Ethology of *Idiops clarus* (Mello-Leitao) (Araneae: Ctenizidae). Experimental studies in digging behaviour.

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Introduction

Idiops clarus (Mello-Leitao) is a rare spider of the suborder *Therasomorphae* and has been found, so far, in two restricted areas of Uruguay near the South East coast (Maldonado, Sierra de las Animas and Florida, San Gabriel). This spider is usually recognised by its capacity for making vertical burrows in the ground. It is a nocturnal animal, with its peak of activity between 9.00 pm and 8.00 am; therefore specimens are not usually found outside their burrows during day-time.

The burrow and its door are valuable tools in the ethological study of the species because variations in their construction are brought about by experimental changes imposed on the animal.

This paper reports experimental studies on the digging behaviour of *Idiops clarus.*

Materials and methods

Experimental animals were collected in Maldonado, Sierra de las Animas, and determination made by comparison with specimens studied by R. Schiapelly and B. G. de Pikelin. Five adult females (Fig. 1) were maintained in captivity at a promedial temperature of 20-23°C, relative humidity of 70% and day-length of 11 to 12 hours natural light. At four day intervals, one fly (*M.domestica*) was given to each spider and water was provided by means of a humid chamber. Most of the experiments were made between May and October 1971.

Each experiment included two animals and was usually repeated five times.

Because our object was to study the digging behaviour of *Idiops clarus*, it was necessary to construct an artificial soil suitable for the experiments. The standard procedure for making such artificial soil was as follows:

1. Clayey earth was put into a polythene bag 30 cm long and 10 cm wide, only half of the bag being filled with earth.
2. Water was added to form a compact mud block.

Two variations of this basic procedure were used in the experiments. When the experiments dealt with the commencement of burrow construction, the polythene bag was removed, and the mud block and spider both placed in a spacious glass container. For studying the reactions of the animal within naturally made burrows, a thin layer (1 cm thick) of loose earth was added on the surface of the mud block (it is important to emphasise that this layer must be made of non-compact loose earth, because this kind of surface triggers the spider digging behaviour). The spider was then put into the polythene bag, and 48 hours after the spider finished the burrow in the normal position; the polythene bag was then removed as described above.

In all cases the mud block was firm enough to stand alone, thus allowing different spatial orientations of the artificial soil surface.

The term *finished burrow* as used in this paper, necessarily implies a burrow covered by a trap-door.

Observations

A. *Experimental changes of the ground orientation. The burrow initiation.*

Two different situations were experimentally explored; (a) the capacity of the spider for making burrows when the surface of the ground lies at 90° to the horizontal plane and, (b) the capacity of the animal for digging and making its burrow against the force of gravity (from down up-wards).

In the first case the animal and the mud block were both put into a spacious container as described earlier. After some hours for adaptation, the spider dug a horizontal burrow and finished it with a typical trap-door (Fig. 2A). The digging behaviour was in this case entirely normal. As mentioned above, the compactness of the soil is an important factor which influences the initiation of digging behaviour (a hard resistant surface inhibits the digging capacity). Fig. 2A shows that in this particular case the loose layer of earth covered the front vertical surface of the mud block. Despite the frequent wandering movements of the spider all over the available block surfaces, the animal always initiated the burrow from the side covered by a non-compact material.

In the second case, the mud block was supported on three pieces of cork, leaving a space of 5 mm between the floor of the container and the under surface of the block. This arrangement offers the animal an opportunity to begin a burrow from underneath upwards. However, the results were always negative. Although the spider can easily reach the lower block surface, it never begins a burrow from this side. On the contrary, an imperfect silk tube was made outside the mud block (Fig. 2B).

B. *Reactions of the spiders within naturally made burrows.*

1. Reactions elicited by changes in the spatial orientation of the burrow and spider.

As stated, the normal natural tendency of this species is to dig a burrow following the direction of the force of gravity. Using the mud block technique it is possible to study the reactions of the animal to changes in the spatial orientation of natural pre-made burrows.

As soon as the spider had finished its burrow the mud block was rotated 90°, the final position being shown in Fig. 2C. After rotation, the animal lies within a horizontal burrow with its door in a lateral position. This new situation does not induce important changes in the spider behaviour. It was noticed however, that the spider now took up its resting position in the medial portion of the burrow (normally it lies close to the trap-door). It is important to emphasise that modifications have not been observed either in the main characteristics of the burrow or in the trap-door position (Fig. 2C).

If a natural burrow with the spider inside is rotated 180° (Fig. 2D), three important changes occur.

(a) The animal digs a small recess from the terminal portion of the main cavity towards the lateral wall of the mud block (Fig. 2D).

(b) This lateral recess is immediately occupied by the spider. The new position of the animal prevents it from controlling the trap-door although this is essential for its survival.

(c) If the animal leaves the burrow it does not enter it again.

2. Reactions elicited by making additional artificial openings in the burrow.

Interesting reactions of *Idiops clarus* can be elicited by rotating the mud blocks and making additional openings in normally made burrows.

If, for example, a burrow is rotated 90° and a new aperture is made as shown in Fig. 2E, the spider makes a second trap-door. But when a hole is drilled, communicating the lateral wall of the mud block with a horizontal burrow (Fig. 2F) the animal's response is to block up the artificial opening with mud.

Finally, if the burrow and the spider are rotated 180° and an artifical opening is made in the upper surface (Fig. 2G) of the mud block, the animal makes a second trap-door covering the new aperture. This second door is the one maintained under the spider's control. In some instances the second trap-door was experimentally destroyed and the opening was blocked with mud. In such cases the spider re-opened the upper portion of the burrow and a new trap-door was made.

Discussion

The ethology of the species pertaining to the family Ctenizidae is still incompletely known. So far the main lines of the investigations have been restricted to the taxonomy and the ecology of the group and no references have been found dealing with experimental studies on burrow construction.

Gerstch (1949) made some comments concerning the possible biological significance of the burrow in the spider's life. However, his statements seem to be deductions based on observations in natural conditions, without any kind of experimental test.

The studies reported here have shown that the normal behaviour of *Idiops clarus* is to make vertical burrows in the ground ("*positive geotropism*"). However, this species is sufficiently adaptable to dig horizontal burrows if the surface with loose earth forms an angle of 90° to the horizontal plane. This means that for *Idiops clarus* the presence of a loose, non-compact layer on the ground is a stimulus of major importance for eliciting the digging behaviour.

The second point which merits comment concerns the artificial re-activation of certain components of the digging behaviour (including the trap-door constructions). Our experiments proved that the complex mechanism involved in burrow construction is potentially active for a long period during the spider's life. The 180° rotation of spiders within their

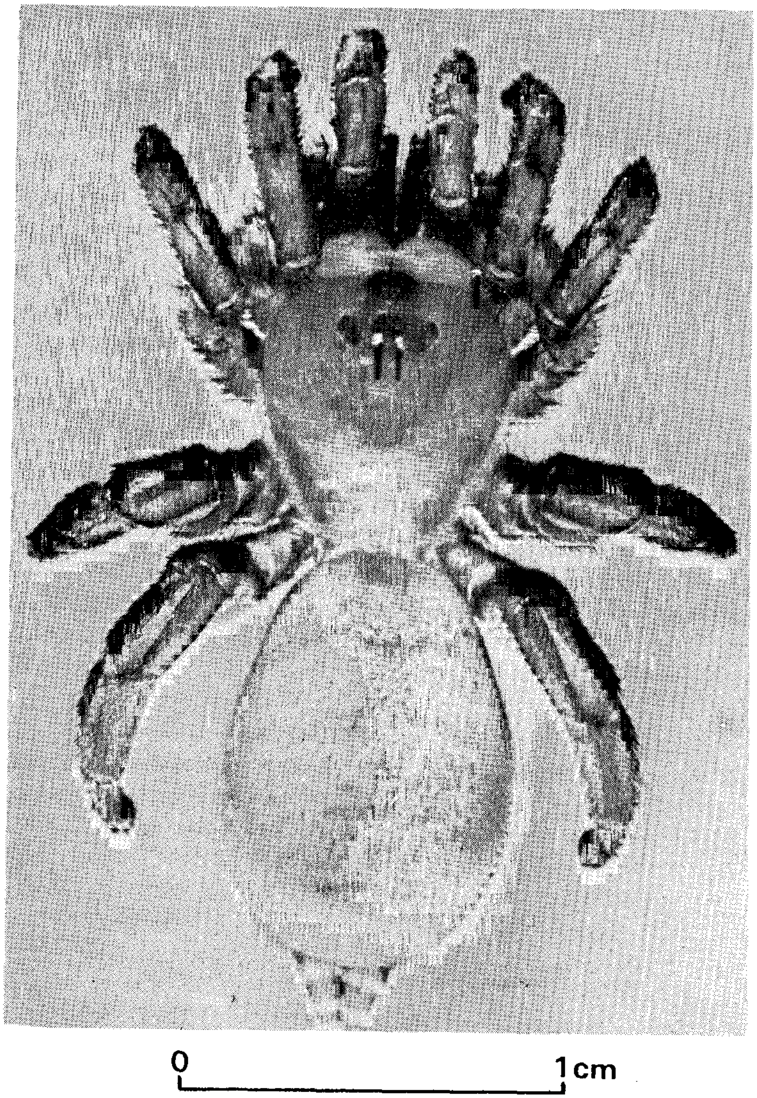

Fig. 1: Adult female *Idiops clarus* (Mello-Leitao)

burrows re-activates some steps of the digging behaviour. As described above, the animal digs a lateral extension from the main burrow. This suggests that the spider cannot withstand the abnormal position imposed by a 180° rotation. Furthermore, if the animal leaves a burrow rotated 180° it does not return to it.

Other examples of re-activation of the digging behaviour are provided by the construction of additional trap-doors when specimens of *Idiops clarus* are stimulated by the presence of artificial openings in their burrows. Usually the door construction is the final step of the digging behaviour, nevertheless, new trap-doors will be made if the animal is re-activated by an adequate stimulus.

Acknowledgements

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References

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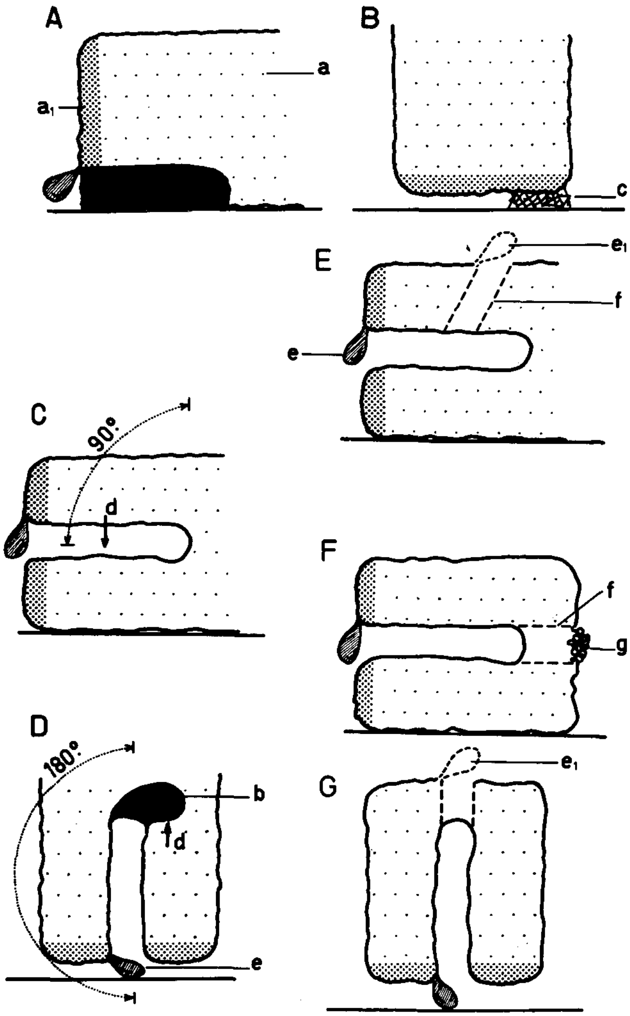

Fig. 2: Schematic diagram of mudblock (a), showing different experimental tests.

A If the loose non-compact layer (stippled area a_1) lies at 90° to the horizontal plane, the spider makes a horizontal burrow.

B The non-compact surface is now separated from the floor of the container by a narrow space. Although the spider can easily reach the most favourable surface it never makes a burrow. A silk tube (c) is consistently made outside the mud block.

C After a 90° rotation, the burrow does not exhibit any kind of modification, but the animal occupies the position indicated by the arrow (d). Normally the spider lies near the proximal extremity of the burrow controlling the trap-door.

D If the mud block is rotated 180° the spider digs a small lateral recess. Such recess (b) is occupied by the spider (arrow (d)), and the trap-door (e) is no longer under the control of the animal.

E When a hole (f) communicating the upper surface of a rotated mud block is drilled, the spider makes a new trap-door (e_1).

F If a hole is drilled communicating the burrow with the posterior lateral wall of the mud block, the spider does not make a new trap-door. It merely blocks the new aperture with mud (g).

G A hole was drilled communicating the upper surface of the mud block with the end of a normal burrow. The new opening was covered with a trap-door. This second door is then controlled by the spider which also uses the artificial opening.