Riproponiamo qui un altro lavoro degli anni '60 che completa l'esplorazione di cui era parte il lavoro riproposto su WP 269. Anche in questo caso si tratta di un Rapporto di Ricerca, circolato in pochissime copie, del Centro di Cibernetica e di Attività Linguistiche dell'Università di Milano che era diretto da S.Ceccato.

An experimental contribution to the problem of the influence of the differences of colour in visual perception (two-dimensional greyscale situations).[a]

Renzo Beltrame[b]

The experimental work here described is designed to cash light on some perceptive habits which act in every type of perception and, to be precise, on those connected with the differences in luminosity present in the physical situation under observation.

For this purpose eight two-dimensional situations were prepared.

They consist of eight pieces of cardboard, 21x29 cm. in size; on each of which were placed three spots of such form or configuration as not to suggest any known object. The colors chosen for the spots and the background were white, black and six intermediate shades of gray.

The various situations differed only in the colors of the background and of the spots, while form and configuration remain unchanged. In Fig. 1, we show one of these situations.

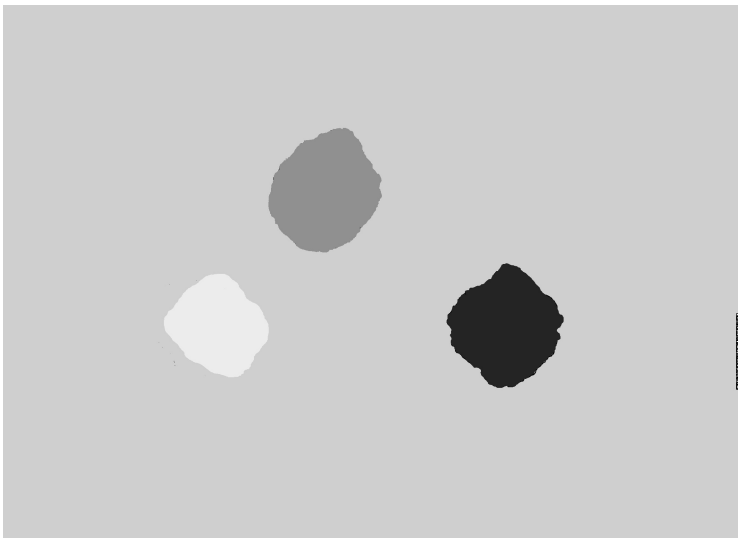

Fig. 1

The choice of only six intermediate shades of gray was determined by our desire to utilize the results of the experiments directly for the "Machine which observes and describes" under construction in our Center (Ceccato, 1965). This machine's optical device discriminates eight levels of luminosity.

The experiment studies the eyeball movements, photographed with a movie camera, during the perception of the two-dimensional situations previously described.

Particular care was taken in presenting the subjects of the experiment with their task: they were asked to look at what would be presented to them without worrying about describing or evaluating

[a]Centro di Cibernetica e di Attività Linguistiche dell'Università di Milano - Research Report 68-1, 1968 - The current paper, on *Methodologia Online* WP 278, March 2014, was obtained by reassembling the OCR of the original report.

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it, but letting their glance wander freely over it, guided by the situation under observation alone.

This is a point of great importance, in that the linguistic guidance furnished to the observer has a determining influence on the activity of perception with very strong repercussions on the movements of the eyeballs (Beltrame et al., 1965a). For these reasons we choose two subjects who were rather well trained to operate perceptively under the guidance of a precise intention.

The subjects, who opened their eyes when the operator said «Go!», had to close them when they thought that the task assigned them had been completed. The graphs obtained, which do not contain repetitions of extended cycles of movements, confirm that this aspect of the task was satisfactorily carried out.

We decided not to interview the subjects after the execution of the task, as has been done in other research on eyeball movements. Any answer given would have been not only irrelevant but also deceptive for the purposes of the experiment, because the linguistic formulation, whatever it was, would have required a particular structuration of the perceptional data, and this could have taken place equally well on a mental representation suggested by the memory of the observed situation.

As we will see in discussing them, the results present a remarkable coherence and can be interpreted only through the entity of the differences in luminosity and some simple spacial relationships. Thus we have an indirect confirmation that the task was correctly executed.

In order to reduce the representational contribution due to the memories of the previously observed situations (Beltrame, 1966) a certain number of analogous situations were intermixed among those involved in the experiment, as a disturbance factor. We hold that this solution was the best possible compromise. It would also have been possible to space the sittings for recording the eyeball movements over a long period of time, but the exceptional nature of the event would nonetheless have acted as a strong stimulus to remember what had already been observed.

The study of eyeball movements does not, as has often been affirmed, exhaust the investigation of the perceptive process connected with the situations presented and the proposed task. In fact in visual perception other systems besides the eye are active, and these others have a very important role in determining the perceptional construct. However, for our purposes those movements are an extremely precious clue, especially because in this case it is most difficult to have recourse to the subject awareness.

A further consideration has to do with the number of subjects: only two. This was dictated above all by the practical difficulties that one comes up against in extending an experimental investigation of the type described to a large number of subjects. A further limitation is constituted, as we shall see, by the considerable individual differences in eyeball movements which we encounter in the execution of the same task. Hence, without a deep knowledge of the subjects experimented with, a comparison of the results would not be very meaningful.

Technical details of the experiment.

The experiment was carried out with a technique already tried out in previous works (Beltrame et al., 1964; 1965a; 1965b). Here we briefly set forth its main points.

For the filming a special bench (Berbenni, 1965), at one end of which the subject is comfortably seated, is used. The head is fixed so as to impede even slight movements. To increase the immobility of the head, the subject is asked to hold firmly between his teeth a small suitably cut piece of wood which is solidly fixed to the bench.

Particular care is taken in the choice of dimension of the object to be observed, of its distance

from the eye and of its position, so as to avoid the subject's having a tendency to move the head during the execution of the task.

The lighting is indirect, using diffused light in order to prevent glare from blinding the subject. Furthermore, as the shooting is at 64 frames per second, such low levels of illumination are necessary that there is no reason for this to occur. Tab. III gives all the technical data on the filming.

Only one eye is filmed - in this experiment the right eye - in order not to reduce excessively the precision of the determination of the movements. A rectangular plate, 1 cm in height, photographed beside the eye gives directly the proper enlargement.

The determination of the movements is made on a special analyzer on which we measure in each frame the orthogonal Cartesian coordinates of the center of the pupil in respect to a reference point. The data, numbered according to the number of the frame, are tabulated and then diagrammed. In the graphs, for convenience sake, abscissa and ordinate are expressed in the standard units of the analyzer, because the enlargement may vary from one series of film recordings to another. In each graph, however, there are two scales which refer to the original.

The frames are numbered progressively starting with the first in which the eye is sufficiently open. This number is put, in the graphs, beside the corresponding point which represents the position of the center of the pupil.

The movement of the eyeball is usually constituted of a suite of large movements mixed with small swings around a point of arrest. In the graphs are diagrammed only the movements of the first type. The position of these points of arrest can be found on the graph observing that it falls where two contiguous points have a number of frame not immediately subsequent.

Accuracy in the determination of the coordinates of the center of the pupil is ± 10 standard units of the analyzer, which correspond in these two series of recordings to ± 0.025 mm. The problem of the accuracy in determining the position of the center of the pupil was extensively treated in (Beltrame et al., 1965b).

For technical reasons the observation of the cards necessitated a certain elevation of the gaze. This elevation was compensated for by a frontwards inclination of the board on which the card was fixed. Tab. II shows the distances that were used for the two subjects.

For the situations to be observed the same eight preparations of colors were employed. From now on we will designate them by the numbers from 0 to 7; 0 is assigned to black and the other numbers designate progressively lighter shades of gray and finally white. Tab. I describes, employing this conventional numeration, the eight two-dimensional situations used in the experiment.

In Figg. 2-9 the graphs are presented that recorded the eyeball movements in the experiment.

Discussion of the results.

We must premise to the analysis of the results some considerations about: (i) the correlation between the graphs of the movements and the configuration of the observed situations, and (ii) the individual differences between subjects.

Earlier experiments have shown us in fact how the closing of the eyes lids, even in blinking, causes a displacement of the position of the center of the pupil observed on the frame, though the subject, before and after the closing of the eyelids, looks at the same point. It is thought that this is due to differences in the quantity and disposition of the lacrimal fluid, but the influence of other factors is not excluded.

The correlation between the situation observed and the graphs of the eyeball movements must hence be gotten from the analogy between the form of the graph and the configuration of the

situation given to be observed.

The problem of individual differences in the execution of the same task has been mentioned also in (Beltrame, 1966). In Figg. 11-12 we give a sample of the differences encountered in the subjects of our experiment. The task consisted in going over, successively and in the order indicated, five points disposed as in Fig. 10, pausing briefly at each point. For the whole series of these results, see (Beltrame, 1967). Therefore it is clear that we cannot ignore these differences in judging the agreement of the results of our experiment.

The graphs in Figg. 2-9 can be explained rather well by bringing in:

- the entity of differences of color between spots and background;
- the nearness;
- a different weight of the left part and the right part of the card.

From the whole set of graphs we also get indirect information on the meaning of a point of rest, in central position with respect to the three spots, which may be noted in many graphs.

The position corresponds rather well to the barycenter of the differences in luminosity between spots and background; furthermore the point of rest tends to lack when the maximum difference in luminosity is in the spot at the top and this difference is rather relevant with respect to that of the other two spots, as in Situation 8.

We infer that there is a preliminary operation of centering on the whole configuration in which a right-left balancing seems to have greater weight than a top-bottom balancing.

The entity of the color differences between spot and background is the factor which in these experiments is decisive in recalling the attention; and it is more so in the first than in the second subject. In the second subject in fact we have deviations from this criterion in Situations 3, 6, 8.

In Situation 3 an ordered left to right exploration prevails; but the central point of rest, little displaced towards the right, indicates an initial hold of the spot at the right.

Situations 6 and 8 show a prevalence of the the spot at the left over that at the right when slight differences of luminosity between spot and background are in play.

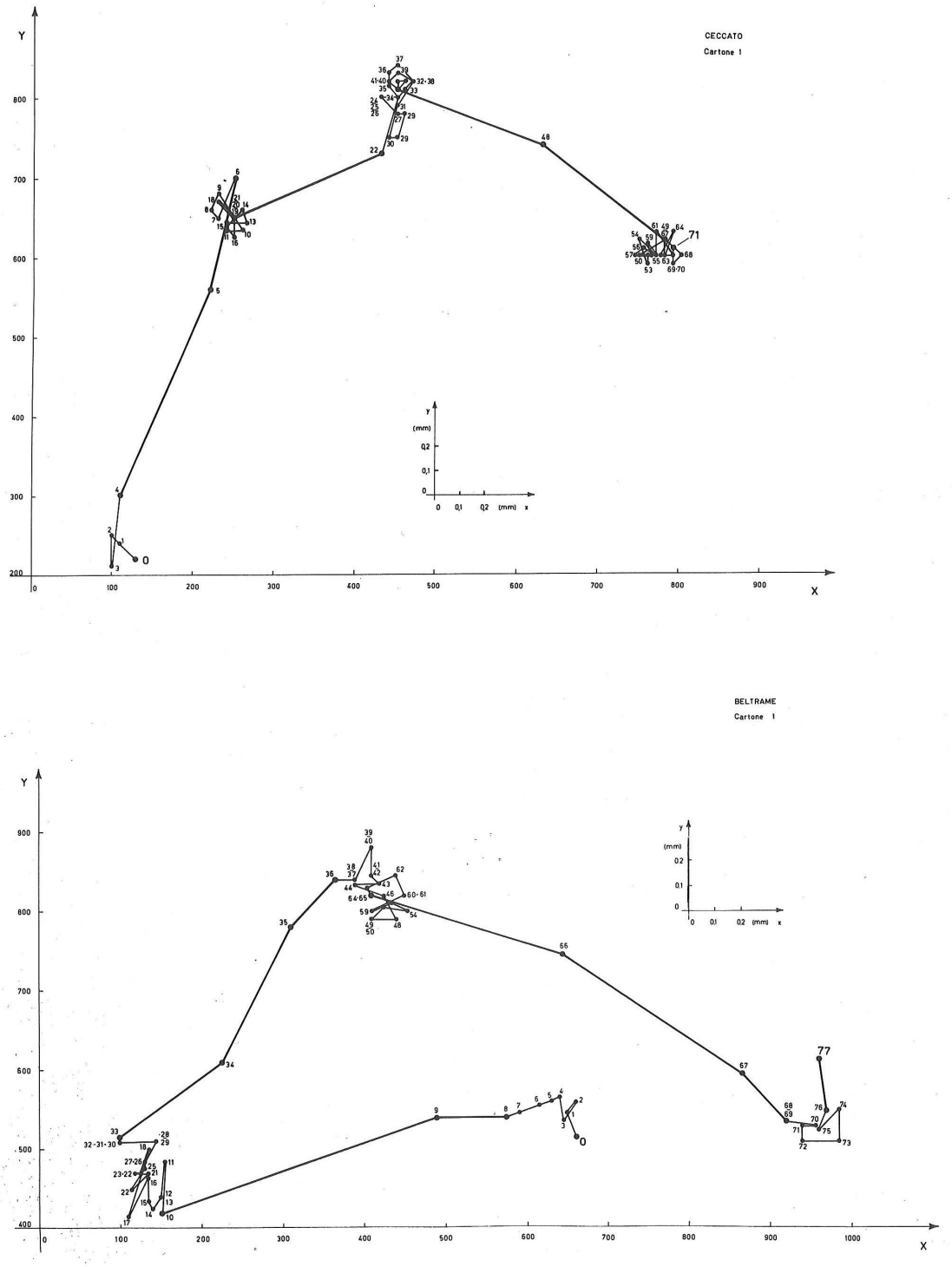


Fig. 2 (Situation 1)

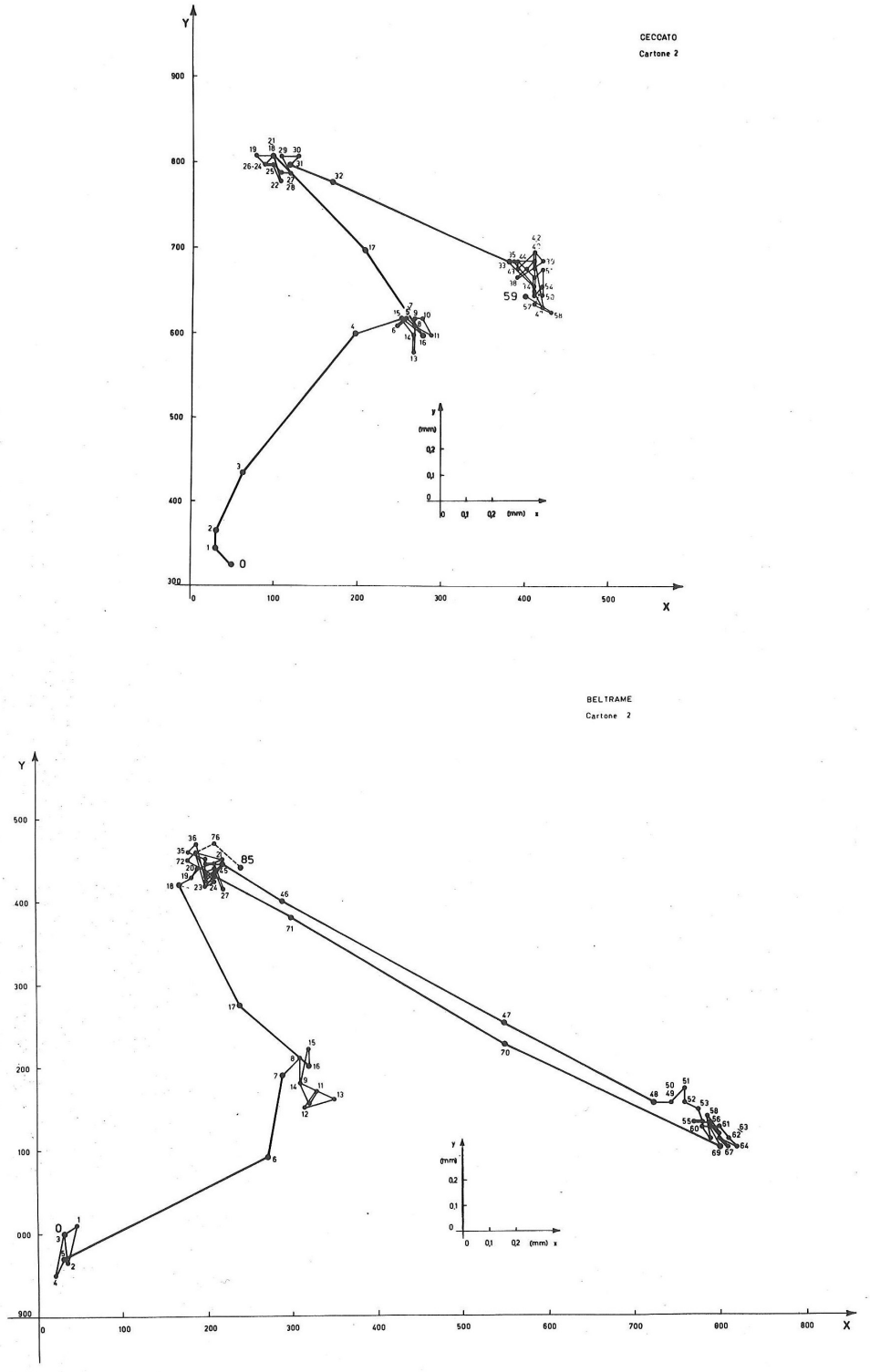


Fig. 3 (Situation 2)

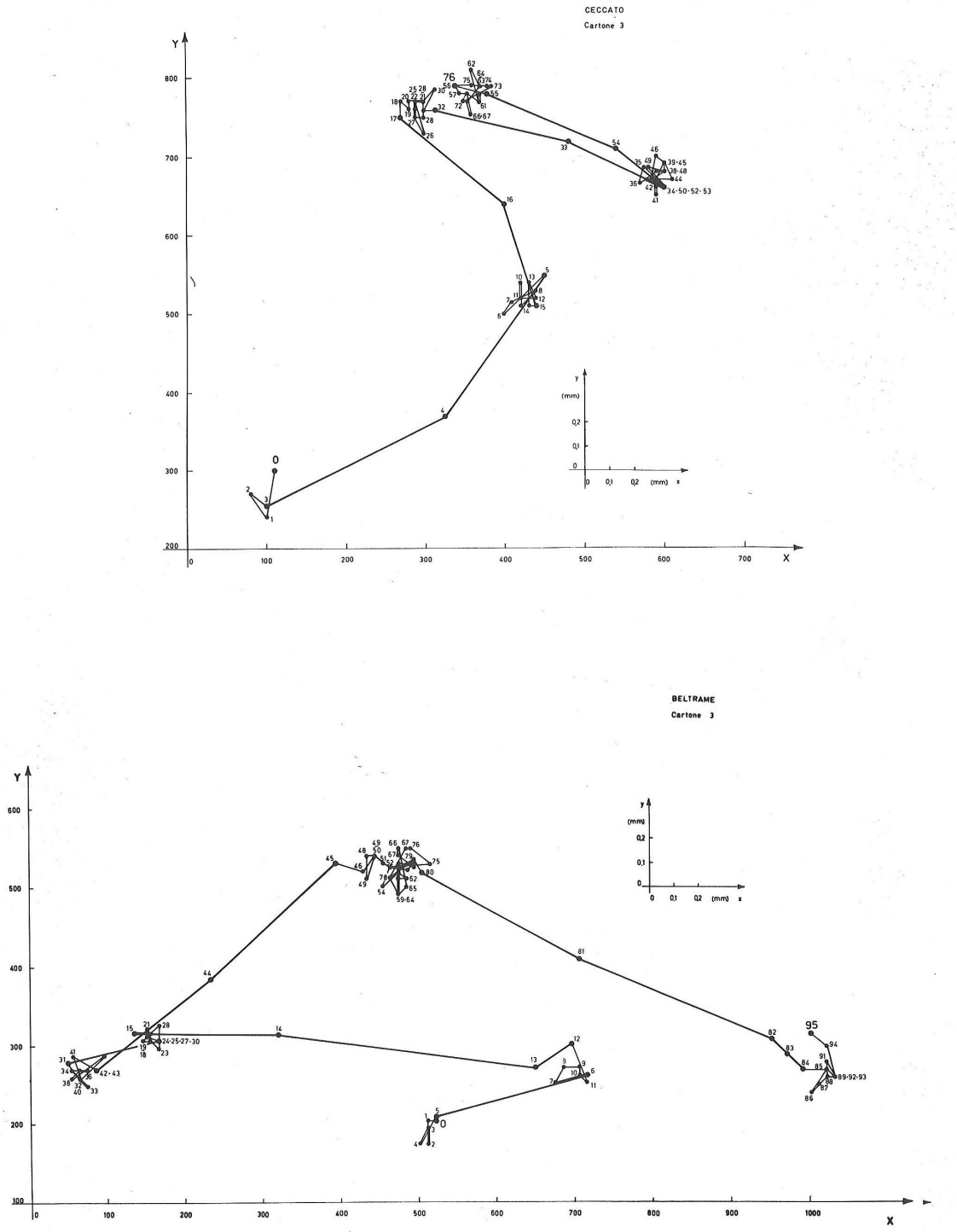


Fig. 4 (Situation 3)

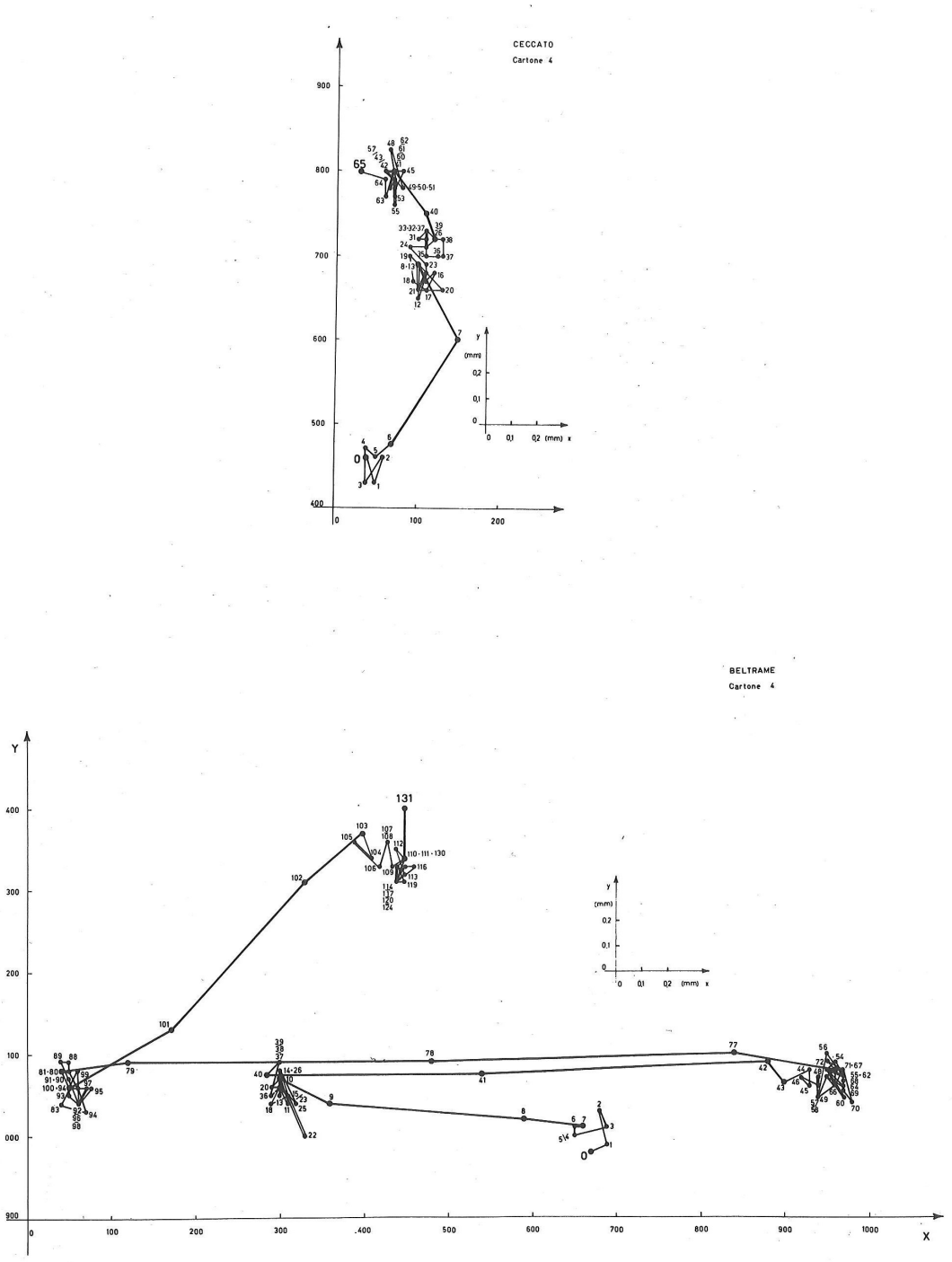


Fig. 5 (Situation 4)

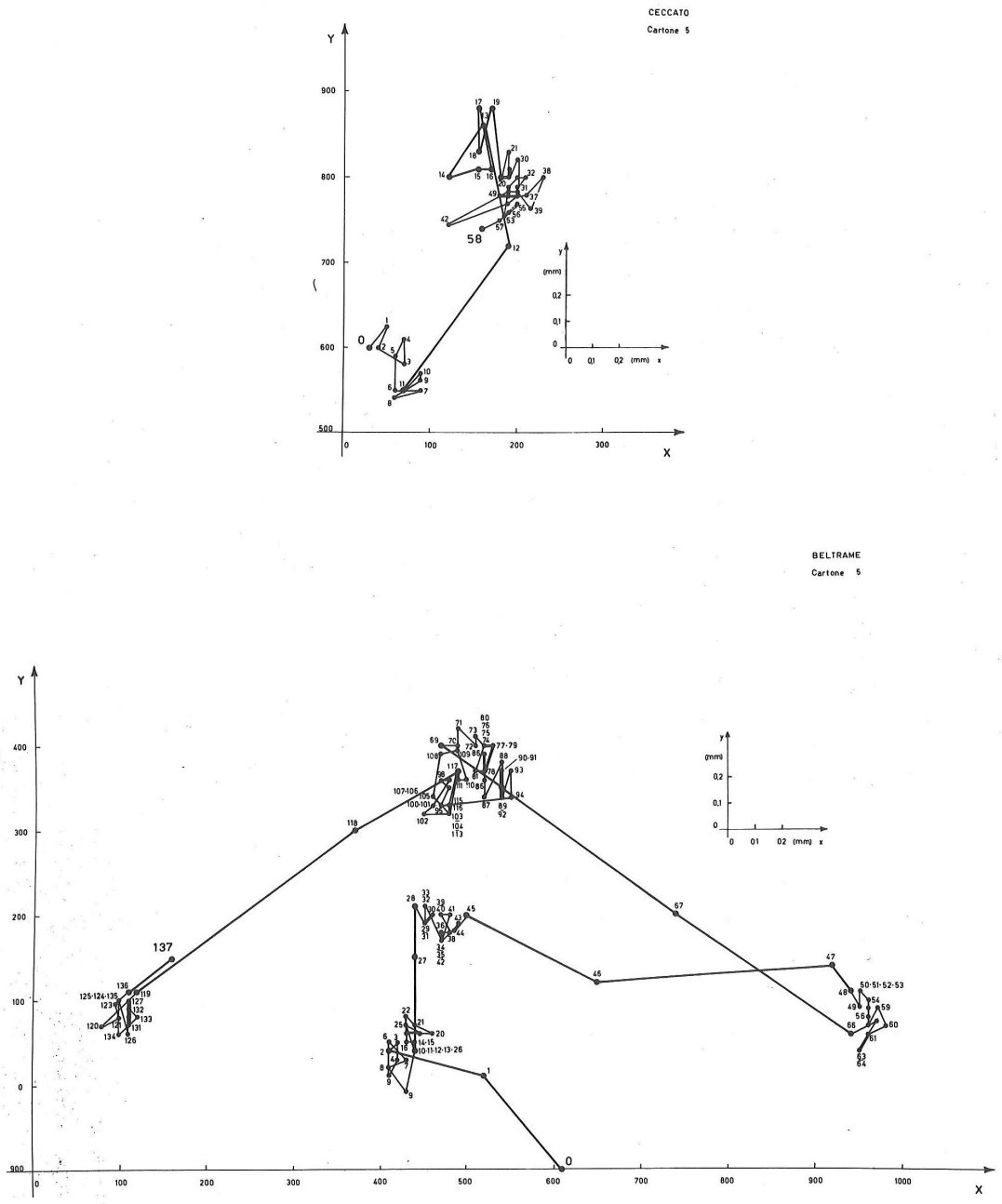


Fig. 6 (Situation 5)

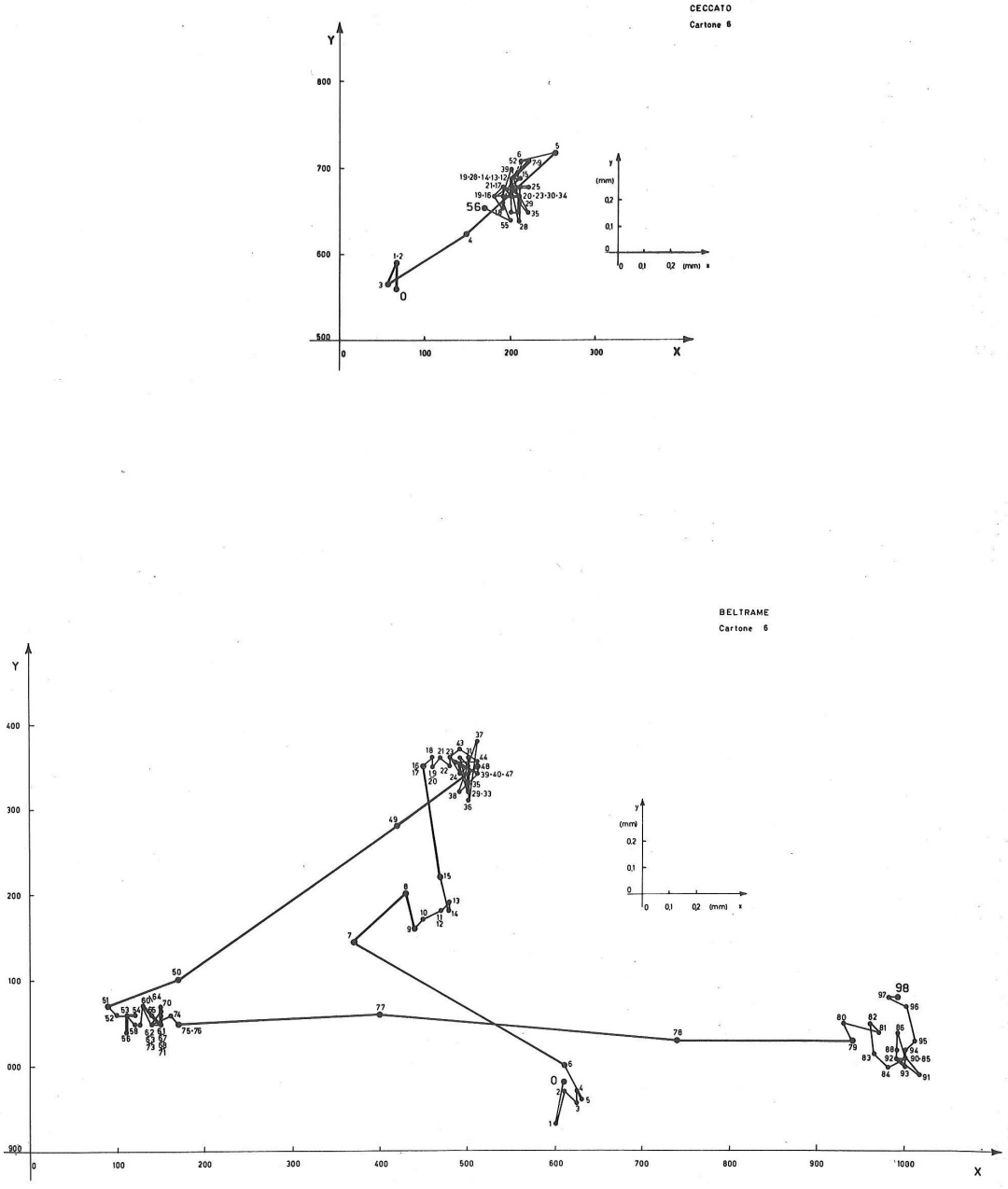


Fig. 7 (Situation 6)

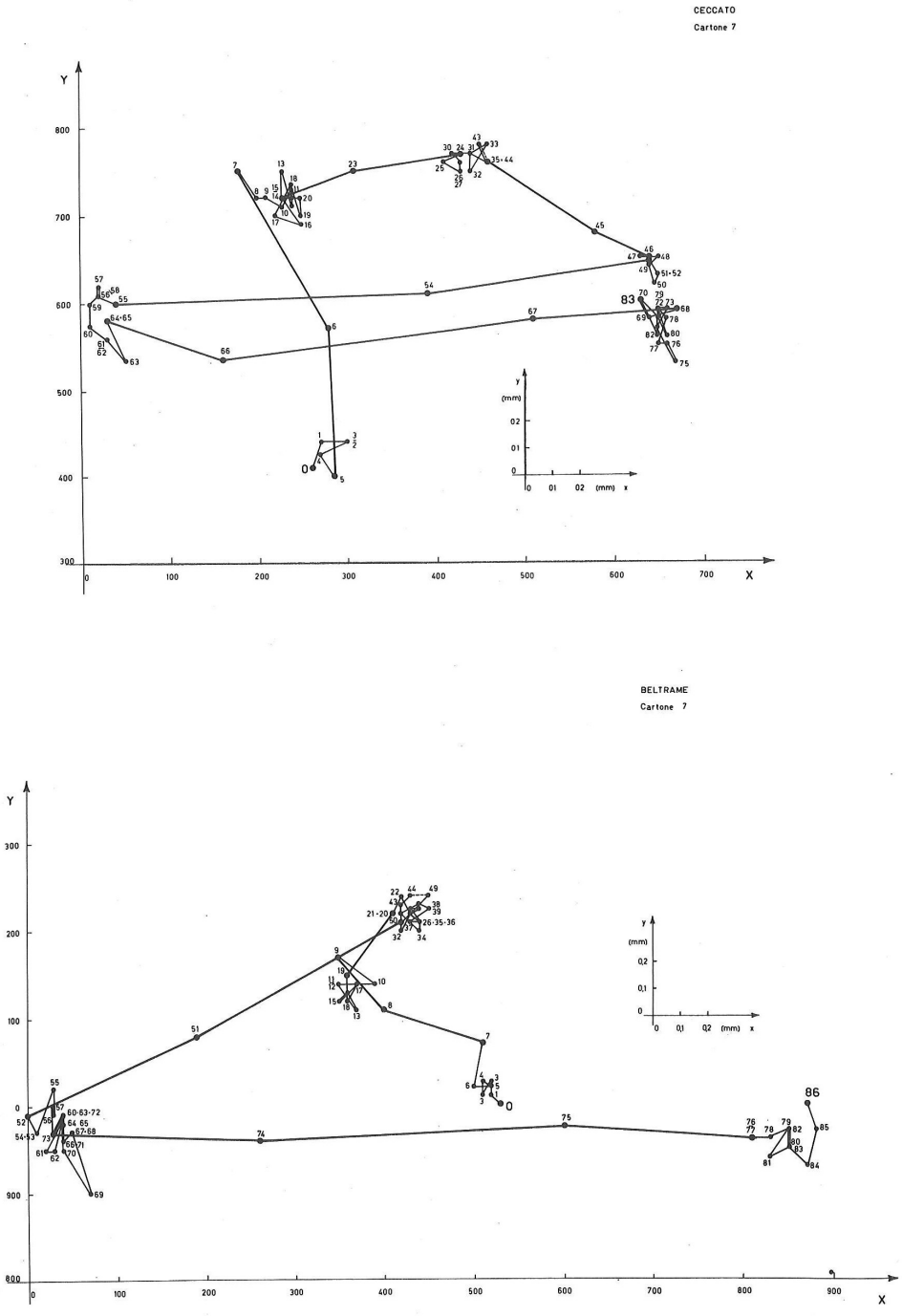


Fig. 8 (Situation 7)

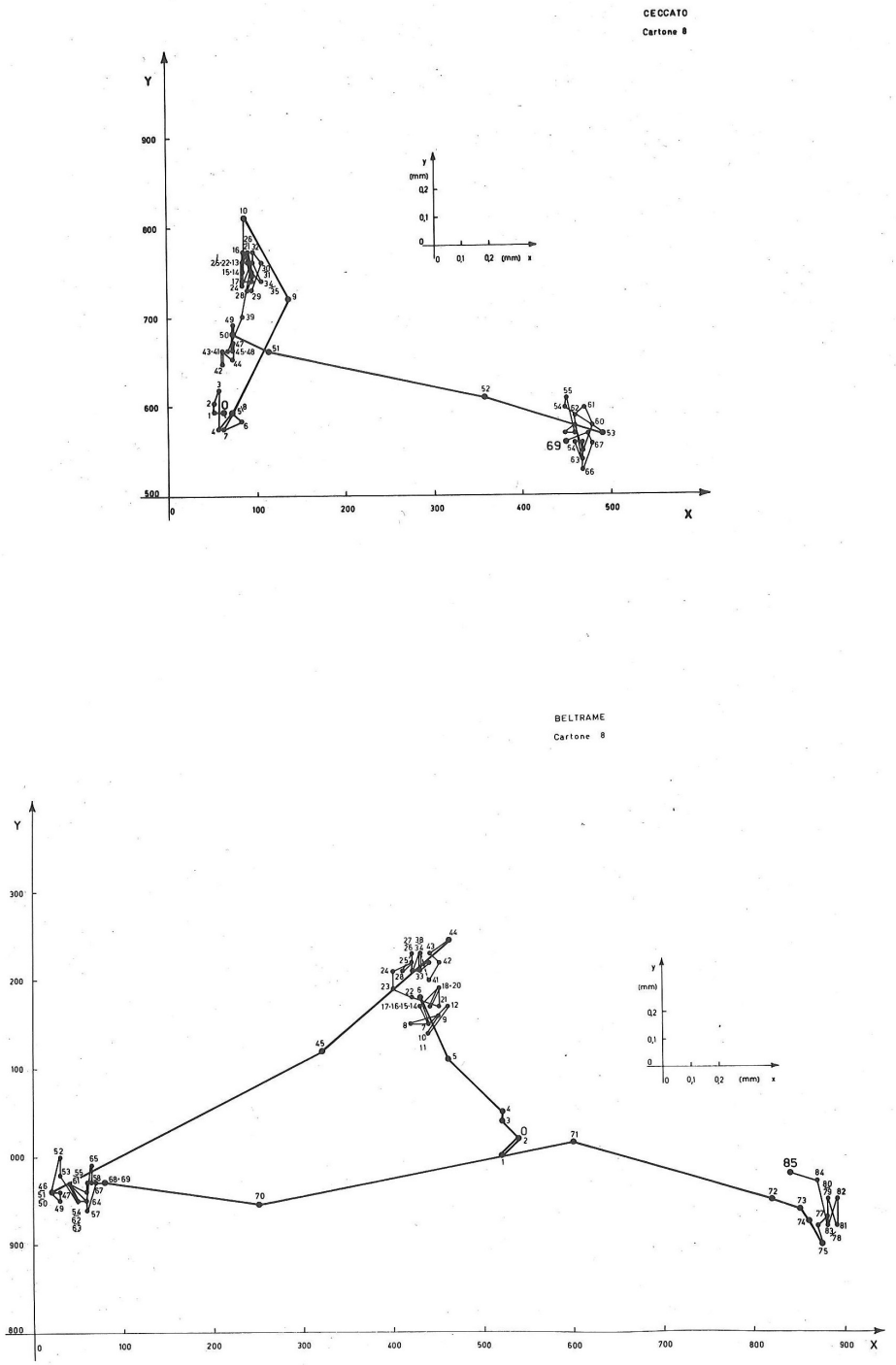
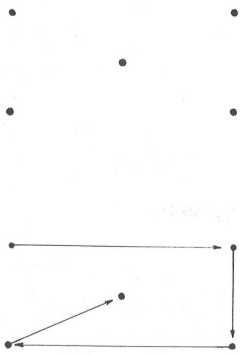
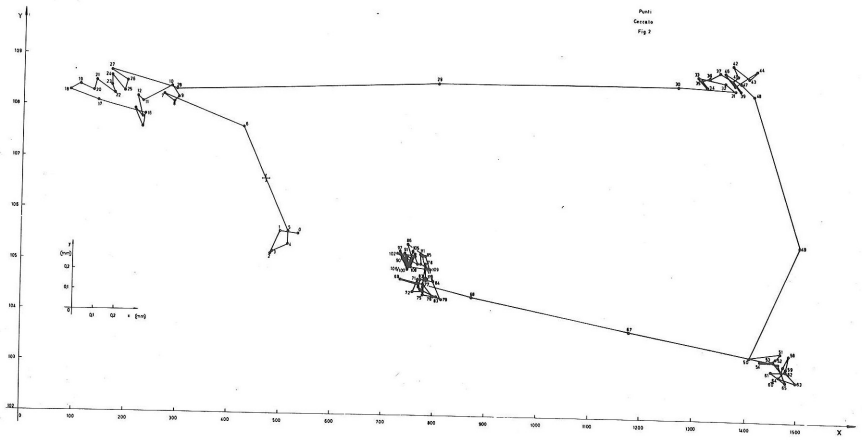


Fig. 9 (Situation 8)



(the order of scanning)

Fig. 10



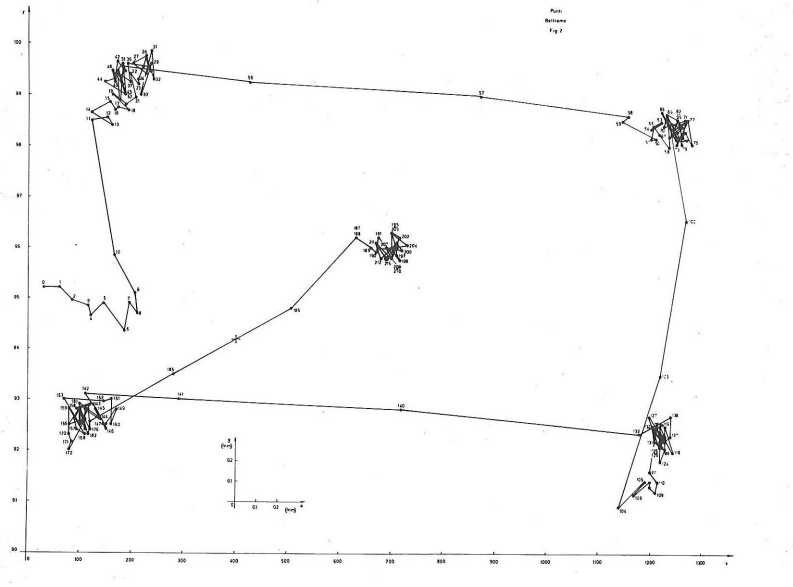


Fig. 11

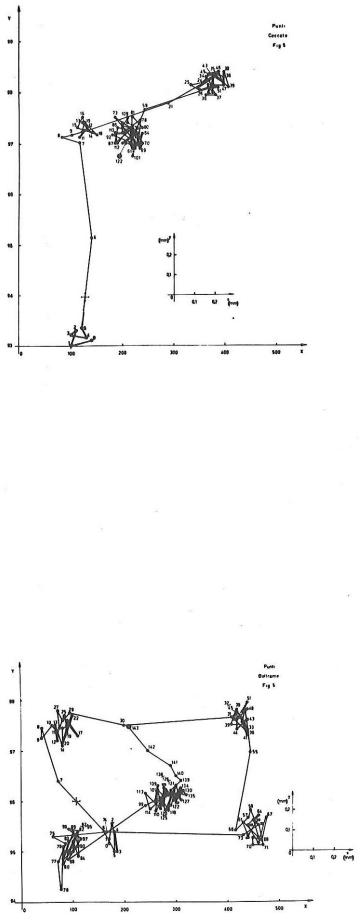


Fig. 12

Tab I - Conventional description of the situations proposed for observation

Situation	Background	Left Spot	Right Spot	Top Spot
1	3	7	1	0
2	0	1	3	2
3	5	7	0	2
4	1	6	7	3
5	7	1	0	6
6	4	3	2	7
7	2	4	3	5
8	6	5	4	2

Tab II - Distances of observation

Subject	A cm	B cm
1	98	50
2	76	42

Tab III - Equipment and filming data

Locality	Ist. Cinematografia Scientifica - Politecnico di Milano - 1967
Object filmed	Right eyeball
color	natural
preparation	none
Camera	Paillard Bolex 16mm Reflex
Objective	Kodak Cine Ektanon Lens 102 mm f/2.7, con allungo 27 mm
Diaphragm	
calculated	f/6.5
employed	f/5.6
Filming speed	64 frame/sec
Photometry	
type	Weston
method	reflection on cardboard Gray-Kodak
Film	Kodak negative for artificial light
type	Double X - 250 ASA
Developing	γ= 0.65-0.70
Picture Analyser	NAC 26 - Nissei Sangyo Co.

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