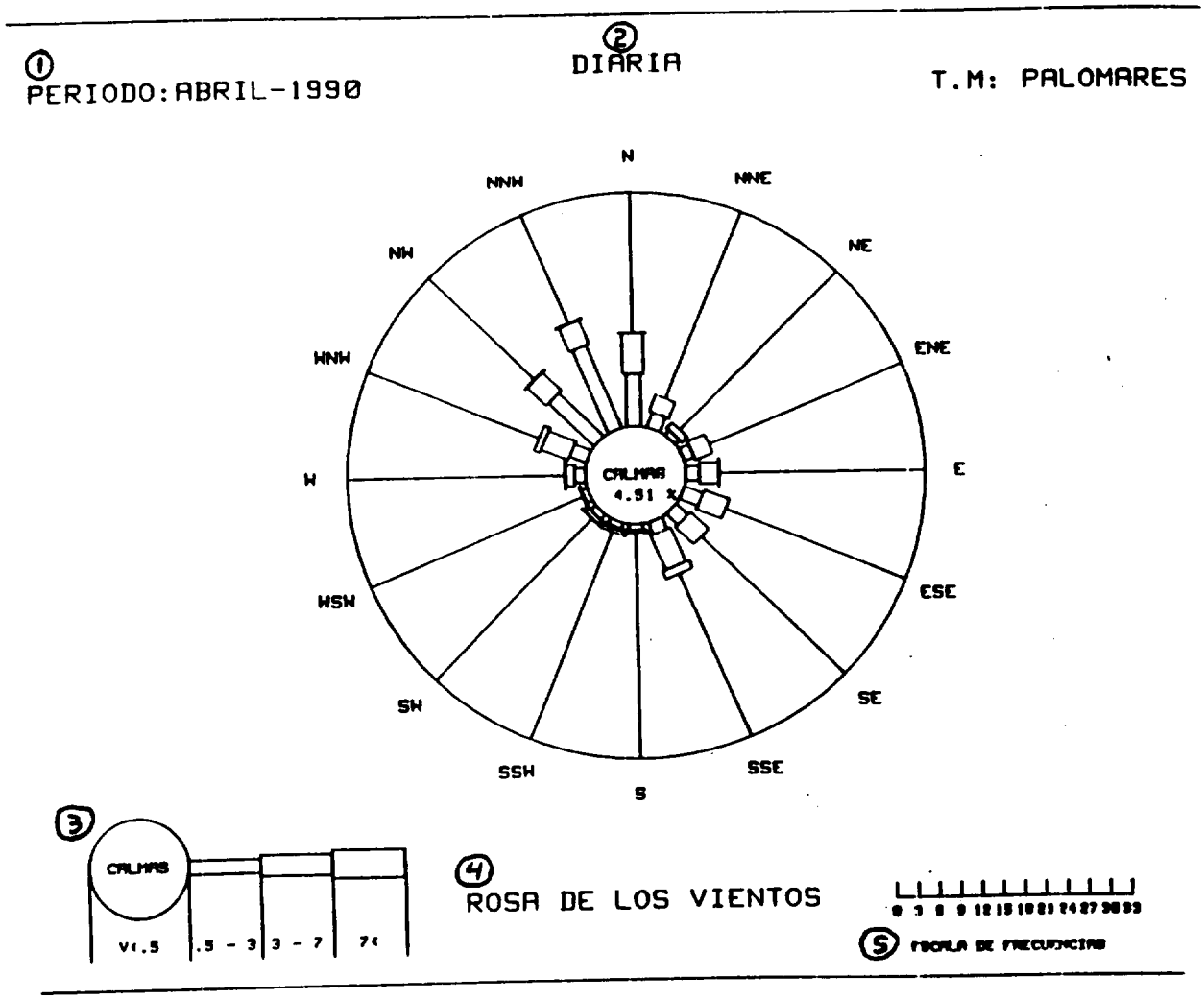

Figura C.4

Figure C.4.

Key: 1) Period: April - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

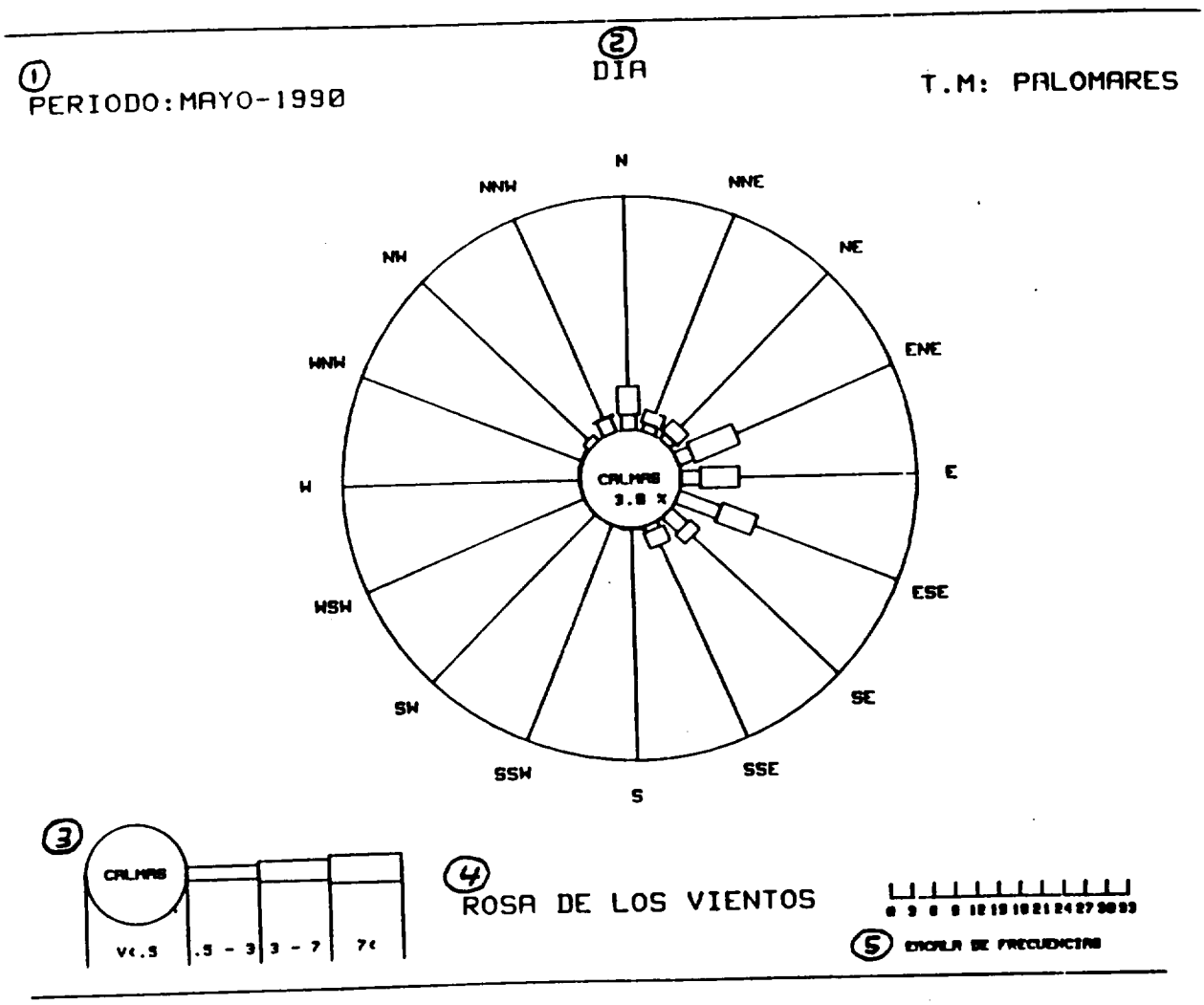

Figura A.5

Figure A.5.

Key: 1) Period: May - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

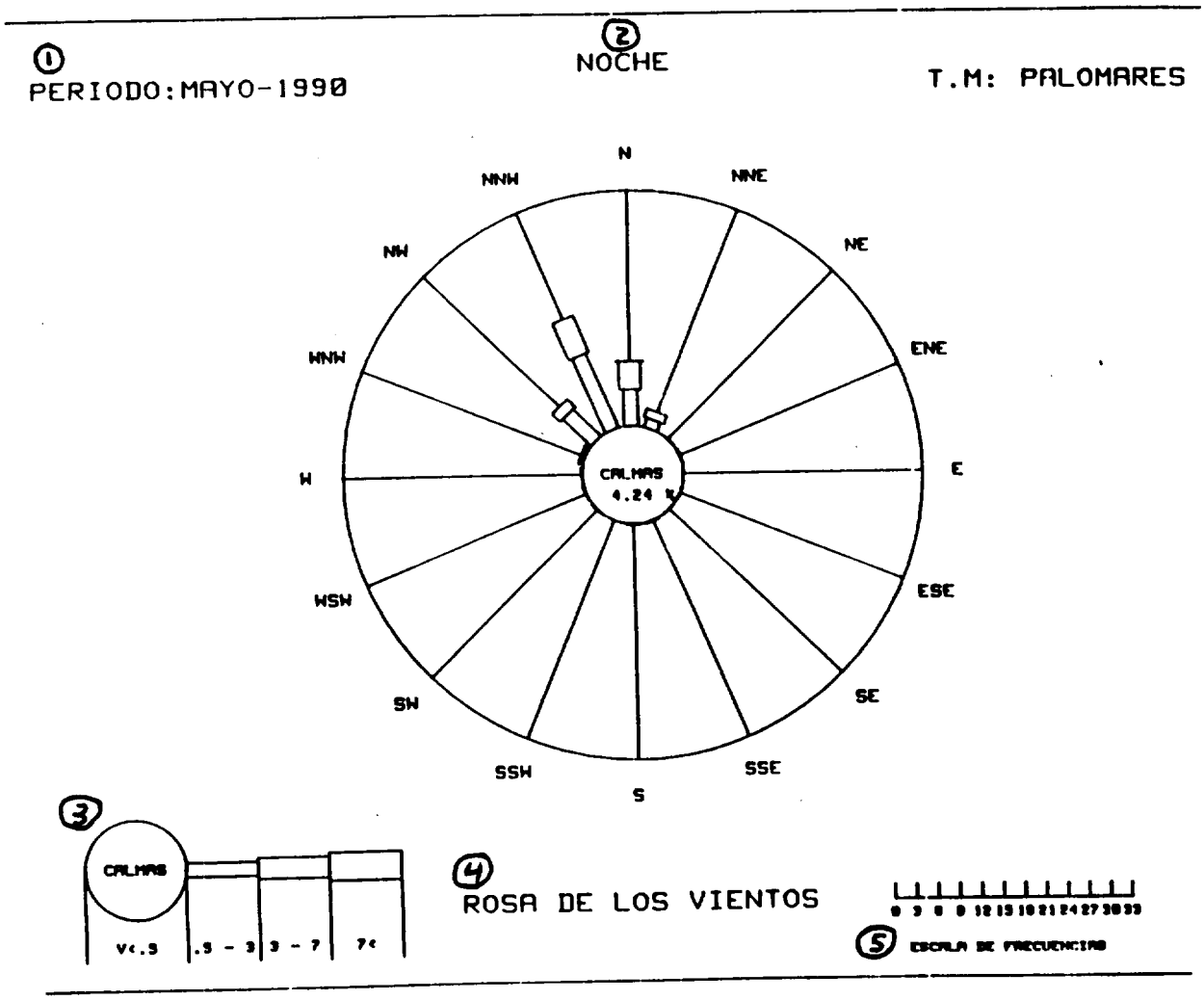

Figura B.5

Figure B.5.

Key: 1) Period: May - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

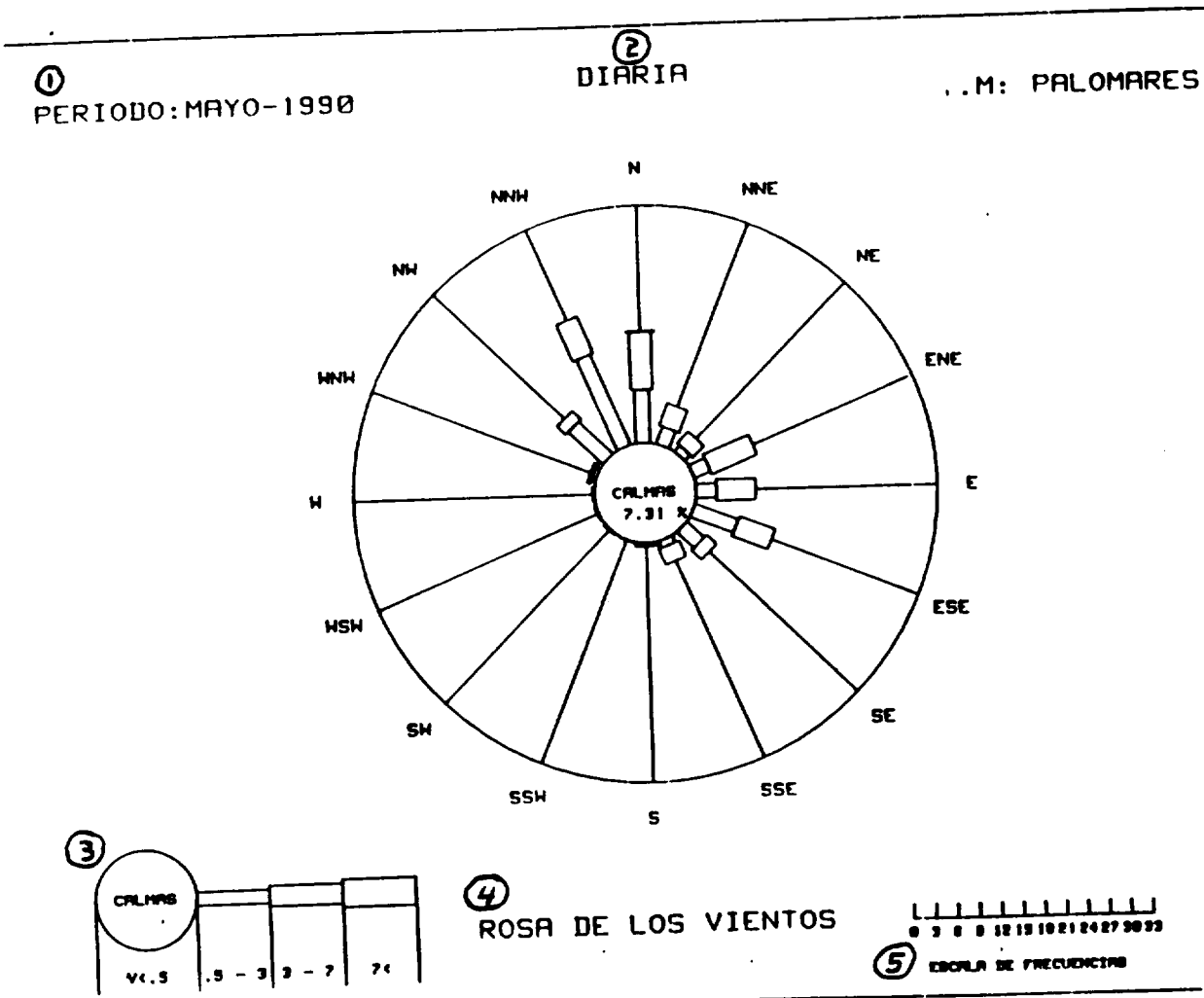

Figura C.5

Figure C.5.

Key: 1) Period: May - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

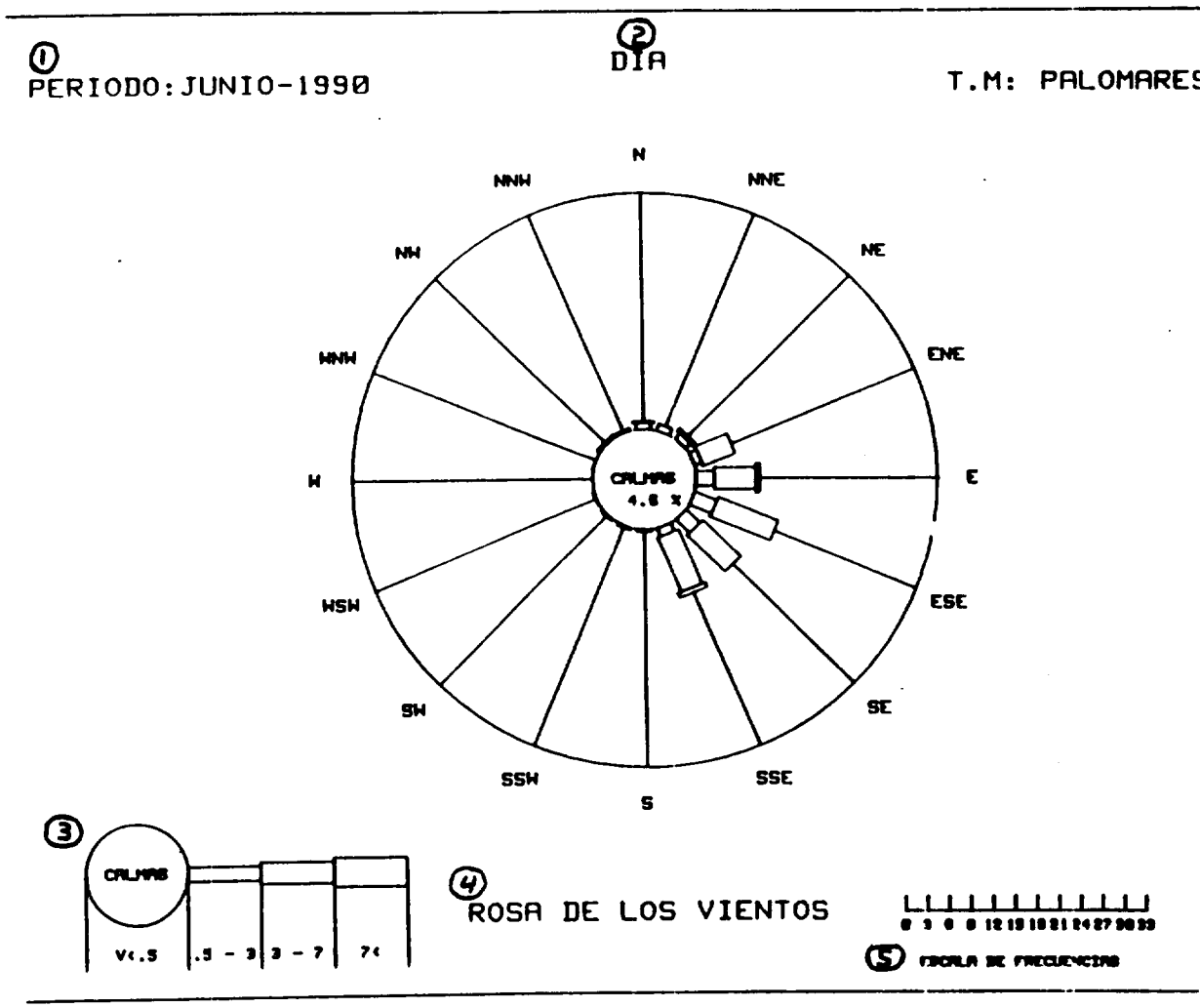

Figura A.6

Figure A.6.

Key: 1) Period: June - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

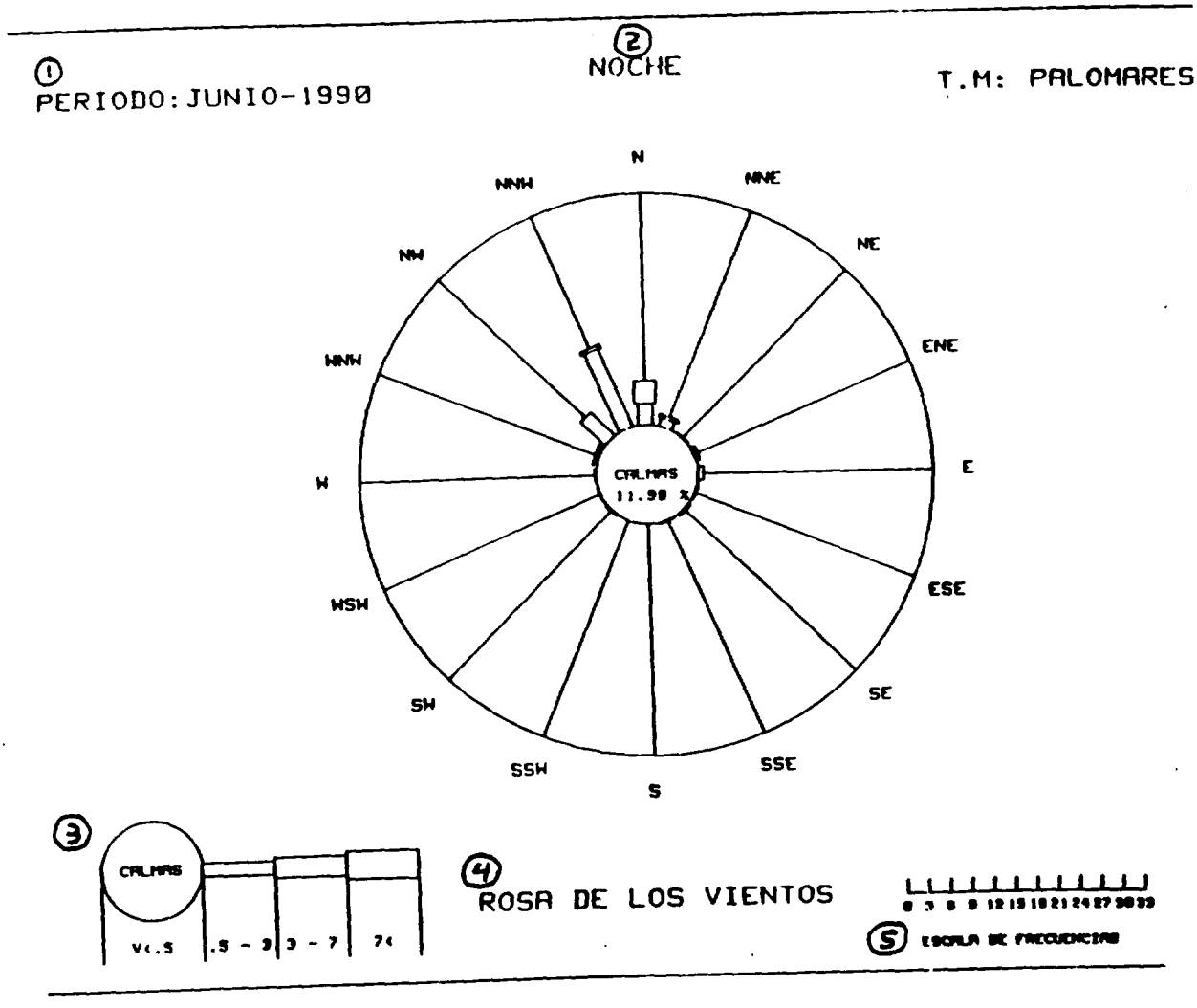

Figura B.6

Figure B.6.

Key: 1) Period: June - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

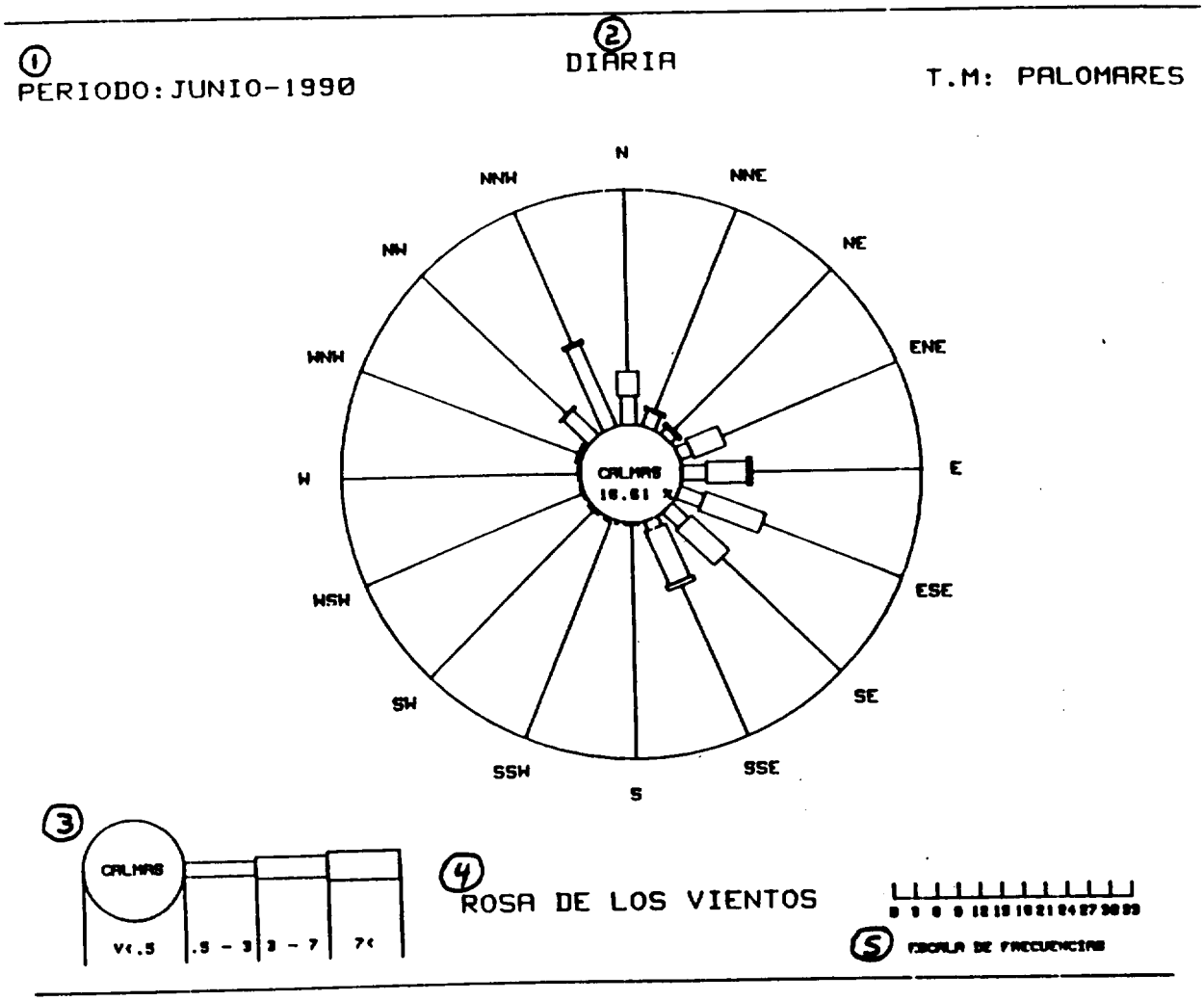

Figura C.6

Figure C.6.

Key: 1) Period: June - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

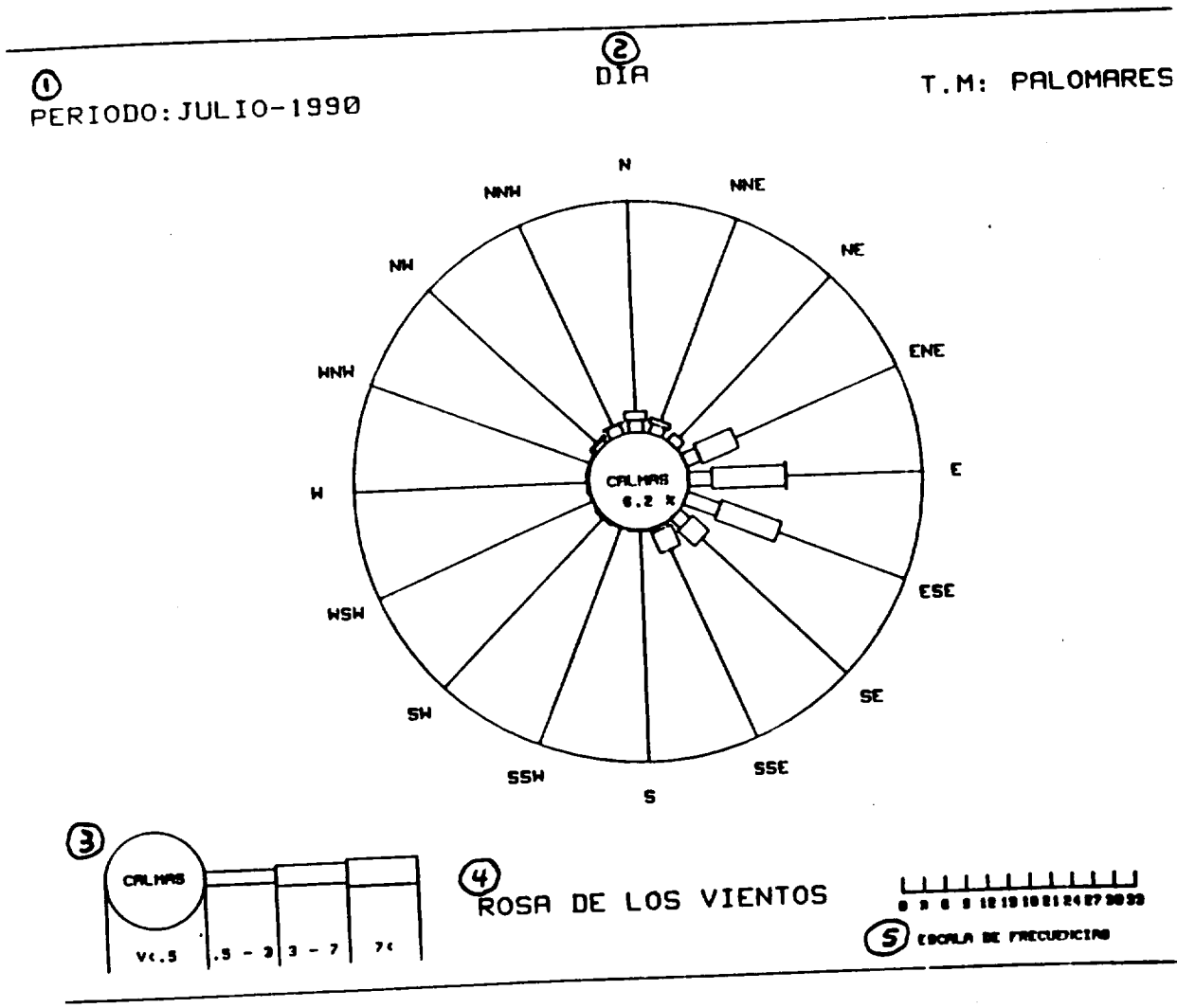

Figura A.7

Figure A.7.

Key: 1) Period: July - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

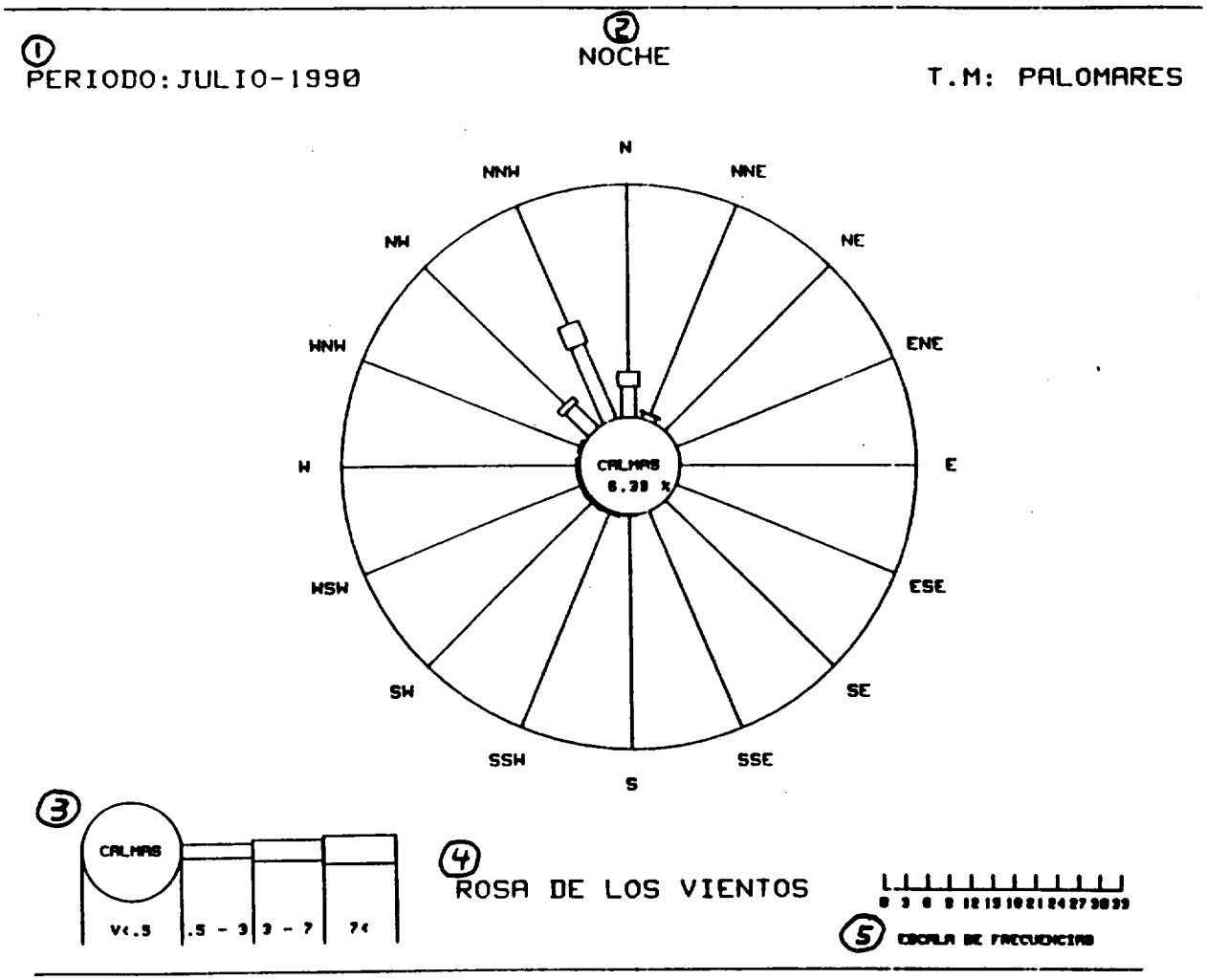

Figura B.7

Figure B.7.

Key: 1) Period: July - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

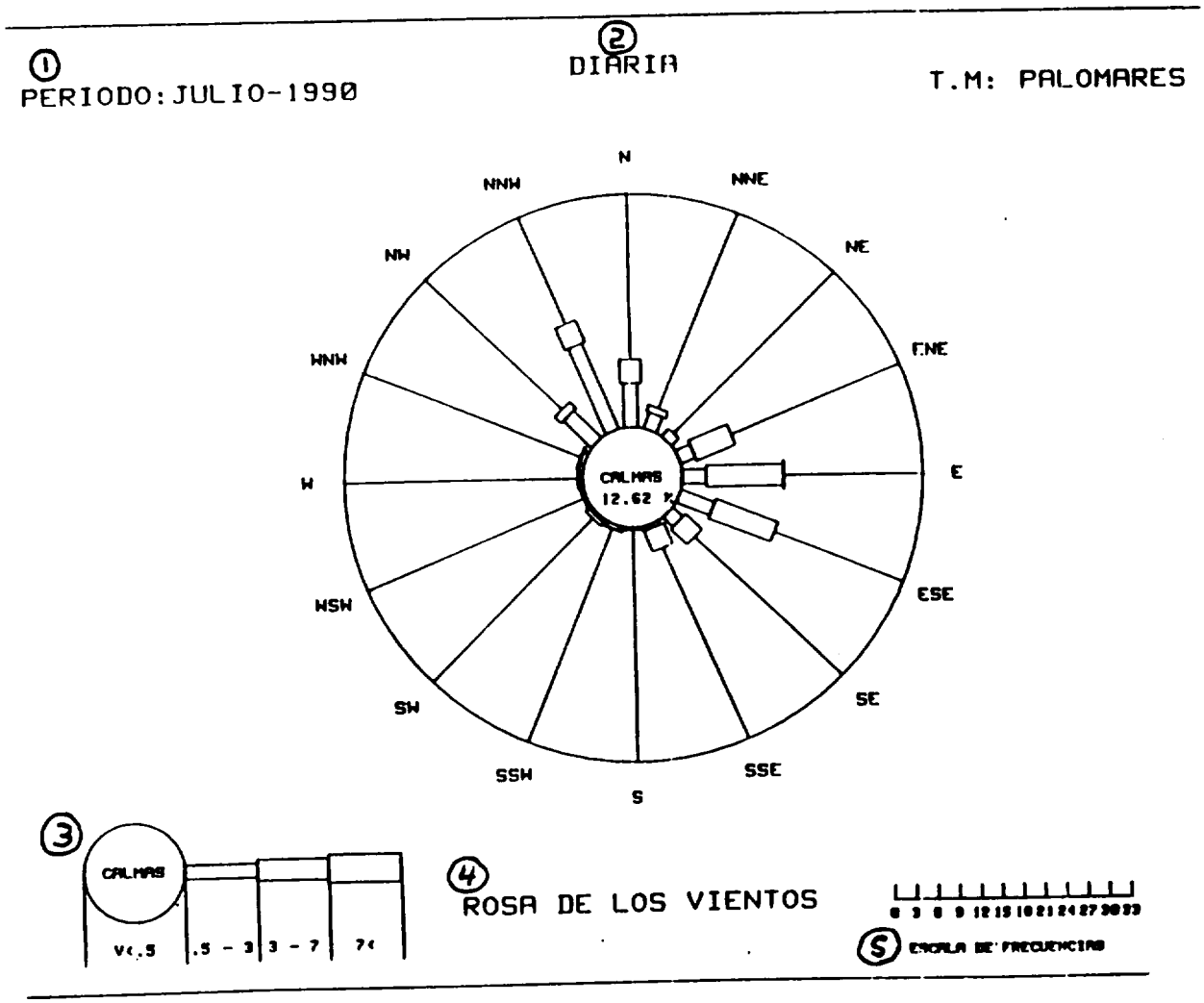

Figura C.7

Figure C.7.

Key: 1) Period: July - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

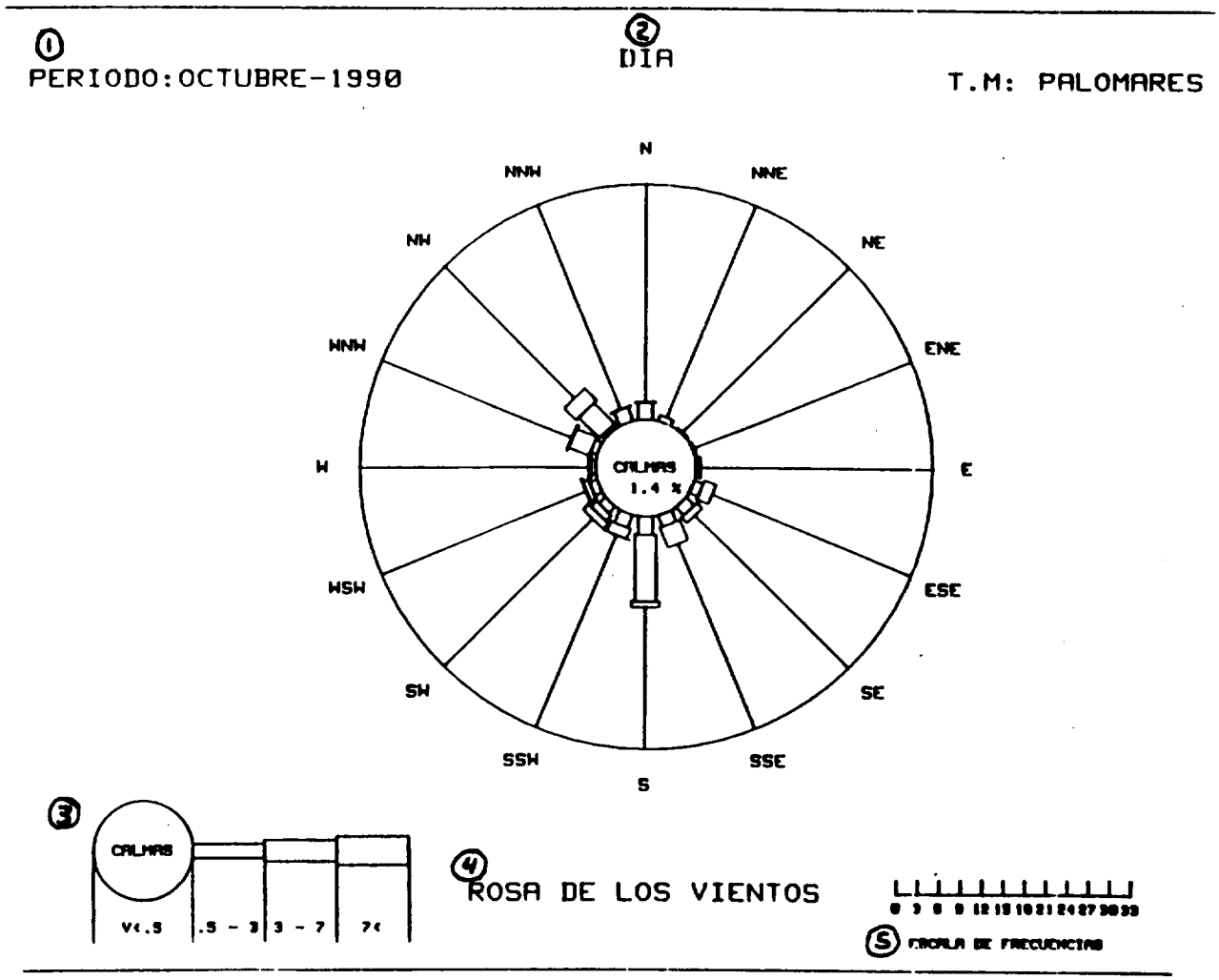

Figura A.8

Figure A.8.

Key: 1) Period: October - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

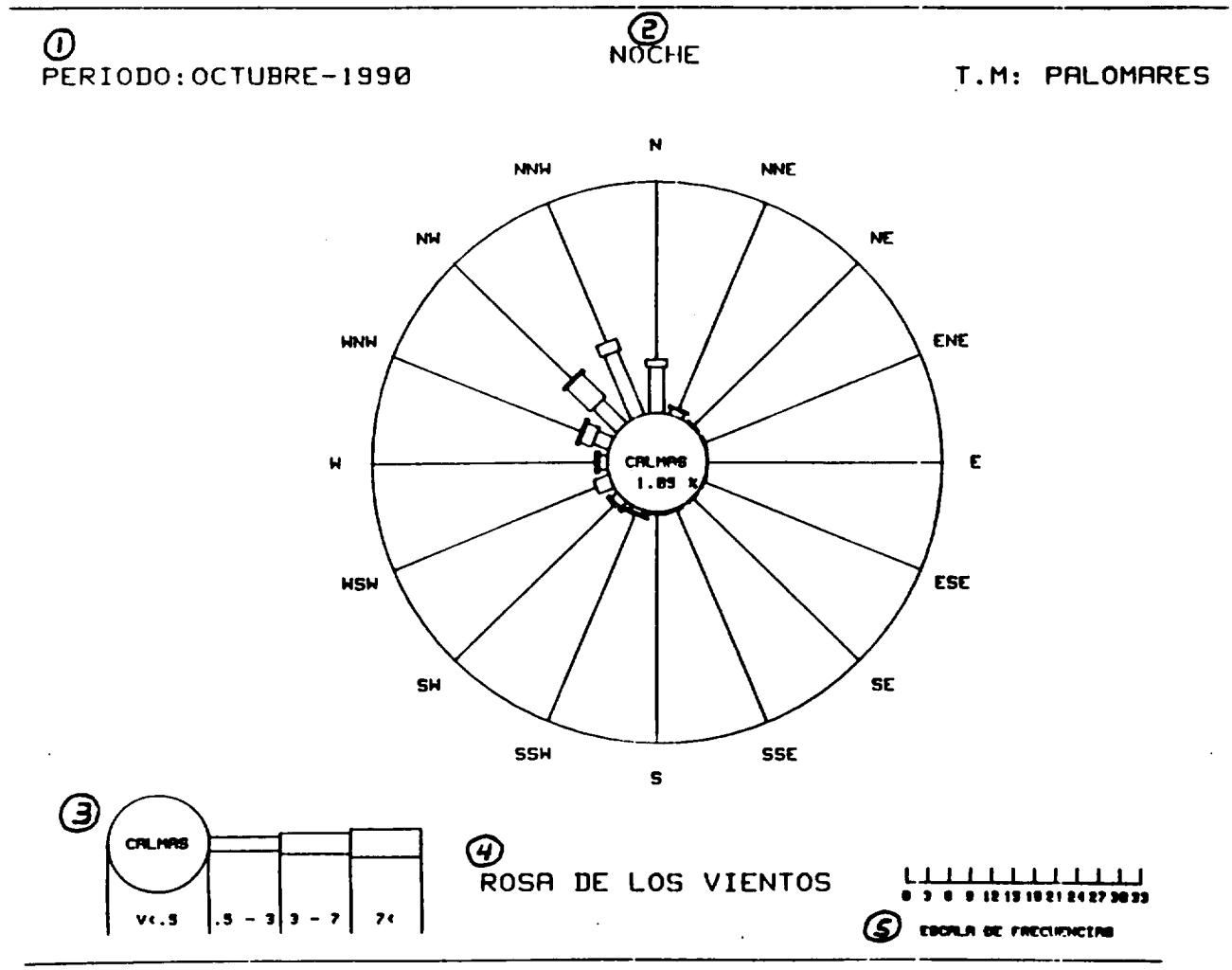

Figura B.8

Figure B.8.

Key: 1) Period: October - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

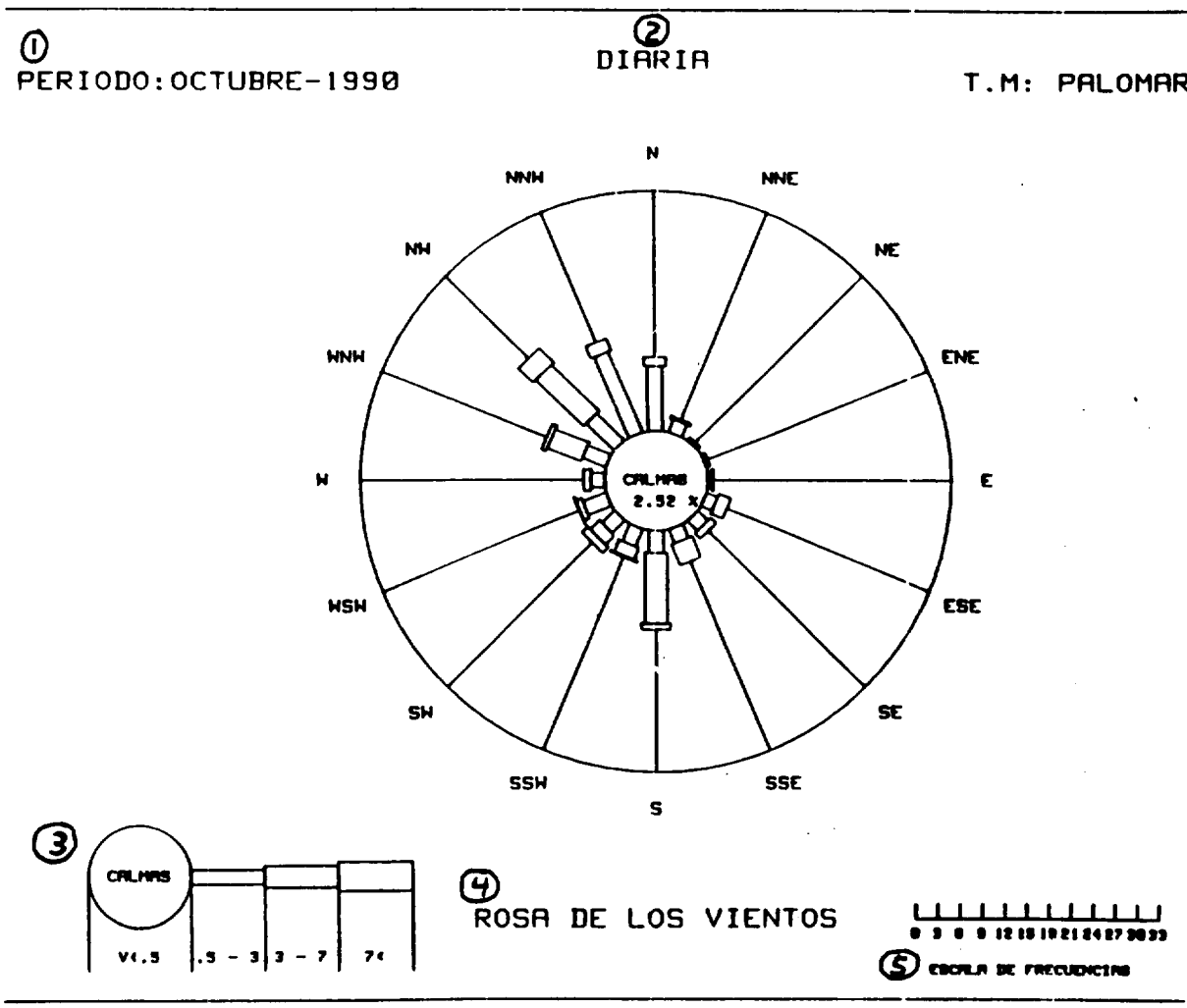

Figura C.8

Figure C.8.

Key: 1) Period: October - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

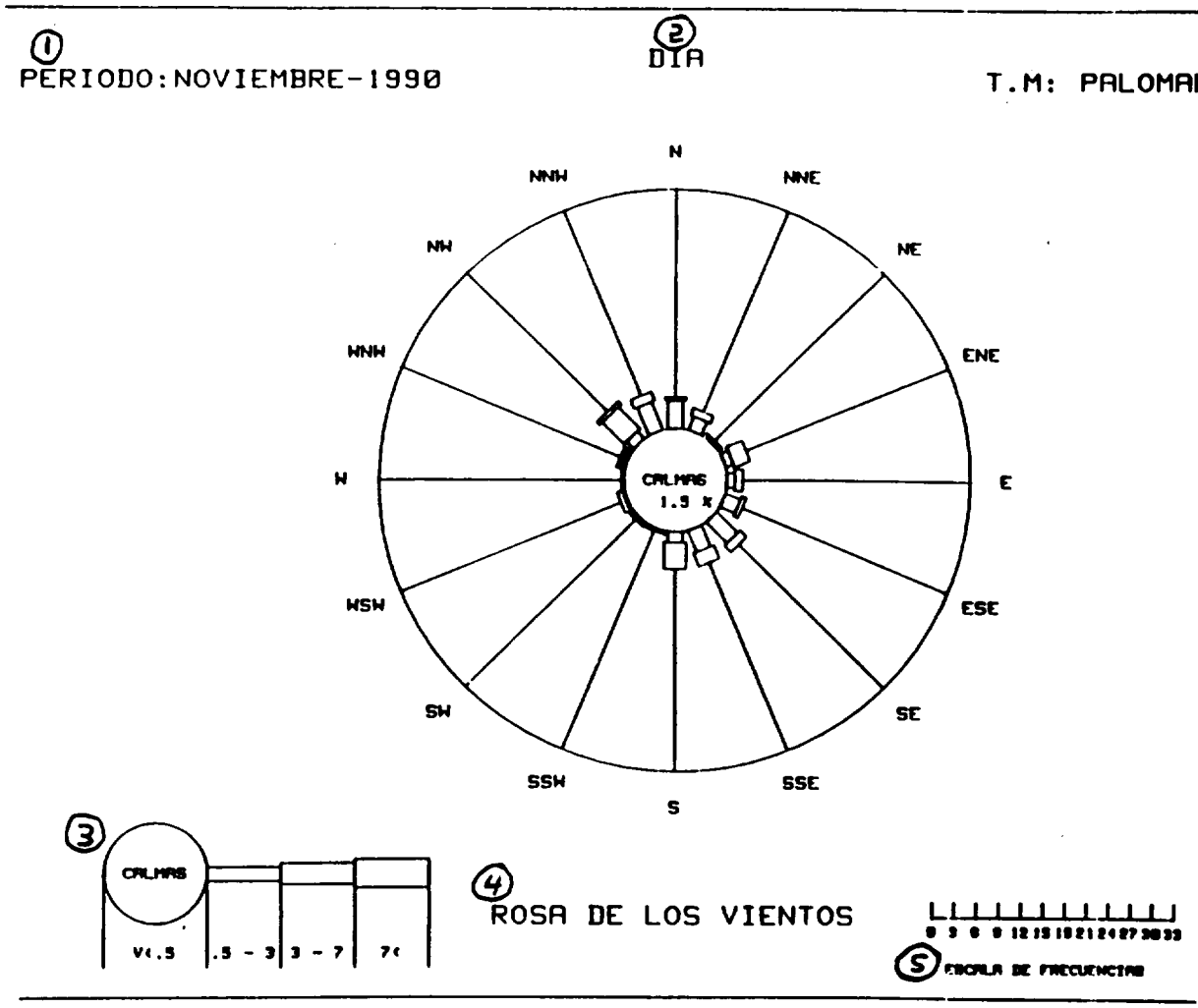

Figura A.9

Figure A.9.

Key: 1) Period: November - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

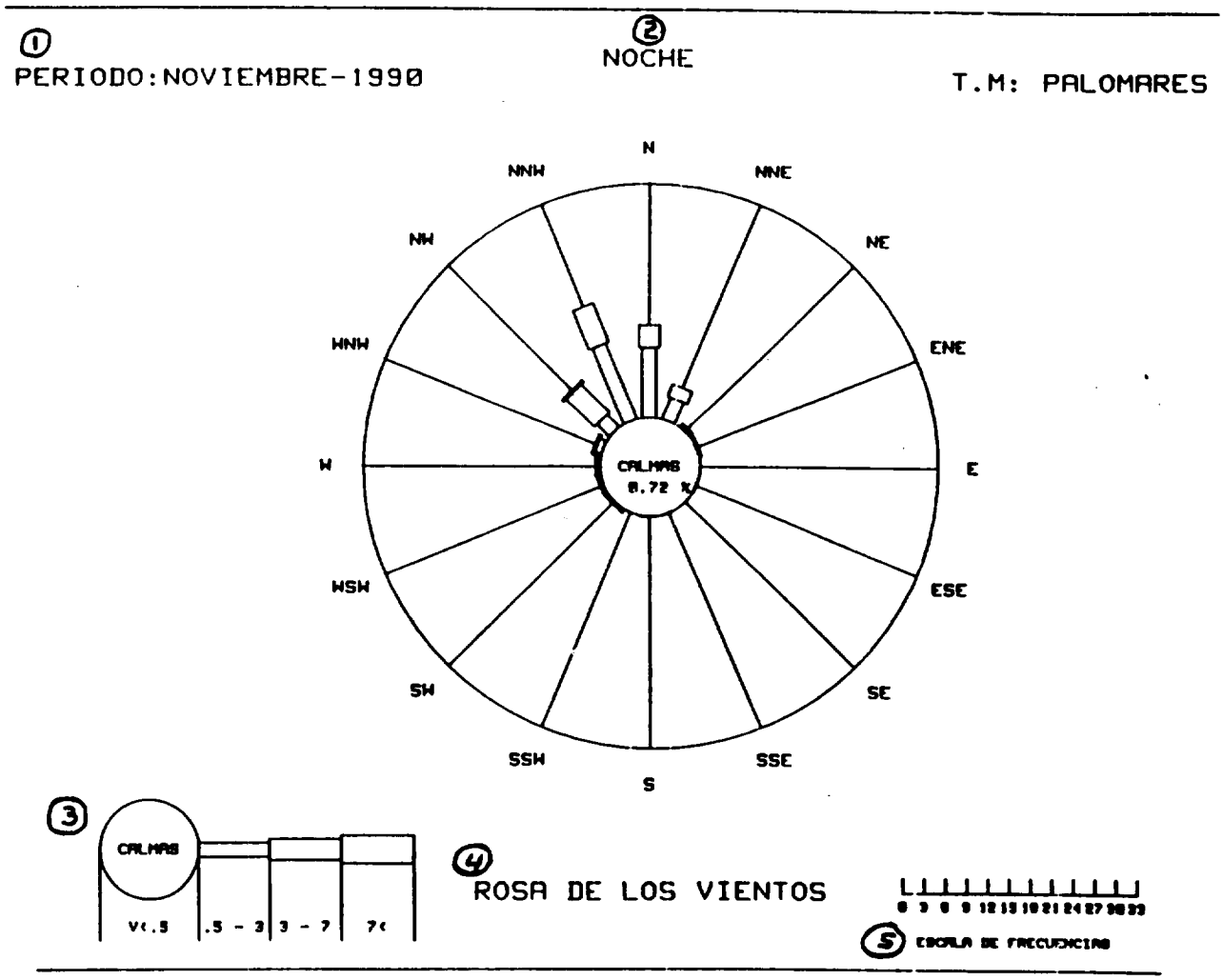

Figura B.9

Figure B.9.

Key: 1) Period: November - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

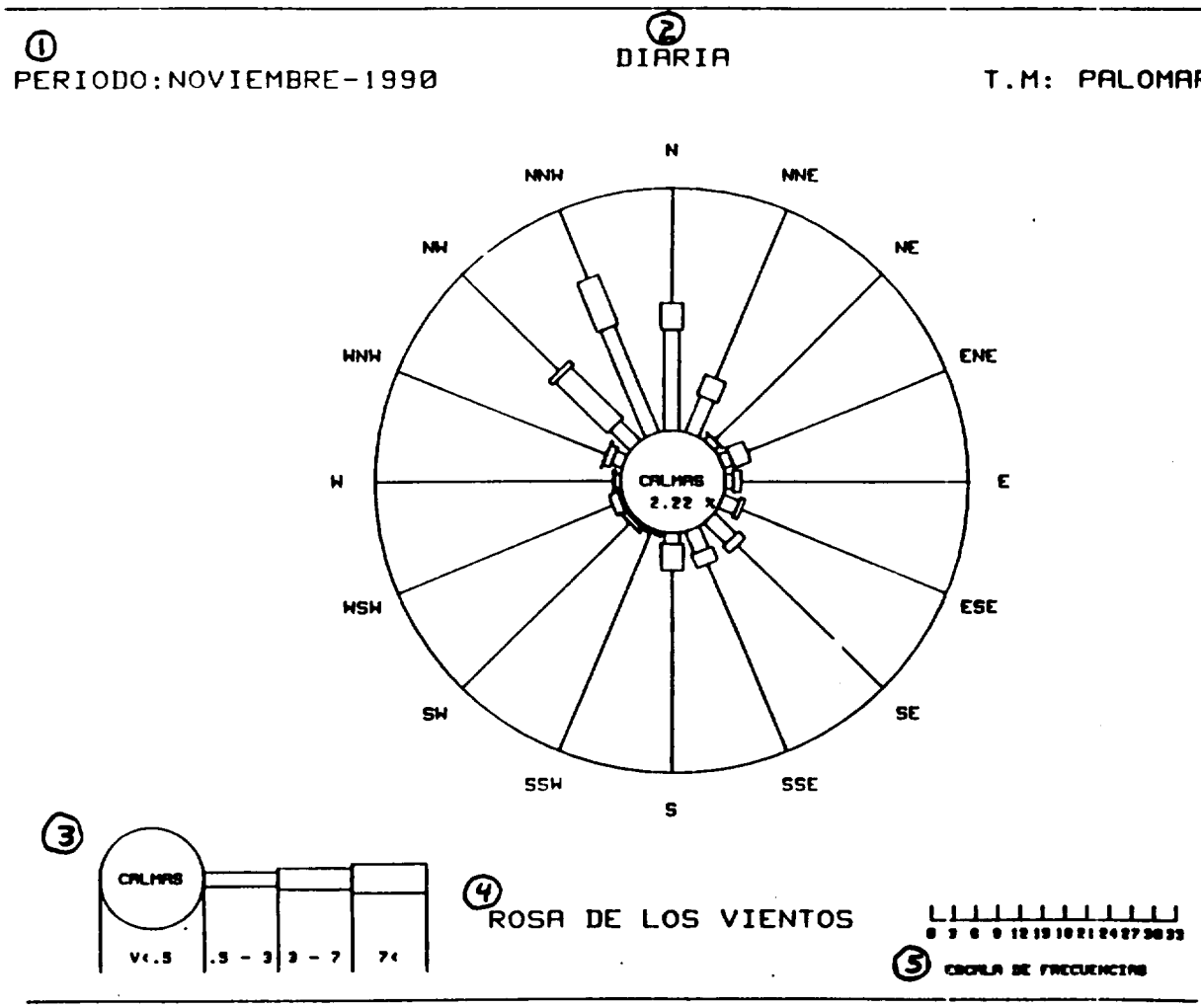

Figura C.9

Figure C.9.

Key: 1) Period: November - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.

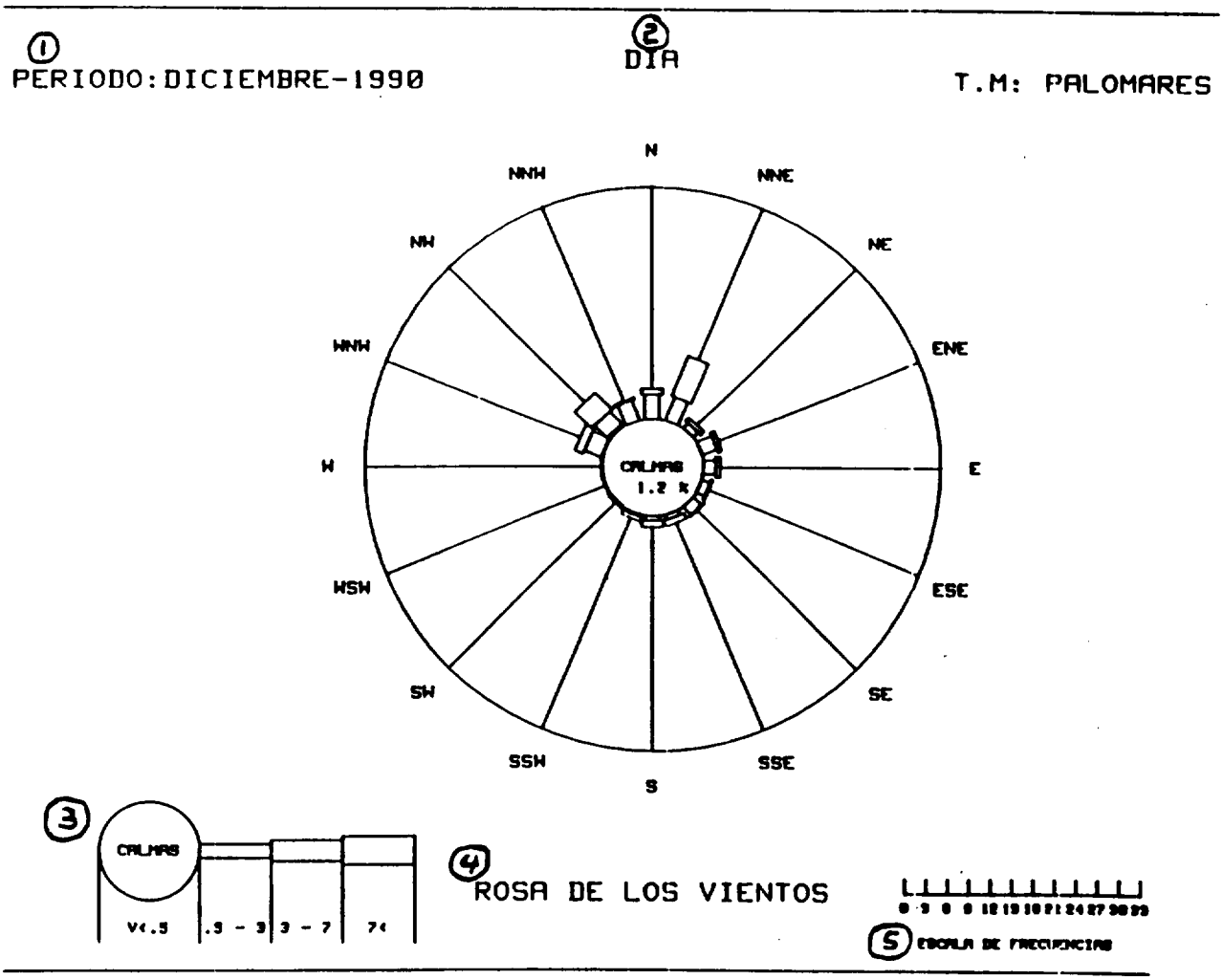

Figura A.10

Figure A.10.

Key: 1) Period: December - 1990; 2) day; 3) calms; 4) wind compass rose; 5) scale of frequencies.

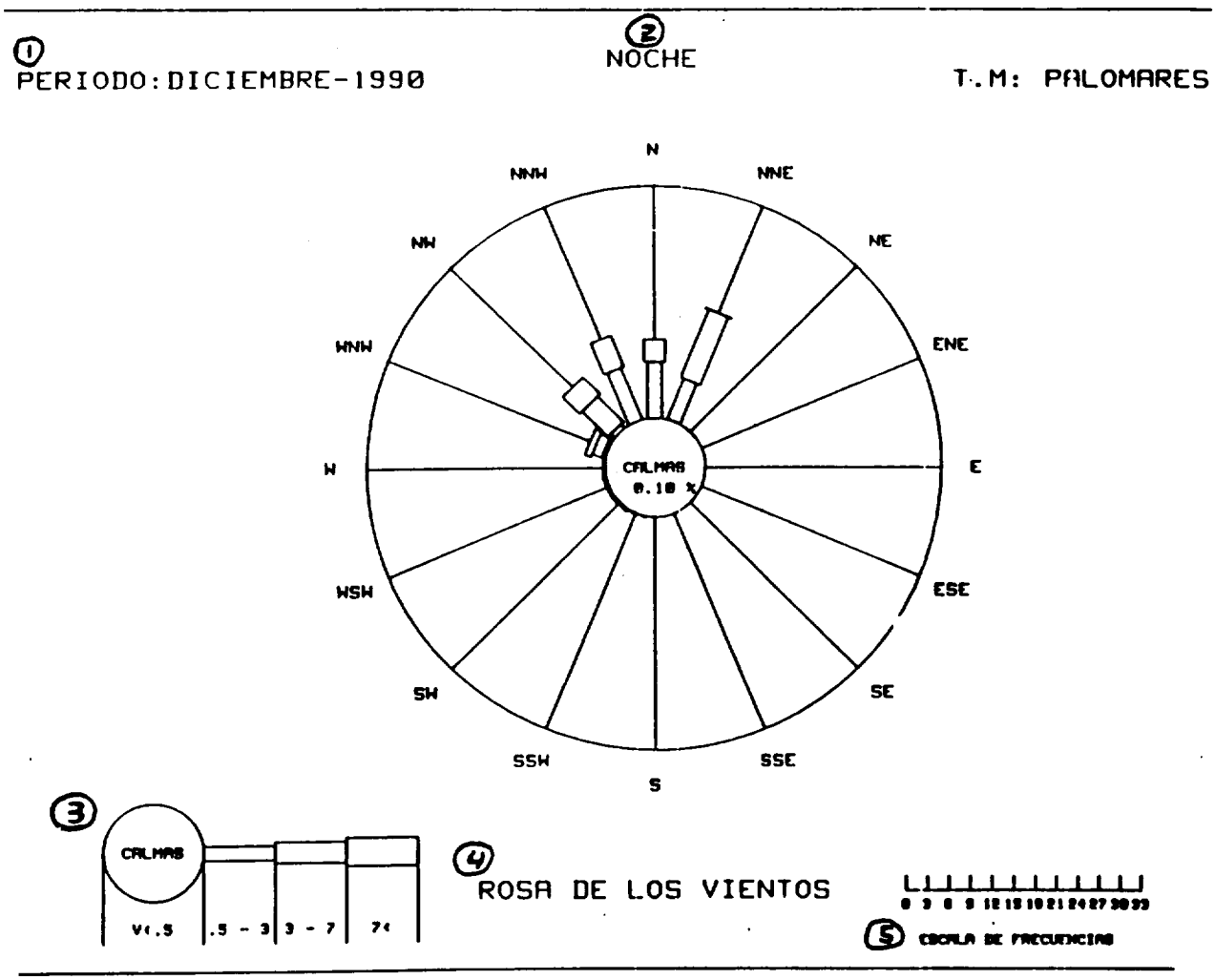

Figura B.10

Figure B.10.

Key: 1) Period: December - 1990; 2) night; 3) calms; 4) wind compass rose; 5) scale of frequencies.

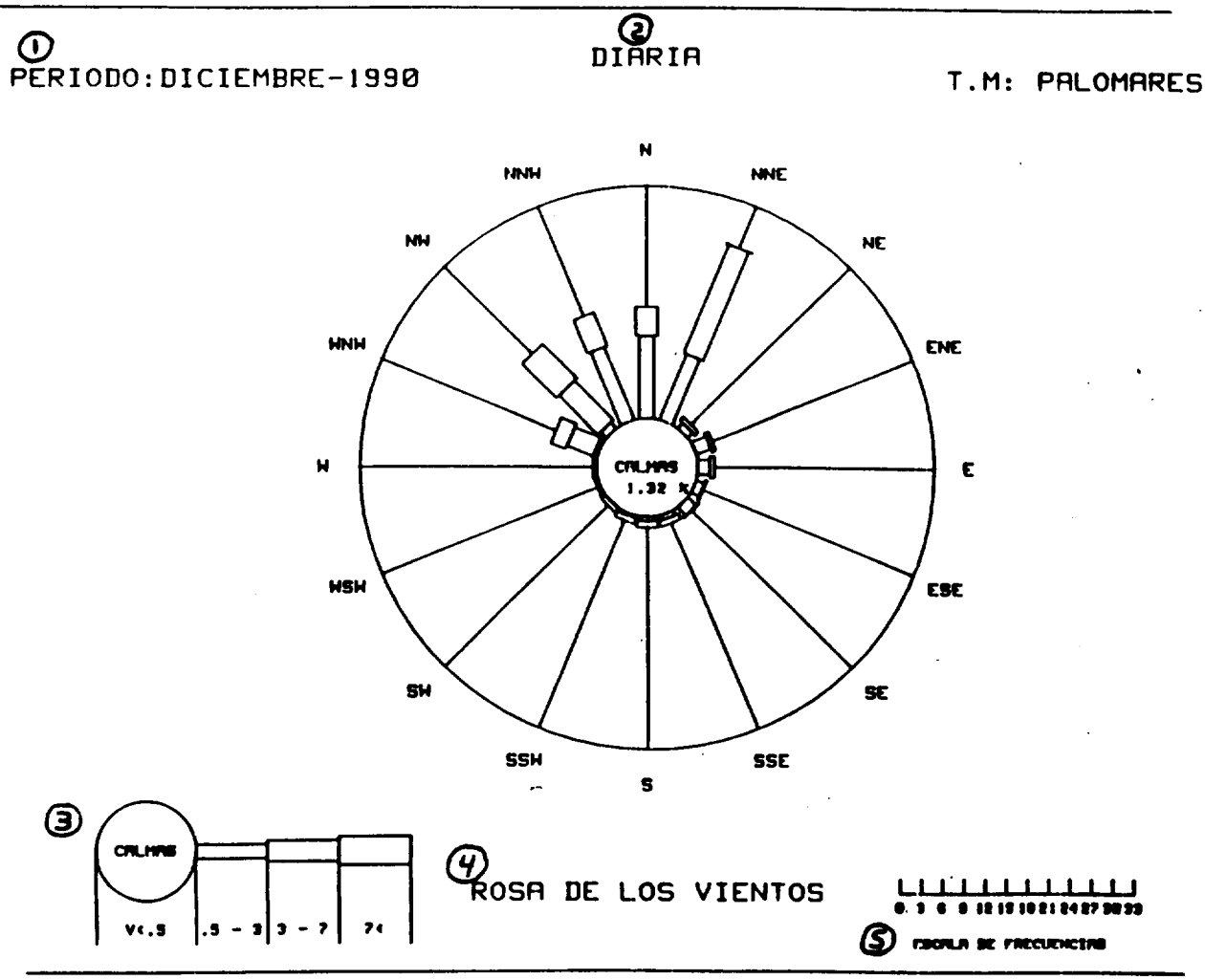

Figura C.10

Figure C.10.

Key: 1) Period: December - 1990; 2) daily; 3) calms; 4) wind compass rose; 5) scale of frequencies.