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# Courtship and Spermatophore of *Plethodon jordani metcalfi*

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ASIDE from one note on incomplete courtship (Green and Richmond, 1944), nothing has appeared in print concerning the courtship of any member of the *Plethodon jordani* group. The following information is based on five field observations and twelve observations on captive *Plethodon jordani metcalfi*. At no time were the specimens under observation treated with drugs or hormones. All observations were carried out on the north facing side of Whitetop mountain, Smyth County, Virginia, during the summer of 1957.

I am indebted to Nelson G. Hairston of the University of Michigan Department of Zoology and Charles F. Walker of the University of Michigan Museum of Zoology for reading the manuscript and to my wife for her assistance in the field.

## COURTSHIP

In general, the courtship of *P. j. metcalfi* follows the pattern described by Noble and Brady (1930) for plethodontid salamanders. Furthermore, the pattern observed in the field was found to correspond rather closely to that displayed by captive specimens. A generalized courtship pattern for *P. j. metcalfi* appears in Figures 1 and 2. These figures represent the more usual positions assumed during courtship and were drawn from numerous field sketches. The figures do not, however, include the many variations as observed in the details of courtship.

The male usually approaches the female and executes a series of nosing movements using his snout and nasolabial grooves. The male then places his mental gland and nasolabial grooves in contact with the side, back, or more often the tail of the female and executes a "foot dance" in which the limbs are raised and lowered (Figs. 1a and 1b). After contact is established between the chin of the male and the integument of the female, the male slowly moves towards the female's head (Fig. 1c). While moving forward along her body, the male occasionally raises his head slowly. As the adhesion between his mental gland and her skin breaks, the male's head snaps upward. He then lowers his head and reestablishes contact with the skin of the female. Having reached the head of the female, the male proceeds to press his mental gland and nasolabial grooves between her eyes and over her nasolabial grooves (Figs. 1d and 1e). The male next circles under the female's chin and laterally undulates his tail as it passes beneath her chin (Fig. 1f). The female places her chin on his tail and moves forward to its base with her limbs astride his tail (Fig. 2g). The two then engage in a tail-walk during which the female maintains her position at the base of the male's tail (Fig. 2h). Should the female slip back towards the tip of his tail, the male stops moving forward but continues to undulate his tail while she regains her position. The male finally stops moving forward and begins a series of lateral sacral rocking motions. The female, which has been relatively passive to this point, now begins a series of lateral head movements in synchronization with but counter to the lateral sacral movements of the male (Figs. 2i and 2j). This latter behavior is identical to that described by Stebbins (1949) for *Ensatina eschscholtzii*. The male then presses his vent to the substratum and deposits a spermatophore. Immediately after deposition, he arches the base of his tail upward slightly (Fig. 2k) and both he and the female move forward and stop when the vent of the female is over the spermatophore (Fig. 2l). The female lowers her sacral region and picks up the sperm cap with her cloacal lips. The entire jelly stalk of the spermatophore is left adhering to the substratum. The pair may continue to court for a few minutes and then separate.

The physical conditions under which courtship occurred in the field are given in Table I. Time is expressed throughout this paper as eastern standard time.

Much of the variation observed in the courtship of *P. j. metcalfi* was due to differences in the position assumed by the male during courtship and spermatophore deposition. On August 3, a courting pair was observed on top of a spruce branch which was lying on the forest floor. Just prior to deposition of the spermatophore, the male bent his tail sharply to the left and curved it downward along the curvature of the branch.

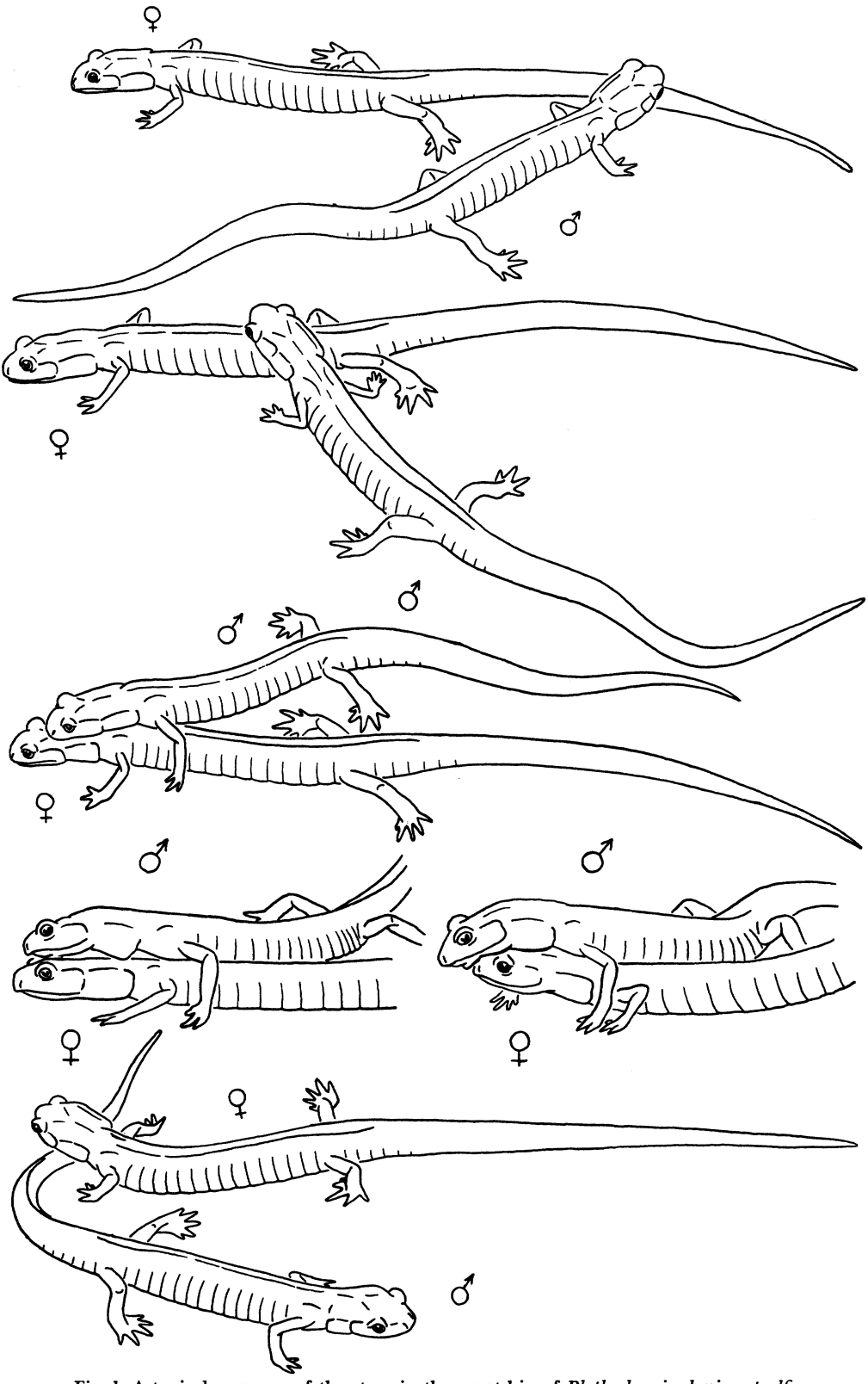

Fig. 1. A typical sequence of the steps in the courtship of *Plethodon jordani metcalfi*.

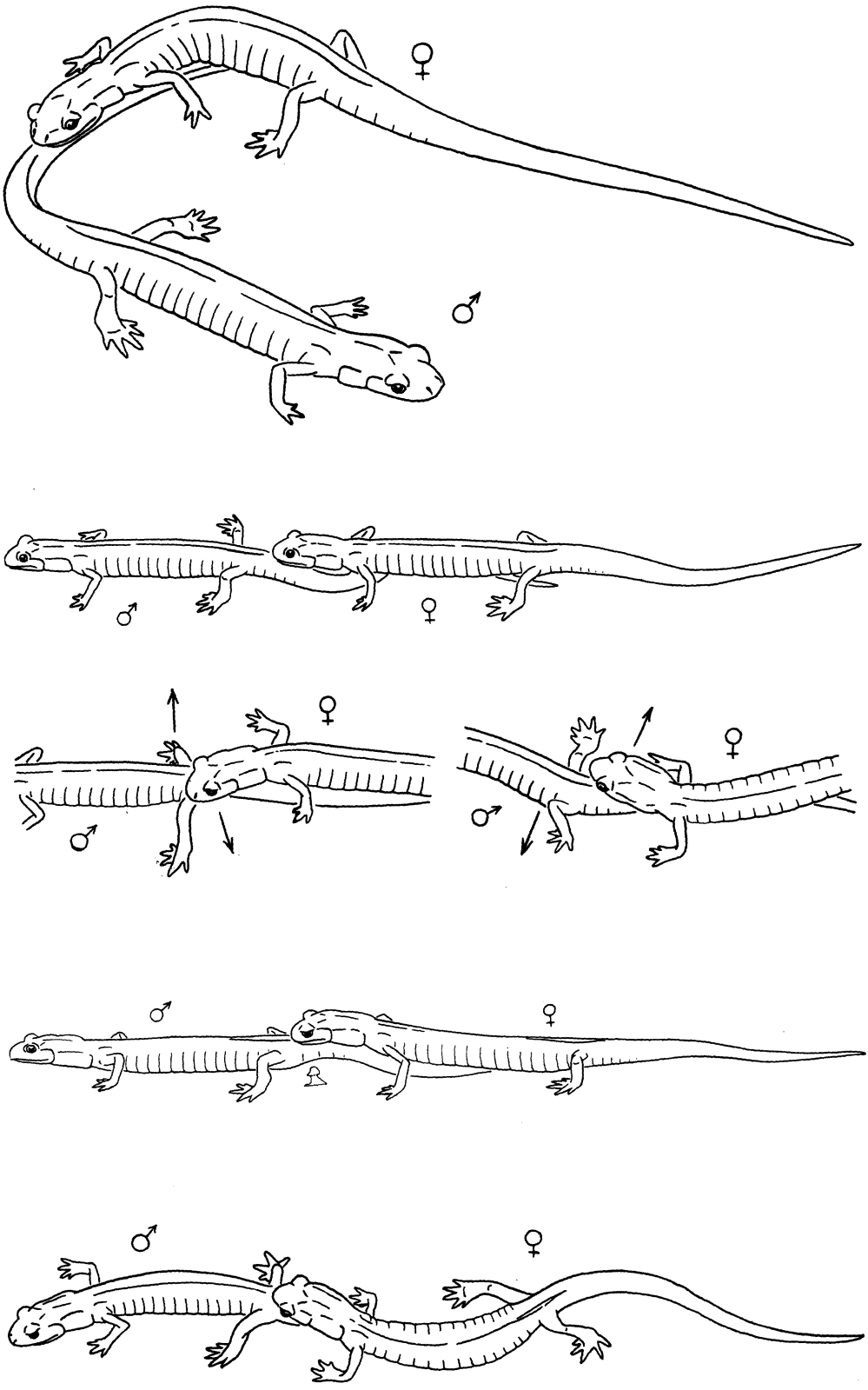


Fig. 2. A typical sequence of the steps in the courtship of *Plethodon jordani metcalfi*.

In five other instances in which spermatophores were observed being deposited, the body and tail of the male remained oriented along a straight axis except for pelvic rocking motions and strong lateral tail undulations.

On August 15, a courting pair was seen on moss on the forest floor. The body of the male was sharply bent to the left in the form of a reversed "C" with his snout almost in contact with that of the female who had her chin pressed against the base of his tail. The male was executing pelvic rocking motions and the female was moving her head laterally in a direction counter to his pelvic movements. The more typical position at this stage of courtship is with the body and tail of both the male and female oriented along a longitudinal axis.

On August 5, 9, 11, 12, and 13, incomplete courtships were observed on captive specimens. In each case, the female seemed reluctant to engage in a tail-walk. The behavior of the females involved was quite characteristic. Whenever the male maneuvered his body or tail into contact with the chin of the female, she raised her head quite high until contact with the male was broken. The male often returned to the female and reestablished contact with her chin but the contact was almost immediately broken again by the female when she raised her head.

The foot dance referred to early in this paper was quite characteristic of the earlier phases of courtship. Unlike *Ensatina eschscholtzii* (Stebbins, 1949), *P. j. metcalfi* engages in this type of limb movement before tail-walk. The raising and lowering of the limbs by the male produces little or no forward movement. The pattern, if there is any, varies from alternate lifting and lowering of all the limbs as though the male were "marking time" to the alternate raising and lowering of merely the hind limbs or the front limbs. On the evening of August 4, these movements were timed in a captive male. All four limbs were moving alternately and the timing was based on the movements of the left hind limb. This limb was raised and lowered as follows: 5 times in 22 seconds, 5 times in 17 seconds, and 17 times in 32 seconds. There was apparently no regular rhythm. The behavior can best be described as that of an animal trying to slowly free itself from a very sticky surface.

The lateral pelvic rocking and tail undulations of the male, however, do seem to have a definite rhythm. On August 5 these movements were timed in a captive male and were found to average one wave every 2.2 seconds. The frequency of these undulations did not vary but the amplitude of the undulations increased just prior to spermatophore deposition.

TABLE I

PHYSICAL CONDITIONS UNDER WHICH COURTSHIP OCCURRED IN THE FIELD

All observations were carried out on the north facing side of Whitetop mountain, Virginia, 1957.

| Date | Eastern Standard Time | Altitude in Feet | Temperature in °C | | Relative Humidity | | Light on Forest Floor |
|---|---|---|---|---|---|---|---|
| | | | Ground | Air | Ground | Air | |
| Aug. 3 | 11:40 PM | 5425 | 16.6 | 17.0 | — | 94% | Total Darkness |
| Aug. 15 | 9:25 PM | 5300 | 16.2 | 16.0 | 100% | 97% | Total Darkness |
| Aug. 19 | 7:45 PM | 3900 | 15.4 | 14.8 | 97% | 89% | After Dusk |
| Aug. 27 | 10:30 AM | 3800 | — | — | — | — | Daylight |

The frequency with which females failed to pick up spermatophores was somewhat surprising. Of a total of 13 spermatophores deposited by captive males, only 4 sperm caps were successfully removed and picked up by females. Five spermatophores were deposited while the salamanders were under observation and, of these, only one was successfully recovered by a female. In most instances, the female passed to one side or the other of the spermatophore. This low incidence of success may well have been due to the confined area of the 8 inch finger bowls in which the salamanders were maintained because the courting pair could not always move forward without turning somewhat.

In only one instance did a male display aggressive behavior during courtship. On August 9 at 10:45 PM, a male was actively courting a female who seemed very reluctant to engage in courtship. She often moved away from the male and tried to escape from the container. This particular female had been

in captivity since July 14 and was presumably accustomed to the container. The male followed her around the container and whenever he placed a part of his body or tail in contact with her chin, she immediately broke contact by raising her head. At 11:24 PM, the male bit her on the side of her head near the eye. She pulled her head back and no damage was observed. The male continued to court her until 1:00 AM on August 10 when he was transferred to another container with five females and three other males.

At 1:05 AM, the transferred male, in rapid succession, bit the tail of a female, the left front limb of a male, and the tail of still another male. The victims moved rapidly away and were apparently undamaged. At 1:08 AM, the transferred male began to court a female that had just molted her skin. The female, however, seemed more intent on trying to locate her shed skin. At 1:11 AM, the male broke off courtship and attacked a nearby stub-tailed male. He bit the tail of another male and returned to the stub-tailed individual. He clamped his jaws over the snout of the latter and both males rolled over twice rather rapidly. The stub-tailed male freed himself and the transferred male chased him around the container repeatedly biting him on the tail and sides. By 1:20 AM, the transferred male was courting a female but broke off courtship after ten minutes and attacked a nearby male biting him on the head twice. At 1:32 AM, the transferred male bit the tail of a female and two minutes later started to court another female. He left her and started to court a second female and then a third. Observations were terminated at 2:00 AM and when the container was again examined later that morning, no evidence of spermatophore deposition was found.

On August 27 at 10:30 AM, while collecting in a deciduous forest on the north facing side of Whitetop mountain, I found two salamanders courting under a log. The body and tail of each were straight and the female had her chin pressed against the base of the male's tail. They remained fixed in this position for a few seconds and then the female ran. The male did not attempt to escape and both were recovered. This is the only instance of diurnal courtship observed in the field; none of the captive specimens engaged in diurnal courtship.

When a courting pair was disturbed, in the field or in captivity, the female immediately tried to escape but the male did not.

### Spermatophore Deposition

Shortly after midnight on August 5, three complete spermatophores were removed from a container holding five females and four males. Later that morning, when the container was reexamined, two more jelly stalks were seen without sperm caps. Subsequent examination of the females in the container revealed that two of them had been inseminated and therefore that two successful courtships had occurred after observations were terminated earlier that morning at 2:00 AM. What is more significant, however, is that a total of five spermatophores or stalks were recovered from a container that held only four males. Thus, at least one male had deposited more than one spermatophore during the course of a single night.

Aside from normal spermatophore deposition during courtship with a female, spermatophores were observed to be deposited under various circumstances. On August 5 at 9:55 PM, upon turning on the light in the room containing the captive specimens, a male was observed pressed down against the moist paper toweling at the bottom of his container. His body and tail were straight and he was rocking his pelvis and undulating his tail laterally. No other salamander was near him, although one might have been frightened away when the light was turned on. At 9:59 PM, he deposited a spermatophore. A female, possibly one involved in courtship before the light went on, approached him and placed her chin on the base of his tail. The two then moved forward and stopped but the female had passed to one side of the spermatophore and did not recover it. A second female approached the spermatophore and placed her nasolabial grooves upon it. She remained in this position for about a minute and a half and then moved away.

On August 8 at 10:00 AM, a spermatophore was found in a container in which three males and five females had been confined on August 6. The spermatophore was adhering to a molted skin but was normally formed. On the evening of August 9 at 10:46 PM, a male was in the process of shedding his skin. As the molted skin passed over the region of his vent, a spermatophore was deposited. This may account for the spermatophore found attached to the molted skin on August 8. In this case, however, the spermatophore did not adhere to the skin but was attached to the substratum in a normal manner. The male then proceeded to eat the molted skin

but ignored the spermatophore which was quite close to it.

Finally, abnormal deposition took place on August 5 during a homosexual courtship between two captive males. The two males had initially been courting the same female but when they came in contact they began to court one another. The details of courtship between these males were essentially the same as those of any normal male-female courtship. The male executing the female role even engaged in lateral head movements counter to the pelvic movements of the male depositing the spermatophore. The males had begun courting at 11:43 PM and the spermatophore was deposited at 11:58 PM. The two males separated immediately after the spermatophore was deposited and there was no attempt to pick up the spermatophore. This homosexual mating was probably not an unusual behavior brought about solely by conditions of captivity and crowding because similar observations were made in the field. On the morning of August 4 at 1:30 AM, two specimens were observed in tail-walk in the field but they were disturbed by the presence of the observers and separated as they attempted to escape. When the two specimens were recovered, they both proved to be males.

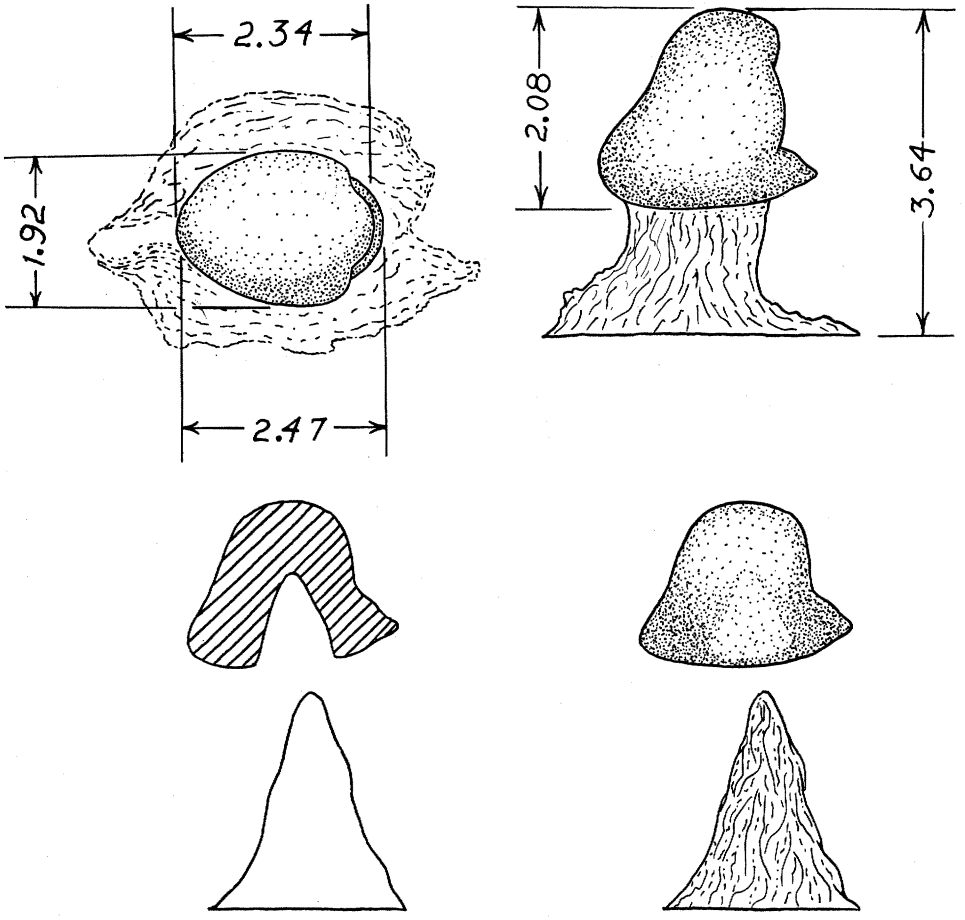


Fig. 3. The spermatophore of *P. j. metcalfi*. a.—Spermatophore viewed from above. b.—Same spermatophore viewed from its right side. c.—Sperm cap and jelly stalk after detachment. d.—Diagramatic section through sperm cap and jelly stalk. Measurements in millimeters.

### SPERMATOPHORE

The only spermatophore recovered from the field was that deposited on August 3. This specimen was recovered by cutting the bark from the branch to which the spermatophore adhered. The spermatophore, still attached to the bark, was brought back to the

cabin and measured and drawn in pen and ink within 15 minutes after it was deposited in the field. It is shown, along with its measurements, in Figures 3a and 3b. In addition to this one field specimen, nine complete spermatophores were recovered after deposition in captivity and four jelly stalks were recovered from spermatophores after the sperm caps had been removed by captive females.

The spermatophores deposited in captivity were identical to that recovered from the field. They are remarkably constant in form and size. The spermatophore of *P. j. metcalfi*, when freshly deposited, is mushroom shaped. It is composed of a clear jelly stalk with a pale buff colored sperm cap. The sperm cap is asymmetrical and dome shaped with a lip or ridge projecting from its anterioventral surface. This lower lip is quite characteristic and can be used to orient the spermatophore. Of the six spermatophores observed during deposition, both in the field and in captivity, the lip was always oriented towards the head of the male depositing the spermatophore.

Not only is the shape of the spermatophore different from previous descriptions of plethodontid spermatophores (Noble, 1929; Noble & Weber, 1929; Gorman, 1956), but also the method by which the sperm cap is attached to the jelly stalk is different. The jelly stalk has a smaller diameter than the sperm cap and extends into the center of the cap as a sharp spike. The sperm cap, when removed from the jelly stalk, resembles a gastrula (Figs. 3c and 3d). Furthermore the cap, in a fresh specimen, is very easily detached from the jelly stalk. The cavity, into which the jelly stalk had projected, remained open when the sperm cap was removed from a fresh specimen. The surface of the cavity was of the same texture as that of the outer surface of the cap and no sperm oozed from either the cavity or the outer surface. The cap had not been ruptured by detachment from the stalk. The stalk remained attached to the substratum as a conical spike which was identical in form to that left after a female was observed picking up a sperm cap from a spermatophore.

The ease of detachment together with the fact that three other spike-like jelly stalks were found in containers with captive salamanders indicates that the jelly stalk of the spermatophore of *P. j. metcalfi* is not picked up or pinched off along with the sperm cap as is the case in *P. cinereus* (Noble & Weber, 1929). This statement is further strengthened by examination of two females which had been freshly inseminated in captivity. In each case, there was no trace of a jelly stalk attached to the cap once it had been picked up by the female. The sperm cap was not apparent until the vents of the females had been spread open by a pair of forceps. The sperm cap, as is typical in the Plethodontidae, was stored towards the rear of the vent.

## Discussion

The courtship of *P. j. metcalfi* agrees quite well with the generalized plethodontid pattern described by Noble and Brady (1930) but these workers made no mention of the raising and lowering of the male's limbs during the initial stages of courtship. Stebbins (1949) described a similar limb movement in male *Ensatina*. In the latter, however, the limb movements were not evident until after the tail-walk had begun.

The tail in *P. j. metcalfi* does not play as prominent a role in courtship as does that of *Ensatina*. The tail of the male *P. j. metcalfi* is not hooked over the hind limb of the female nor is it curved over the back of the female while she picks up the spermatophore.

The olfactory system probably plays an important role in courtship. During the initial stages of courtship, the male often touched his nasolabial grooves to the substratum as though he were searching for the female. Having made contact with the female, the male's nasolabial grooves were in almost constant contact with the skin of the female until he circled under her chin and led her in the tail-walk.

The olfactory system may be just as important in helping the female to orient during courtship. This is suggested by the behavior of the female who approached a freshly deposited spermatophore and remained with her nasolabial grooves in contact with it for a minute and a half. The scent of the spermatophore must certainly have been the same as the male's vent. This scent, however, was not sufficient to hold the female's attention for a long period of time. The combination of scent and tail undulations from the male is probably sufficient to evoke and maintain interest on the part of the female and to keep her oriented at the base of the male's tail over his vent.

Since at least one spermatophore was deposited while a male was shedding his skin, it may be concluded that the spermatophore is formed and retained in the vent of the male prior to courtship.

The aggressiveness displayed by one cap-

tive male may have been unusual and until future field observations confirm this behavior, it must remain uncertain that this is a normal behavior pattern occurring in the field and not the result of conditions of captivity.

The conditions under which courtship occurred in the field seem to be rather variable. Since one courtship was observed during the day and one other just after dusk, it is assumed that total darkness is not an absolute requirement for courtship. Leaving a light on in a room with captive specimens seemed to disturb them less than turning a light on or off. Captive females seemed to be more disturbed by the light, however, than did the males. This may indicate a greater level of excitement on the part of the male during the courting season. Certainly whenever a courting pair was disturbed, either in the field or in captivity, it was always the female who immediately ran for cover. The male seemed to be less aware of his surroundings during courtship and especially during spermatophore deposition. In short, during the proper season, courtship in *P. j. metcalfi* will occur under almost any field conditions and special stimuli like rain, high humidity, or total darkness do not seem to play a very great role in evoking courtship activity.

The structure of the spermatophore in this species is unusual; future work should be directed towards discovering the mechanism whereby the spermatophore is formed with the jelly stalk extending well into the center of the sperm cap.

The courtship season for *P. j. metcalfi* at Whitetop mountain, Virginia, extends at least from August 3 to August 27. The season is probably much longer but no courting pairs were observed during the month of July, even though much time was spent in the field at night during that period.

I suggest that courtship in the other subspecies of *Plethodon jordani* also occurs during late summer.

## Summary

Courtship in *Plethodon jordani metcalfi* observed in the field and in captivity consists of a series of rather stereotyped phases somewhat variable in details.

The male approaches the female and executes a series of nosing movements with his snout. The male places his nasolabial grooves and mental gland in contact with the skin of the female and moves towards her head while executing a foot dance. At the head of the female, he places his mental gland and nasolabial grooves between her eyes and over her snout and then circles under the chin of the female.

The male and female engage in a tail-walk and then the male executes a series of lateral pelvic rocking motions while the female executes lateral head movements counter to the movements of the male. The male deposits a spermatophore, arches the tail and moves forward with the female until her vent is over the spermatophore. The female picks up the sperm cap from the spermatophore with her vent but leaves the entire jelly stalk attached to the substratum.

A male *P. j. metcalfi* is capable of depositing more than one spermatophore in a single night.

One courting male displayed aggressiveness and attacked females and other males by biting them.

Male *P. j. metcalfi* may sometimes engage in homosexual courtship which may result in spermatophore deposition.

Spermatophores may be deposited when a male sheds his skin indicating that the spermatophore is formed and retained in the vent of the male prior to courtship.

The spermatophore of *P. j. metcalfi* is mushroom shaped and constant in appearance. It is composed of a spike-like jelly stalk extending into the center of a light buff colored sperm cap which is easily detached from the stalk. The sperm cap has a characteristic projecting lip on its anterioventral surface.

Courtship usually occurs at night between dusk and dawn but may occasionally occur during the day when specimens are under cover.

The breeding season for *P. j. metcalfi* on Whitetop mountain, Virginia, extends at least from August 3 to August 27.

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# A New Species of *Sauromalus* from Mexico

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THE 1952 and 1953 Sefton-Stanford expeditions to the Gulf of California collected reptiles that were deposited in the Natural History Museum of Stanford University. A report has been published on the snakes (Cliff, 1954). This paper is the first in a series dealing with the lizards found on the Gulf islands.

### *Sauromalus ater* DUMERIL, 1856

*Sauromalus ater* is known from the following Gulf of California islands: Espiritu Santo, San Francisco, San Jose, San Diego and Santa Cruz. It is not known from the mainland of Baja California. Three specimens from San Jose Island, Stanford Natural History Museum register Nos. 15722 and 16139–40, constitute a new record for this species.

The three specimens from San Jose Island are typical of this species in scale counts: ventrals number 125-135-136, caudals 29-29-29, humerals 39-40-44 and central dorsal scales per head length 28-31-32. In coloration, however, these three specimens are somewhat different. The dorsal transverse bands are almost obsolete; the yellow ground color has invaded them and they are broken into a reticulate pattern. Specimens from the other islands are generally somewhat darker and have four or five dark transverse bands, sometimes with light centers, but are not reticulate. Spots may be present in the interspaces between the transverse bands.

### ***Sauromalus shawi**, sp. nov.*

HOLOTYPE.—SU 16120, collected on San Marcos Island by James Böhlke and Jay M. Savage on April 22, 1952. There are five paratypes (SU 16121–5) collected by Böhlke, Savage and Jon Lindbergh on April 22 and 23, 1952.

*Diagnosis.*—An insular species most closely related to *S. ater* from which it can be distinguished in having large, acutely pointed scales in the lateral neck fold, almost equal in size to the largest scales on the top of the head, and by its especially pronounced lateral neck fold. It differs from *S. klauberi* in having transverse bands, and from *S. slevini* in possessing a higher number of ventral scales. It differs from *S. australis* in possessing fewer ventral scales and fewer caudals.

*Description of type.*—Form stout, body laterally compressed. The head is swollen lateral to the commissure, above the tympanum and to a lesser extent above the eye; it tapers to an obtuse point anteriorly and is rounded, rather than truncate when viewed from above. The top and sides of the head are covered by scales that are not imbricate, except for the two lateral series above and including the supralabials. The largest scales of the head are on the crown between the nostril and the eye and immediately anterior to the tympanic opening. There is a series of 7 large scales beneath the eye which increases in size posteriorly. The nostril is pierced in a single scale, is directed upward and slightly anteriorly and is much closer to the rostral than the eye. The rostral scale is about the same height and about twice the length of a supralabial. The supralabials are about the same size as the infralabials, subequal, although they increase slightly in size posteriorly. Posterior to the commissure and in line with the supralabials are three enlarged, obtusely pointed scales. The ear opening is nearly vertical and is bordered anteriorly by 4 enlarged pointed scales with their apices directed posteriorly.

Posterior to the ear opening there is a pronounced lateral neck fold. The posterior and lateral edges of this fold bear enlarged and pointed scales. These enlarged scales are