

KARYOTYPES AND ACCESSORY REPRODUCTIVE GLANDS IN THE  
RODENT GENUS *SCOTINOMYS*

The following information on karyotypes and male accessory glands is directed toward understanding kinships of *Scotinomys*. Though the genus was recently revised (Hooper, 1972), its relationships with other rodents are not yet entirely clear. Authors have linked *Scotinomys* with akodont rodents of South America, but those resemblances may be ones of ecological equivalents not necessarily closely related (Hershkovitz, 1972:387-88). Other authors have suggested that close affinities are with a North and Middle American group of some 12 genera variously referred to as peromyscines and neotomines (Hooper, 1959, 1960; Hooper and Musser, 1964), the tribes Reithrodontomyini, Onychomyini and Neotomini (Vorontsov, 1959), or "pastoral peromyscines"—tribe Peromyscini (Hershkovitz, 1962:85, 1972:387-88). These and other views regarding propinquity of *Scotinomys* need further testing by new sorts of data, for example, from chromosomes and accessory reproductive glands.

The animals used for karyotypic analysis consisted of both wild-caught individuals and their F<sub>1</sub>, laboratory-raised progeny as follows: *S. teguina* (Costa Rica, Cartago, Volcán Irazú, 12; Nicaragua, Matagalpa, Santa María de Ostuma, 2); *S. xerampelinus* (Costa Rica, Cartago, Volcán Irazú, 4; Volcán Turrialba, 2).

Mitotic chromosome spreads were prepared as described by Patton (1967) with the exception that cells in the sodium citrate solution were incubated at 38° C for approximately 20 minutes. A total of 94 spreads, approximately five per individual, were counted and 32 were photographed for more detailed examination and comparisons. The standard four-class system (metacentric, submetacentric, subtelocentric, acrocentric) was employed in describing the chromosomes. Voucher specimens are deposited in the University of Michigan, Museum of Zoology.

Dissection of ten reproductively-mature males of each species, together with ten examples of *Baiomys* for comparison, provided information on the number and kinds of accessory reproductive glands. The specimens, preserved in formalin or alcohol, are as follows: *S. teguina* (Costa Rica: Cartago, Moravia, 2; Volcán Irazú, 2; Puntarenas, Monte Verde, 3; Nicaragua: Matagalpa, Santa María de Ostuma, 1. Panamá: Chiriquí, Río Chiriquí Viejo), 2); *S. xerampelinus* (Costa Rica: Cartago, Volcán Irazú, 5; Volcán Turrialba, 3; San José, Cerro de la Muerte), 2); *Baiomys musculus* (México: Chiapas, Berriozabal, 2; Tuxtla Gutiérrez, 4; Oaxaca, Tapanatepec, 1; Tlacolula, 1; Etla, 2).

The reproductive tracts were examined under a Bausch and Lomb Stereozoom scope (7×-30×), and sketched with the aid of a camera lucida. Greatest lengths of the various glands (measured to the nearest 0.1 millimeter (mm) from the point of entrance of the glandular duct into the urethra to the extreme margin of the gland) were recorded. Additional immature individuals were examined to determine extent of variation associated with age. Anatomical terminology follows Arata (1964).

*Karyotypes*.—A diploid number of 58 was observed in both species of *Scotinomys*. There was no variation in the diploid count. The species also are similar in gross chromosome morphology—the autosomal complement pairs consist of 9 metacentrics, 7 submetacentrics, and 12 acrocentrics to yield a fundamental number of 88 (Fig. 1). The X-chromosome in both species is a large subtelocentric. The element designated as the Y-chromosome is a small metacentric in *xerampelinus* and a medium-sized submetacentric in *teguina*. This difference, however, may be due to an artifact in processing (over-contraction) or a mismatch of the chromosomes. Slight heteromorphism noted among individuals of both species was particularly evident in the largest pair of metacentrics and of submetacentrics (Fig. 1). Thomas (1973) noted a high degree of heteromorphic chromosome pairing in those populations of *Peromyscus* exhibiting a high fundamental number.



FIG. 1.—Karyotypes of (A) *Scotinomys teguina* and (B) *S. xerampelinus*; males from Volcán Irazú, Costa Rica.

*Male Accessory Reproductive Glands.*—The male accessory glands in *S. teguina* (Fig. 2), described below, provide a basis with which the tracts of *S. xerampelinus* and *Baiomys* may be compared.

One large pair of preputial glands lie alongside the glans penis in *S. teguina*. The long tapering ducts of the preputials are embedded in connective tissue under the prepuce; they open at the edge of the preputial orifice. The preputials, small in immature animals, increase greatly in size with the advent of reproductive activity (about 4 to 6 weeks in age), and in mature animals they cover as much as 5 mm of the *M. rectus abdominis*.

One pair of bulbo-urethral glands is situated anterior and lateral to the bulb of the penis in *S. teguina*. These prism-shaped glands are partly embedded in the bulbocavernosus muscle, and their ducts pass between the ischiocavernosus and bulbocavernosus muscles to empty into the bulb of the penis.

The ampullary glands of *S. teguina* consist of a paired mass of branched tubules and 8 to 12 unbranched tubules. Each group of branched tubules forms a fairly compact coiled glandular mass situated anterior to the vas deferens and nestled between the pair of anterior prostates. Each group of branched tubules appears to unite forming a common

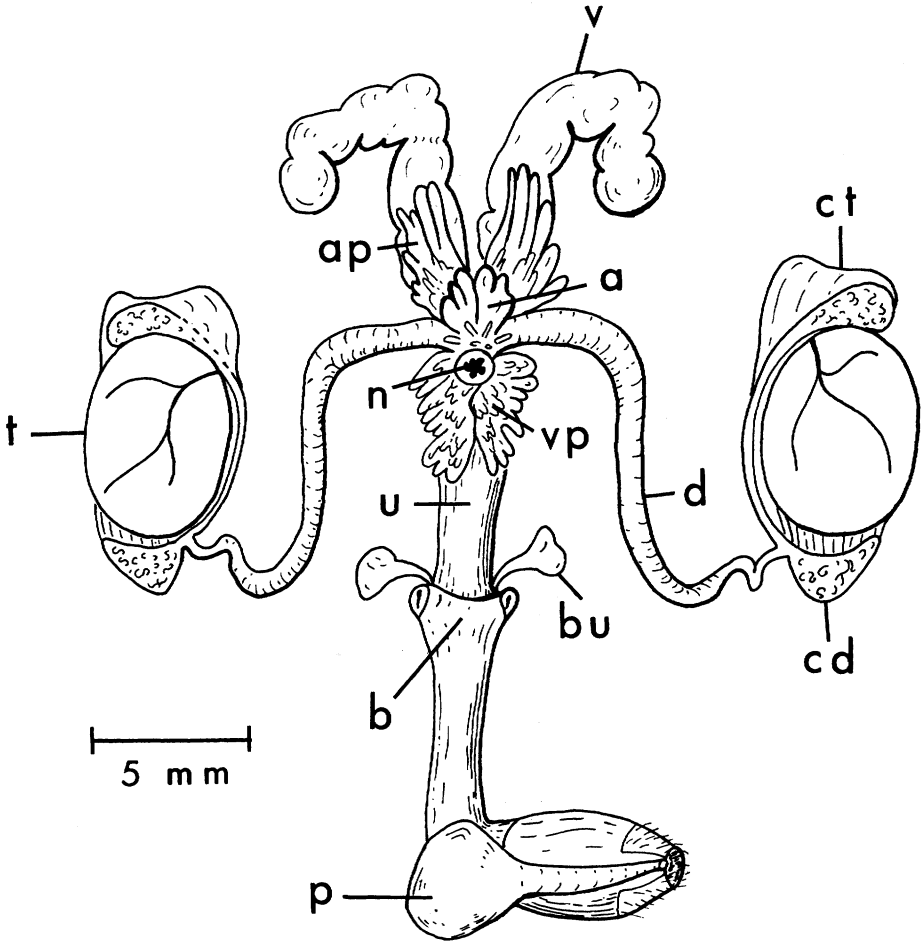


FIG. 2.—Male genital tract, ventral view, of *Scotinomys teguina*: a, ampullary gland; ap, anterior prostate gland; b, bulb of penis; bu, bulbo-urethral gland; cd, cauda epididymis; ct, caput epididymis; d, deferent duct; n, neck of urinary bladder (body excised); p, preputial gland; t, testis; u, urethra; v, vesicular gland; vp, ventral prostate.

ductway, and then to conjoin the vasa deferentia just cranial to the vasa's entrance into the urethra. It is quite evident that the unbranched tubules open separately into the vasa deferentia and not into the urethra. These single tubules (as much as 1 mm long) appear as outpocketings of the walls of the deferent ducts and are located primarily on ventral and posterior surfaces of those ducts. The branched tubules together with the unbranched ones partially encircle the base of the deferent ducts. They do not, however, wholly enclose or cover the ventral surface of the vasa deferentia, as seen in many species of *Peromyscus* (Linzey and Layne, 1969). In specimens that were all freshly-preserved with the same fixative (10 percent buffered formalin) the color of the ampullary glands varied, white in some individuals, light pink in others.

One pair of vesicular glands, the largest in the accessory gland complement, is situated at the anterior end of the prostatic urethra in *S. teguina*. These glands are slightly con-

TABLE 1.—Average lengths (in mm) of male accessory reproductive glands in *Baiomys musculus* and species of *Scotinomys*. *N* = 10 for each species.

| Accessory gland   | <i>Scotinomys teguina</i> | <i>Scotinomys xerampelinus</i> | <i>Baiomys musculus</i> |
|-------------------|---------------------------|--------------------------------|-------------------------|
| Preputial         | 8.1                       | 8.9                            | 8.0                     |
| Bulbo-urethral    | 2.9                       | 3.4                            | 3.4                     |
| Ampullary         | 2.0                       | 1.9                            | 2.1                     |
| Vesicular         | 7.0                       | 8.1                            | 8.7                     |
| Dorsal Prostate   | 2.5                       | 2.7                            | 3.3                     |
| Ventral Prostate  | 4.1                       | 5.2                            | 3.0                     |
| Anterior Prostate | 4.8                       | 4.0                            | 5.2                     |

stricted at intervals and curved gradually through their length to a subterminal flexure. The vesiculars are smaller, smoother, and less curved in immature animals.

One pair of each of the three kinds of prostate glands, namely dorsal, ventral, and anterior are found in *S. teguina*. Dorsal prostates, tubular structures lying on the prostatic urethra and bordering the descending colon, drain through ducts situated just posterior to those of the vesicular glands. Ventral prostates connect to the urethra through a series of ducts (1 to 3) located lateral and anterior to the stalk of the bladder. Each gland, appressed close to the urinary bladder, is a compact mass of filamentous tissue which shows secondary branching of tubules. Anterior prostates extend along approximately one-half the lesser curvature of the vesicular glands and adhere tightly to them. Anterior prostates are composed of comparatively elongate tubules which branch at the base of the gland near the ducts; the ducts drain adjacent to those of the vesiculars.

The accessory glands in *S. xerampelinus* differ slightly in proportions from those of *S. teguina* (Table 1). The preputial glands of *S. xerampelinus* are relatively larger, and there is less demarcation between gland body and duct (the body of the gland tapers gradually into the short duct); anterior prostates are smaller; the vesiculars are slightly longer; ampullary glands lack the single unbranched tubules opening into the base of the deferent ducts. In those ampullaries, however, there are clusters of branched tubules situated between the anterior prostates, much as seen in *teguina*.

To judge from our specimens, *Scotinomys* and *Baiomys* are similar in accessory glands, with minor differences in structure and proportions as follows: vesiculars in *Baiomys* smaller in total volume, simpler in form—with less constrictions and curvature, almost straight in some individuals; anterior prostates more filiform and not as tightly clustered as in *Scotinomys*; ampullary glands in both *Baiomys taylori* (Arata, 1964) and *B. musculus* (our specimens) consisting of mainly single, short tubules opening into the base of the deferent ducts. These ampullary tubules (some tightly coiled) in *Baiomys* are most numerous on the anterior side of the deferent ducts adjacent to the anterior prostates, but this concentration of tubules is not as large as in *Scotinomys*.

*Discussion.*—Of the 12 genera of neotomine-peromyscines (Hooper and Musser, 1964) *Scotinomys* has the highest diploid number of chromosomes ( $2N = 58$ ) reported to date. Species of 9 of the 12 genera have been karyotyped; diploid counts range from 36 in *Tylomys nudicaudus* to 58 in both species of *Scotinomys*. Other species with high numbers include several kinds of *Neotoma* (52 to 56; Baker and Mascarello, 1969) and *Ochrotomys nuttalli* (52; Patton and Hsu, 1967). Diploid number is 48 in *Peromyscus* (20 species; Hsu and Arrighi, 1968), *Neotomodon* (Uribe *et al.*, 1973), and *Onychomys* and *Baiomys* (Hsu and Benirshke, 1967). The  $2N$  ranges from 38 to 50 in *Reithrodontomys* (Hsu and Benirshke, 1968; Shellhammer, 1967) and from 36 to 52 in *Tylomys* (Pathak *et al.*, 1973).

Thus, among these rodents there is considerable inter- and intrageneric variation such that supposedly closely related species may have identical or widely different chromosome numbers. We have no clear guidelines for interpreting this variation in terms of kinships of the species.

In structure of male accessory reproductive glands *Scotinomys* fits with other genera having a simple glans penis (Hooper and Musser, 1964), and within that group it closely resembles *Baiomys*. The amount of difference between those two genera is less than that reported between some subgenera of *Peromyscus* (Linzey and Layne, 1969). Among the similarities of *Scotinomys* and *Baiomys* are the large preputial glands and poorly-developed ampullary glands, with unbranched single tubules (seen in *S. teguina*, *Baiomys taylori*, and *B. musculus*, but not *S. xerampelinus*). The principal difference observed is the relatively larger size of the vesicular glands in *Scotinomys*. In this respect, *Scotinomys* more closely resembles species of *Reithrodontomys*, or of the subgenus *Peromyscus*, than those of *Baiomys*.

Current information on accessory glands does not entirely support Arata's characterization of *Baiomys* in relation to other peromyscines. Arata (1964) assembled *Baiomys* with *Ochrotomys* and *Onychomys* in a group characterized by absence or reduction of some accessory glands, but the retention of preputials. He contrasted that group with a second assemblage, comprised of *Peromyscus* and *Reithrodontomys*, which have no preputials, but otherwise possess a full complement of glands. Linzey and Layne (1969) have since shown that some species of *Peromyscus*, particularly those in the subgenus *Haplomydomys*, do have preputials, which are minute compared to those of *Scotinomys* and *Baiomys*. Further, the small size of the ampullaries observed in *Baiomys* and *Scotinomys* do not contrast as sharply with *Peromyscus* or *Reithrodontomys* as they do with *Onychomys* and *Ochrotomys* which have no ampullaries. Moreover, there are large vesiculars in *Baiomys* and *Scotinomys*, in contrast to none in *Onychomys* and minute ones in *Ochrotomys*. Thus, on the basis of male accessory reproductive glands, *Baiomys* and *Scotinomys* form a unit nearer *Peromyscus* (*Haplomydomys*) than *Ochrotomys* and *Onychomys*. That unit also contrasts with the South American cricetine species examined to date in having slight (rather than well-developed) ampullaries and a single pair (rather than two pairs) of preputials.

Financial support was provided to E. T. Hooper by the National Science Foundation (GB-5810, GB-35500).

#### LITERATURE CITED

- ARATA, A. A. 1964. The anatomy and taxonomic significance of the male accessory reproductive glands of muroid rodents. Bull. Florida State Museum, Biol. Sci., 9:1-42.
- BAKER, R. J., AND J. T. MASCARELLO. 1969. Karyotypic analysis of the genus *Neotoma* (Cricetidae, Rodentia). Cytogen., 8:187-198.
- HERSHKOVITZ, P. 1962. Evolution of neotropical cricetine rodents (Muridae) with special reference to the phyllotine group. Chicago Nat. Hist. Mus., 46:1-524.
- . 1972. The recent mammals of the Neotropical region: a zoogeographic and ecological review. Pp. 311-431, in *Evolution, mammals and southern continents* (A. Keast, ed.), State Univ. New York Press, Albany, 543 pp.
- HOOPER, E. T. 1959. The glans penis in five genera of cricetid rodents. Occas. Papers Mus. Zool., Univ. Michigan, 613:1-11.
- . 1960. The glans penis in *Neotoma* (Rodentia) and allied genera. Occas. Papers Mus. Zool., Univ. Michigan, 618:1-20.
- . 1972. A synopsis of the rodent genus *Scotinomys*. Occas. Papers Mus. Zool., Univ. Michigan, 665:1-30.
- HOOPER, E. T., AND G. C. MUSSER. 1964. Notes on classification of the rodent genus *Peromyscus*. Occas. Papers Mus. Zool., Univ. Michigan, 635:1-13.

- Hsu, T. C., AND F. E. ARRIGHI. 1968. Chromosomes of *Peromyscus* (Rodentia, Cricetidae). I. Evolutionary trends in twenty species. *Cytogen.*, 7:17-446.
- Hsu, T. C., AND K. BENIRSHKE. 1967. An atlas of mammalian chromosomes. Springer-Verlag, New York, vol. 1.
- . 1968. An atlas of mammalian chromosomes. Springer-Verlag, New York, vol. 2.
- LINZEY, A. V., AND J. N. LAYNE. 1969. Comparative morphology of the male reproductive tract in the rodent genus *Peromyscus* (Muridae). *Amer. Mus. Novitates*, 2355:1-47.
- PATHAK, S., AND T. C. HSU. 1973. Chromosome homology in the climbing rats, genus *Tylomys* (Rodentia, Cricetidae). *Chromosoma*, 42:215-228.
- PATTON, J. L. 1967. Chromosome studies of certain pocket mice, genus *Perognathus* (Rodentia: Heteromyidae). *J. Mamm.*, 48:27-37.
- PATTON, J., AND T. C. HSU. 1967. Chromosomes of the golden mouse, *Peromyscus* (*Ochrotomys*) *nuttalli* (Harlan). *J. Mamm.*, 48:637-639.
- SHELLHAMMER, H. S. 1967. Cytotaxonomic studies of the harvest mice of the San Francisco Bay region. *J. Mamm.*, 48:549-556.
- THOMAS, B. 1973. Evolutionary implications of karyotypic variation in some insular *Peromyscus* from British Columbia, Canada. *Cytol.*, 38:485-495.
- URIBE, M., A. LAGUARDA, AND J. ROMERO. 1973. Chromosome analysis and meiotic behavior of *Neotomodon alstoni*. *Mamm. Chrom. Newsletter*, 14:12.
- VORONTSOV, N. N. 1959. The system of hamster (Cricetinae) in the sphere of the world fauna and their phylogenetic relations. *Bull. Mosk. Obsh. Ispyt. Prirody, Biol. Soc.*, 64:134-137.

MICHAEL D. CARLETON, EMMET T. HOOPER, AND JAMES HONACKI, *Museum of Zoology, The University of Michigan, Ann Arbor, Michigan, 48104* (present address of Honacki: *Museum of Natural History, University of Kansas, Lawrence, Kansas 66045*). Submitted 28 June 1974. Accepted 5 April 1975.

#### MOLT IN THE NORTH AMERICAN BADGER, *TAXIDEA TAXUS*

In the summer of 1963, I examined approximately 1000 badger (*Taxidea taxus*) skins in the U.S. National Museum. Additional skins were examined in other collections; their location and use are acknowledged elsewhere (Long, *J. Mamm.*, 53:725-759, 1972). Some juvenal pelages and numerous adult ones provided information on molting in *Taxidea*.

Badgers change from juvenal to adult pelages in their first spring and summer, and molt annually thereafter. The annual molt usually occurs in summer or autumn (at least in the large northern badgers, *Taxidea taxus taxus*, *T. t. jacksoni*, and *T. t. jeffersonii*) so that the badger spends the winter with prime fur. By the following spring the pelage is usually worn and bleached. The northern badger may bring forth young, on the average, somewhat later in its northern latitudes. It also may pass through its pelage change later, on the average, in northern latitudes.

Series of juveniles of *jeffersonii* from Idaho (mostly from the vicinity of Georgetown) and from Jungo, Nevada, provide data on juvenal pelage. The youngest specimens examined (USNM 22,017-22,019) taken 25 May 1916 are from 20 miles northeast of Georgetown. They are creamy yellow dorsally. There is a small, pale yellowish stripe extending along the midventral area. The feet are dark brownish. The tail, extremely short, is concolor with the dorsum. There is dark brown on the dorsal parts of the pinnae of the ears, and the dark brownish patches ("badges") are immediately anterior to the pinnae, which are whitish adjacent to the brownish areas. Posteriorly from the nose in each specimen a narrow whitish stripe extends onto the crown and neck. Dark brownish