

## Jumping mice (Zapodidae) in Indiana

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### Abstract

The meadow jumping mouse, *Zapus hudsonius*, has been taken in 45 counties and doubtless occurs throughout Indiana, but the woodland jumping mouse, *Napaeozapus insignis*, should no longer be considered a resident of the state. *Zapus hudsonius* is a hibernator; early spring records for Indiana are April 23, 24, 25, and 28, and late records are October 24, 27, 28, November 12 and 20. Less than 15% of the animals taken in late fall had accumulated fat indicating that *Zapus* probably accumulates fat quickly, and immediately enters hibernation. *Dermacarus hypudaci*, a non-feeding transport stage (hypopus) of a mite was the most abundant form of associate found in the fur of *Z. hudsonius*, at an estimated average of 42.7 per mouse. Other mites taken, were *Androlaelaps fahrenheitzi* [209 taken], *Ornithonyssus bacoti* [8], *Macrocheles* sp. [1], and *Radfordia* sp. [1], and the chiggers *Euscongastia peromysci* [12], *Neotrombicula whartoni* [5], *Eutrombicula alfreddugesi* [3], and *Leptotrombidium myotis* [1]. Three ticks, all *Dermacentor variabilis*, and one flea, *Orchopeas leucopus*, were also taken. Internal parasites have not been identified, but 7 mice harbored cestodes and 2 harbored trematodes. The 12 most important foods of *Zapus* in our sample of 131 mice were *Impatiens* seeds, *Endogone*, unidentified grass seeds, *Triodia flava* seeds, *Setaria* seeds, lepidopterous larvae, miscellaneous vegetation, *Phleum pratense* seeds, green grass seeds, *Hymenogaster*, unidentified seeds, and *Dactylus glomerata* seeds.

### Introduction

Two species of jumping mice, Zapodidae, have been reported from Indiana, *Zapus hudsonius*, the meadow jumping mouse, and *Napaeozapus insignis*, the woodland jumping mouse. *Zapus hudsonius* was indicated by Lyon (12) to be found "sparingly throughout Indiana," and "nowhere common in the state." Hahn (3) who did much trapping failed to take a single specimen. Mumford (15) stated that *Zapus hudsonius* "is uncommon over the northern one-third of the state and rare almost everywhere else." *Napaeozapus insignis* is known from a single specimen (No. 65310 in the Museum of Zoology at the University of Michigan) from Turkey Run State Park in Parke County (13), collected July 28, 1930, by P. F. Hickie.

The purposes of this study were to present information on the food, habitat, parasites and reproduction of *Zapus hudsonius* and to determine the present status of *Napaeozapus insignis* in Indiana.

### Materials and Methods

A total of 152 specimens of the meadow jumping mouse, *Zapus hudsonius*, was taken by snap-back mousetraps, mostly from Vigo [71 specimens], Parke [45], Gibson [14], Pulaski [10] and Martin [4] Counties, with one or two specimens being taken from several other counties. Specimens are distributed over the seasons as follows: April [4 specimens], May [3], June [16], July [12], August [2],

September [102], October [16] and November [2]. Most specimens were examined for external and larger intestinal parasites, and standard measurements and reproductive observations were recorded. Stomach contents were emptied into watch glasses, and the percent volume of each kind of food was estimated. Most jumping mice were collected between 1965 and 1970.

*Napaeozapus insignis*

The general range of *Napaeozapus insignis* is northeast and approaches Indiana most closely in Oakland County, in eastern Michigan, or about 75 miles northeast of Indiana (4). However, Klingener (9) studied the Oakland County specimen and concludes that it is *Zapus hudsonius*. This means that the closest Michigan localities where *Napaeozapus* has been taken are in Crawford and Oscoda Counties in the northern part of the lower peninsula or about 185 miles north of the Indiana border, and 335 miles northeast of the Turkey Run locality. In Ohio, the locality nearest to Indiana where this species has been taken is in Geauga County, about 310 miles northeast of the Turkey Run locality, and about 150 miles east of Indiana.

A total of 22,428 trap-nights of effort was conducted in wooded areas in and around Turkey Run State Park in several habitats which would have been good *Napaeozapus* habitat in New York (21). No woodland jumping mice were caught, although 372 mammals were taken, including 45 meadow jumping mice. (Other mammals taken in Turkey Run Park under permits from the Indiana Department of Natural Resources, Division of State Parks, were *Peromyscus leucopus* [232 individuals], *Blarina brevicauda* [76], *Zapus hudsonius* [45], *Microtus pinetorum* [6], *Tamias striatus* [4], *Mus musculus* [4], *Sorex cinereus* [1], *Sorex longirostris* [1], *Synaptomys cooperi* [1], *Microtus ochrogaster* [1], and *Microtus pennsylvanicus* [1].

There would seem to be several possibilities for our failure to take *Napaeozapus*. The original specimen could have been misidentified. Both skin and skull are present and have been studied by both Klingener (9) and us. All agree that the specimen in the Michigan museum is *Napaeozapus insignis*, even though it is faded and is a subadult. Also, there is no question whether Hickie was in Turkey Run at the proper time. There is a specimen of *Tamias striatus* in the Michigan Museum taken there by Hickie on July 28, 1930.

The possibility that the species has become extinct in Turkey Run was raised by Mumford (15). This seems unlikely since Turkey Run Park today affords excellent *Napaeozapus* habitat and has for many years. Possibly the species is very rare in the park, but in view of the amount of trapping during the present study, and since *Zapus* utilizes the habitats often occupied by *Napaeozapus*, we have tended to feel that this alternative is not the correct one.

Possibly a labeling error occurred, with the specimen not originating at Turkey Run at all. It seems strange that Hickie would overlook

a fresh specimen of *Napaeozapus* since fresh specimens are quite distinct from *Zapus*, and since Hickie was, we assume, familiar with *Napaeozapus* from Michigan but he donated the specimen in question to the museum as *Zapus*. It was only later recognized as *Napaeozapus*. Also Hickie was attuned to the idea of finding species new to Indiana. He and Harrison turned up the first woodrats, *Neotoma floridana*, and swamp rabbits, *Sylvilagus aquaticus* (6, 7) known from Indiana. The specimen in question was not catalogued in the Michigan Museum until 2 years after its capture. Could a specimen of Hickie's from Michigan have been mislabeled as an Indiana specimen from Turkey Run? We feel that this or some other labeling error is a distinct possibility.

We conclude that *Napaeozapus* should not be considered as a resident in Indiana until such time as another specimen should turn up.

### *Zapus hudsonius*

#### Distribution in Indiana

*Zapus hudsonius* has been collected in 45 widely-distributed Indiana counties although there are none from the counties along the Ohio River in southeastern Indiana (Fig. 1).

#### Hibernation Period and Fat Accumulation

*Zapus hudsonius* was first taken in traps in New York after continuous trapping on April 30, May 2, April 25, and April 25 in 4 consecutive years, with males preceding the females from hibernation (20). Females were taken an average of 15.5 days after the first males those same years. Dates of the last *Zapus* taken, again with continuous trapping in 3 consecutive years were October 18, November 1, and October 20.

No effort was made to determine the dates of emerging or entering into hibernation during the present study, but the following records are noteworthy. Four jumping mice were seen or taken on April 23, 24, 25 and 28. Two of these dates are 1 and 2 days earlier than any taken in New York. In Indiana 5 mice were taken after October 22 (only 2 mice were taken after October 22 in New York, even with concentrated trapping). Late dates for the Indiana specimens are October 24, 27, and 28, and November 12 and 20. It appears that *Zapus* is active somewhat longer in Indiana than in New York.

In New York surprisingly few jumping mice were very fat even in the last 2 weeks before hibernation (20). Also, there was a decrease in the population size of *Zapus* between fall and spring, and the average weight of individuals in the spring population was slightly greater than that in the fall population. Whitaker concluded that some individuals started building a layer of fat about September, that it took about 2 weeks for this to occur, that the animals then immediately entered hibernation, and that only those animals that were able to reach the adult size and attain a layer of fat survived hibernation. There is evidence (5, 14, 16) that fat production takes

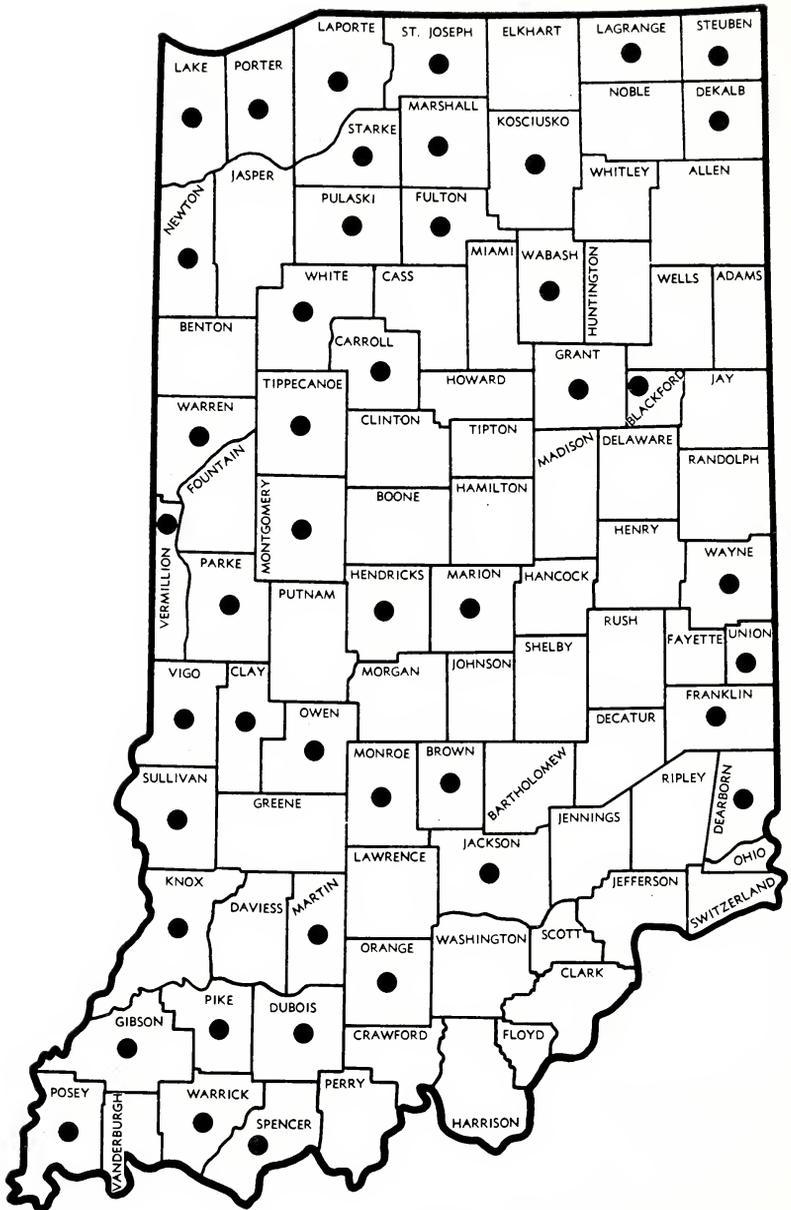


FIGURE 1. Indiana counties from which there are specimens in collections of *Zapus hudsonius*.

about 2 weeks and that individuals enter hibernation at different times. Whitaker further concluded that the smaller animals must have entered hibernation since they disappeared from the field, but that they must have died during hibernation.

Only 8 of 68 (11.8%) mice taken in the last half of September had accumulated a gram or more of fat, while of those taken in October and November, 2 of 14 (14.3%) had. These figures are very close to the percentages of fat animals found during the New York studies.

### Reproduction

Little reproductive information was accumulated during the present study, but 3 females were pregnant, with 6 (20 May), 5 (21 June) and 5 embryos (21 July). None of 17 adult females taken in September was pregnant, but 3 had placental scars, indicating August pregnancies.

### External parasites

Ticks, fleas, botflies and lice are relatively uncommon on meadow jumping mice (20), but the forms that have been reported from this species are the ticks *Dermacentor variabilis*, and *Ixodes muris*; the fleas *Orchopeas leucopus*, *Megabothris asio*, *M. quirini*, *M. wagneri*, *Stenoponia americana*, *Corrodopsylla curvata*, *Ctenophthalmus pseudagyrtis*, the botfly, *Cuterebra* sp., and a louse *Neohaematopinus* sp. The main external parasites of *Zapus* in New York were the hypopus (non-feeding, or transport stage) of the mite "*Labidophorus*" which has now been identified as *Dermacarus hypudaei* (17). Hypopi were found on 57.7% (334) of 579 mice from New York examined for these, and many of the mice examined had several hundred of the mites. *Radfordia ewingi*, a small white mite which is often imbedded in the skin was also often taken on *Z. hudsonius* in New York, being found on 49 of 579 mice (8.5%). *Androlaelaps fahrenheitsi* (= *Haemolaelaps glasgowi*) was found on 14 (2.4%) of the mice examined. Other mites found on *Zapus* from New York were *Eulaelaps stabularis*, *Laelaps kochi*, *Haemogamasus ambulans* (= *H. alaskensis*) and the chiggers, *Neotrombicula subsignata*, *Eutrombicula alfreddugesi* and *Necoschongastia* sp.

*Dermacarus hypudaei* was the most abundant of the external parasites of *Zapus* in Indiana with 60 of the 100 mice examined harboring a total of 4275 mites of this species for an average of 42.7 per mouse (conservatively estimated). Unsuccessful attempts were made to get hypopi to transform into adults.

A total of 21 chiggers was found on 6 of the 100 individuals of *Z. hudsonius* from Indiana examined during the present study. Twelve were *Euschongastia peromysci* (Ewing), five were *Neotrombicula whartoni* Ewing, three were *Eutrombicula alfreddugesi* Oudemans and one was *Leptotrombidium* sp. Of these, only *E. alfreddugesi* had been previously reported from Indiana, and only *E. alfreddugesi* had been reported from *Z. hudsonius*. The chigger identifications were confirmed

by Dr. Richard B. Loomis of Long Beach State College, Long Beach, California, and *Leptotrombidium* sp. is currently being described by him.

The most abundant external parasite of *Z. hudsonius* in Indiana other than labidophorine hypopi was *Androlaelaps fahrenheitsi* (Berlese), found on many species of small mammals. A total of 209 specimens was found on 22 of the jumping mice examined, for an average of 2.09 per mouse (range of 1 to 93).

Eight mites, *Ornithonyssus bacoti* Hirst, were found on three individuals of *Z. hudsonius*. *Ornithonyssus bacoti* is primarily found on the housemouse, *Mus musculus*. Three ticks, *Dermacentor variabilis* (Say), were found on two of the mice, and a flea, *Orchopeas leucopus* (Baker), was found on one. One immature male myobiid, *Radfordia* sp., and a macrochelid, *Marocheles* sp. were taken. Eight mites, not identified, but apparently occurring as free-living accidentals, were also found.

#### Internal parasites

Eight of 127 (6.3%) mice examined during the present study harbored larger internal parasites (Bacteria and Protozoa were not sought). A total of 79 cestodes was found in 7 (5.5%) and a total of 158 trematodes was found in 2 of the mice (1.6%), 157 of them in one mouse which also contained 20 cestodes. Identification of the internal parasites will be made at a later date. Thus internal parasites are not abundant in *Zapus hudsonius* in Indiana as was the case in New York (20); other records of internal parasites in *Zapus hudsonius* are in several papers (1, 2, 10, 11, 18).

#### Food habits

*Zapus hudsonius* accepted most kinds of insects and most fruits and seeds in laboratory food preference studies (16). Whitaker (20) presented information on the stomach contents of 796 individuals of *Z. hudsonius* from New York. In spring, animal materials, particularly lepidopterous larvae and Coleoptera were important, but as the summer progressed, seeds especially grass seeds became more heavily used, with the kinds of seeds varying as they became available. The subterranean fungus, *Endogone*, was an important food in the summer and fall, forming 10 to 20% of the total food by volume at that time.

The stomachs of 131 *Zapus* were examined during this study (Table 1). Seeds of touch-me-not (*Impatiens*) were most important followed by the fungus (*Endogone*), unidentified grass seeds, seeds of foxtail grass (*Setaria*), and seeds of purple-top grass (*Triodia flava*). Seeds of *Impatiens* became available in the late summer and fall and can be easily identified often before the stomach is opened, because the blue endosperm of the seed can be seen even through the stomach wall. *Endogone* is a particularly common food of both *Zapus hudsonius* and *Napaeozapus insignis* (19). It forms about 12% of the diet in *Z. hudsonius* and about 35% of the diet of *Napaeozapus insignis*. Little is known about the biology or occurrence of the fungus and it is not

known how or where the mice find it. The food value that might be obtained from this food is questionable. The question is often raised whether *Endogone* might be ingested along with other food. This does not appear to be the case. *Endogone* is not found consistently with any other food, and more important, *Endogone* spores often make up a very large portion of the stomach contents. Percent volume estimates of *Endogone* in 17 of the 131 stomachs examined were 100, 85, 80 [3 stomachs], 70, 60 [3], 55 [2], and 50 [6]. Also 50.4% of the mice had some *Endogone* in their stomachs, a greater percentage than was the case for any other food. These data leave no doubt that the fungus is sought out and eaten by the mice. Possibly they locate it by olfaction.

TABLE 1. Food of 131 meadow jumping mice, *Zapus hudsonius*, from Indiana.

| Item                                  | Percent volume | Percent frequency |
|---------------------------------------|----------------|-------------------|
| <i>Impatiens</i> seeds                | 21.4           | 27.5              |
| <i>Endogone</i>                       | 15.6           | 50.4              |
| <i>Setaria</i> seeds                  | 10.0           | 10.7              |
| Unidentified grass seeds              | 9.6            | 18.3              |
| <i>Triodea flava</i> seeds            | 9.0            | 13.7              |
| Lepidopterous larvae                  | 5.7            | 13.7              |
| Miscellaneous vegetation              | 4.6            | 15.3              |
| <i>Phleum pratense</i> seeds          | 3.7            | 3.8               |
| Green grass seeds                     | 3.4            | 6.1               |
| <i>Hymenogaster</i>                   | 1.8            | 4.6               |
| Unidentified seeds                    | 1.7            | 4.6               |
| <i>Dactylus glomerata</i> seeds       | 1.5            | 1.6               |
| Slugs                                 | 1.3            | 1.6               |
| Curculionidae                         | 1.1            | 2.3               |
| Green vegetation                      | 1.0            | 1.6               |
| <i>Cerastium</i> seeds                | 0.9            | 4.6               |
| <i>Rumex acetosella</i> seeds         | 0.8            | 2.3               |
| <i>Bromus</i> seeds                   | 0.8            | 0.8               |
| <i>Panicum</i> seeds                  | 0.8            | 0.8               |
| <i>Elymus</i> seeds                   | 0.8            | 0.8               |
| <i>Echinochloa</i> seeds              | 0.6            | 0.8               |
| <i>Rubus</i> fruit                    | 0.6            | 1.6               |
| Unidentified animal                   | 0.5            | 2.3               |
| <i>Oxalis</i> seeds                   | 0.5            | 0.8               |
| * Other items comprising <0.5% volume | 2.5            | —                 |
|                                       | 100.2          |                   |

\* Other items in order of decreasing importance: Coleopterous larvae, *Poa* seeds, mast, *Chenopodium* seeds, Carabidae, *Prunus* seeds, Chrysomelidae, unidentified Coleoptera, *Festuca* seeds, *Leerzia* seeds, Reduviidae, Dipterous larvae, and *Polygonum* seeds.

Potential energy value of *Endogone* collected from the stomachs and intestines of four jumping mice was determined by means of a Parr Oxygen Bomb Calorimeter. *Endogone* samples from the stomach and intestines were each divided into two equal masses, weighed, and burned. The two masses in the stomach averaged 2735.50 cal per g (2610.31 and 2860.69), while the two masses in the intestine averaged 2266.44 cal per g (2169.42 and 2363.46), or significantly less than

the material in the stomach ( $t = 9.23, 2 \text{ df}$ ). For comparison, some calorific measurements of seeds obtained by Kendeigh and West (8) are *Echinochloa crusgalli* (4819, hulled), *Elymus virginicus* (4695), *Setaria faberii* (4585, hulled), *Zea mays* (4317), *Polygonum pennsylvanicum* (4515), *Fraxinus nigra* (5625). It would appear that *Z. hudsonius* is getting energy from *Endogone*, but that the potential amount of energy in *Endogone* is much less than in many kinds of seeds. Additional study is needed.

Another fungal food, *Hymenogaster*, was occasionally eaten. This fungus forms pea-sized oval bodies which are attached to the bases of plants.

Seeds are the mainstay of the diet of *Z. hudsonius* in Indiana as in New York, with specific kinds of seeds occurring progressively as they ripen. Seeds comprised 50.4% by volume. Less animal material was found in the Indiana stomachs than in the New York stomachs, but this is probably because of the small number of early spring stomachs examined rather than being indicative of any real difference in food habits. Foods found during the present study, but not previously recorded for *Zapus hudsonius*, are the seeds of *Triodea*, *Panicum*, *Elymus*, *Chenopodium*, *Prunus*, *Festuca* and *Polygonum*, and the true bug, Reduviidae.

#### Literature Cited

1. ERICKSON, A. B. 1938. Parasites of some Minnesota Cricetidae and a host catalogue of helminth parasites of native American mice. Amer. Midland Natur. 20:575-589.
2. FREEMAN, R. S. 1956. Studies on *Taenia mustelae* Gmelin, 1790 and the taxonomy of certain taenioid cestodes from Mustelidae. Can. J. Zool. 34:219-242.
3. HAHN, W. L. 1909. The mammals of Indiana. 33rd. Annu. Rep. Dep. Geol. and Natur. Res. Indiana. 419-654.
4. HALL, E. R., and K. R. KELSON. 1959. The mammals of North America. Ronald Press. New York. 1038 p.
5. HAMILTON, W. J., JR. 1935. Habits of jumping mice. Amer. Midland Natur. 16:187-200.
6. HARRISON, T., and P. F. HICKIE. 1931. Indiana's swamp rabbit. J. Mammal. 12:319-320.
7. HICKIE, P. F., and T. HARRISON. 1930. The Alleghany wood rat in Indiana. Amer. Midland Natur. 12:169-174.
8. KENDEIGH, S. C., and G. C. WEST. 1965. Caloric values of plant seeds eaten by birds. Ecology 46:553-555.
9. KLINGENER, D. 1965. Notes on the range of *Napaeozapus* in Michigan and Indiana. J. Mammal. 45:644-645.
10. LICHTENFELS, J. R., and A. J. HALEY. 1968. New host records of intestinal nematodes of Maryland rodents and suppression of *Capillaria bonnevillei* Grundmann and Frandsen, 1960 as a synonym of *C. americana* Read, 1959. Proc. Helminth. Soc. Wash. 35:206-211.

11. LUBINSKY, G. 1957. List of helminths from Alberta rodents. *Can. J. Zool.* **35**:623-627.
12. LYON, M. W., JR. 1936. Mammals of Indiana. *Amer. Midland Natur.* **17**:1-384.
13. ————. 1942. Additions to the mammals of Indiana. *Amer. Midland Natur.* **27**:790-791.
14. MORRISON, P., and F. A. RYSER. 1962. Metabolism and body temperature in a small hibernator, the meadow jumping mouse, *Zapus hudsonius*. *J. Cell. Physiol.* **60**:169-180.
15. MUMFORD, R. E. 1969. Distribution of the mammals of Indiana. Monograph 1, Indiana Acad. Sci., State Library, Indianapolis. 114 p.
16. QUIMBY, D. C. 1951. The life history and ecology of the jumping mouse, *Zapus hudsonius*. *Ecol. Monogr.* **21**:61-95.
17. RUPES, V., and J. O. WHITAKER, JR. Mites of the subfamily Labidophorinae (Acaridae, Acarina) in North America. *Acarologia* **10**:493-499.
18. SCHAD, G. A. 1954. Helminth parasites of mice in northeastern Quebec and the coast of Labrador. *Can. J. Zool.* **32**:2 15-224.
19. WHITAKER, J. O., JR. 1962. *Endogone*, *Hymenogaster*, and *Melanogaster* as small mammal foods. *Amer. Midland Natur.* **67**:152-156.
20. ————. 1963. A study of the meadow jumping mouse, *Zapus hudsonius* (Zimmermann), in central New York. *Ecol. Monogr.* **33**:215-254.
21. ————. 1963. Food, habitat, and parasites of the woodland jumping mouse in central New York. *J. Mammal.* **44**:316-321.