of 1000 ml used at the rate of 50 ml/min, the central nervous system could be supplied from internal stores for 20 minutes without external oxygen source. And, indeed, the upper limit of diving time in this animal is approximately 20 minutes (*6*).

This finding suggests that the primary adaptive mechanism permitting prolonged diving is selective arterial constriction, that it operates to conserve available oxygen stores for cerebral metabolism, and that once oxygen stores are depleted, diving must cease or death will occur.

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Courtship in Spiders without Prior Sperm Induction

Abstract. *Experiments with a lycosid spider demonstrated that courtship behavior is displayed by males independently of whether sperm induction had occurred following the final molt. Contrary to earlier suggestions, proprioceptive feedback from sperm-filled palps is not essential for the onset of reproductive display.*

Studies of the ontogenesis of courtship display in the wolf spider *Lycosa rabida* Walckenaer showed that such behavior appeared 5 to 6 days after the final molt in normal males and in males that were not allowed to fill their palps with sperm.

Copulation in all spiders (class Arachnida, order Araneae) involves insertion by the male of sperm-filled palps into the genital opening of the female. A number of days after the final molt, a small sheet-like web is constructed by the male, and seminal fluid is deposited upon the upper surface. Male *L. rabida*, standing above the web, bend the palps in alternation beneath the sternum and press them against the lower surface of the web to absorb the seminal fluid through the web fibers (*1*). This act of filling the palps with sperm, which Montgomery (*2*) called "sperm induction," obviously must precede copulation if fertilization of the female is to result.

Petrunkevitch (*3*), referring to *Dugesiella hentzi*, said "My observations leave no room for doubt that a male with empty palpi does not court and avoids contact with the female." After observing reproductive behavior in numerous species, Gerhardt (*4*) concluded that this statement was true for all spiders. Both authors apparently based their assumptions on the fact that the male does not court when presented with a female during a variable period of time following the male's final molt. A tendency to display first appears at about the same age that sperm induction is observed to occur. On the basis of this correlation, Gerhardt (*4*) suggested that the readiness of a male to court depends on a sense of fullness in the palps; that is, that proprioceptive feedback by way of palpal nerves is a prerequisite for courtship behavior in spiders.

Later authors (*5*, *6*), when discussing the relation between sperm induction and courtship, have relied on the statements of Petrunkevitch and Gerhardt. Gering (*6*) suggested that the stimulus for sperm induction "seems to be instrumental in initiating the chain-reflex sequence that apparently constitutes the sexual biology of spiders." Heretofore, experimental approach to this problem has been lacking.

The relation of sperm induction to the onset of courtship was examined in *L. rabida*, a wolf spider abundant in grassy fields of the eastern half of the United States. The 55 individuals used in this study were collected in Maryland as immature instars during June and early July of 1964 and 1965. All animals were maintained in isolation and did not see conspecifics until they were tested. Penultimate males could be identified by their swollen palpal tarsi. A few days prior to molt, the body and leg coloration became darker, and such animals were checked frequently thereafter to find out when the final molt occurred. In this way it was possible to insure that sperm induction was not performed by males prior to any experimental treatment. When the spider drank molting fluid from the cast skin, an indication that molt was completed (*7*), the animal was treated. Two groups of males were treated during the penultimate instar stage to preclude the possibility of sperm induction.

Autotomy of the palps was induced by tying the tibiotarsal joint of both palps to one side of the cage while the animal was under carbon dioxide anesthesia. After recovery, the spider pulled away, removing the distal four segments (Fig. 1*a*). Melted paraffin was used to close the male genital pore, to seal and immobilize the spinnerets, or to fix the palps in a position dorsal to the cephalothorax (Fig. 1*b*). All animals were inspected before and after testing to insure that paraffin seals were intact. The temporal patterning of courtship in this species is not affected by palp autotomy (*8*).

Experimental males were divided into five groups of five animals each and one group (group F) of 10. Individuals of group A autotomized both palps during the penultimate instar; members of group B, also palpless as penultimate instars, in addition had their spinnerets sealed and immobilized with paraffin immediately after the final molt; and group C males autotomized their palps after the final molt. In group D the palps were fixed with paraffin dorsal to the cephalothorax; after the final molt, the spinnerets were sealed and immobilized in group E; and a seal was placed over the genital pore of males in group F as soon as molt was completed.

As a result of these treatments, members of groups A, B, and C lacked palps which could be filled with sperm; males in B and E were unable to construct sperm webs; and those in D could not place the palps in the proper position for sperm induction. Members of group F had empty palps because they could not release sperm from the genital pore; however, they were not prevented from performing the movements associated with sperm-web construction and sperm induction.

Two groups of ten males each served as controls. One group underwent no treatment; the other was subjected to carbon dioxide anesthesia immediately

after the final molt. A drop of paraffin was placed on the cephalothorax near the palps of five members of this group. Paraffin was placed beside the genital pore of the other five. The latter ten males served as controls for the effects of the anesthesia-paraffin treatments.

To determine the approximate onset of courtship, 26 of the experimental and all of the control animals were tested daily, beginning 1 day after the final molt. The remaining nine experimental animals were tested at 2 weeks after the final molt. For each test, the male was introduced to one side of a glass finger bowl, 19 cm in diameter, which was divided in half by a vertical glass partition. A moving female *L. rabida* on the other side of the partition provided a visual stimulus. All 35 experimental males displayed courtship typical for the species. The mean adult age at the onset of courtship (in days after molt) of the 26 experimental males tested daily was 5.9 ± 0.2 S.E. (range, 4 to 8). Onset in the 10 animals of the untreated control group was 5.3 days ± 0.4 S.E. after the final molt (range, 3 to 8); and the mean age at onset for the 10 treated control animals was 5.4 days ± 0.5 S.E. (range, 4 to 8). The differences between the experimental and the control groups, the latter taken either singly or together when compared with the experimental group in *t*-tests, were not significant at the 5-percent level.

These results indicate that the onset of courtship in this species does not depend on proprioceptive feedback from sperm-filled palps, as was suggested by Gerhardt (*4*). Since the experimental groups included spiders which could not perform movements associated with sperm-web construction, or sperm induction, or both, it also appears that the male need not carry out these acts prior to displaying courtship. Thus, there is no "chain-reflex sequence" (*6*) involved in the sexual biology of this spider. The reproductive behavior of the male probably is regulated instead by maturational changes in the gonads, or the central nervous system, or both. Such regulation of sexual behavior has been suggested for other arthropods (*9*).

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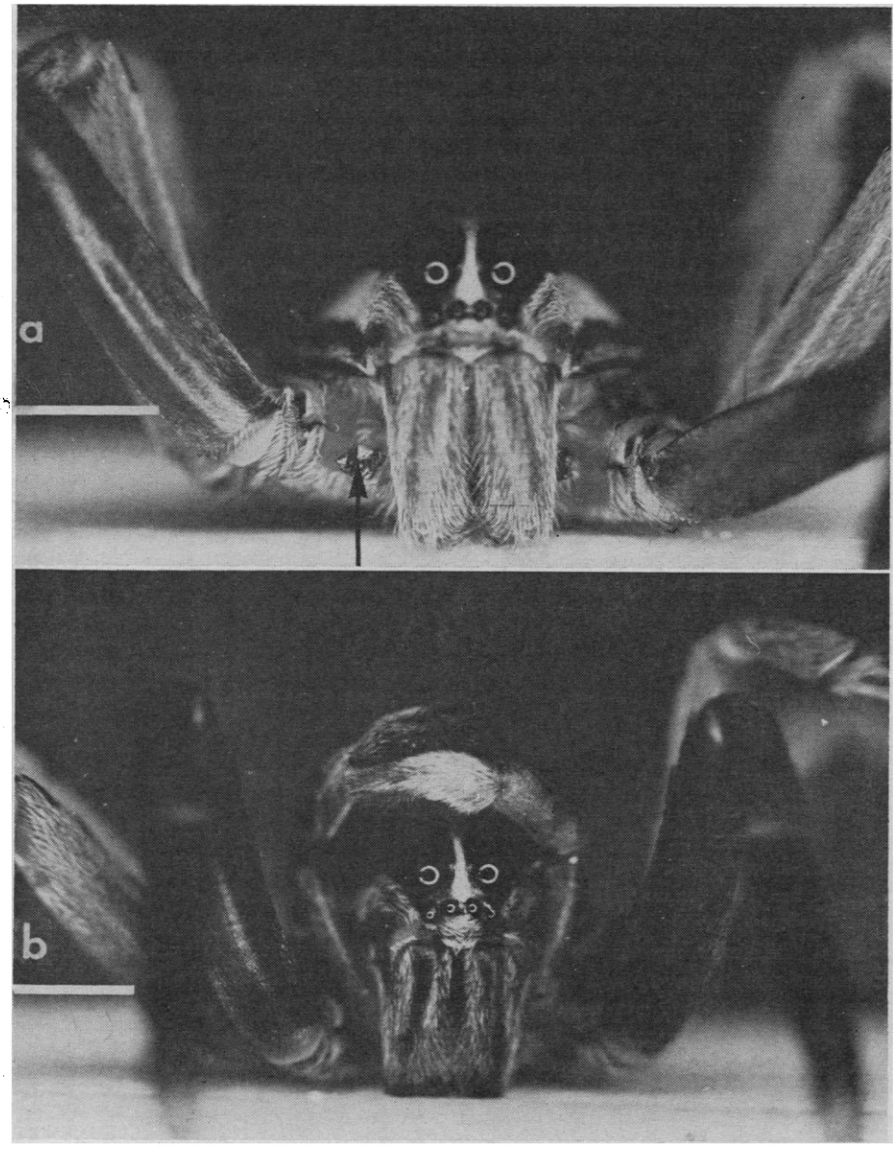

Fig. 1. Adult male *Lycosa rabida* treated immediately after molt to prevent sperm induction. (*a*) Male with autotomized palps. Courtship pattern of palpal movements persists in trochanter (arrow) and coxa of each palp. (*b*) Male with palps fixed dorsal to cephalothorax. Both spiders were photographed while under CO_2 anesthesia. Peculiar appearance of the eyes is due to reflection of the circular flash unit. Scale in both photographs is 2 mm.

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30 November 1965

Mohole: Preliminary Drilling

Plans are now well advanced for drilling to attain certain scientific objectives during the period of engineering tests of the Mohole drilling platform. The Mohole Advisory Committees of the National Academy of Sciences met with representatives of the National Science Foundation, sponsor of the project, and Brown and Root, the prime contractor, in Houston on 4 and 5 January.

The Mohole Advisory Committees recommended drilling four or more holes within a 160-km radius of lat.