A NEW SPECIES OF POLYGENIS JORDAN FROM FLORIDA, WITH REMARKS ON ITS HOST RELATIONSHIPS AND ZOOGEOGRAPHIC SIGNIFICANCE

(SIPHONAPTERA: RHOPALOPSYLLIDAE)

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Polygenis Jordan is a group of Neotropical origin. Although the majority of its species occur in South and Central America, several are found in Mexico and one species, *Polygenis gwyni* (C. Fox), extends into the southern United States where it is typically found on the cotton rat, *Sigmodon hispidus.*

Recent collections of ectoparasites in the course of ecological studies on small mammals in Florida[3] have revealed the presence of a new species of *Polygenis.* Perhaps even more surprising than the occurrence of this undescribed form at the periphery of the geographical distribution of the genus is the fact that it has been found only on the Florida deer mouse, *Peromyscus floridanus,* a species of the wide-ranging genus *Peromyscus,* that is endemic to Florida. The new species belongs to a group which contains *P. gwyni* but it appears no more closely related to *gwyni* than to certain South American species particularly *P. occidentalis* (Cunha).

In addition to diagnosing, describing, and illustrating the new flea, this paper considers the factors involved in its narrow host specificity and the possible zoogeographic significance of its occurrence on *Peromyscus floridanus.*

Polygenis floridanus Johnson and Layne, new species

Type data.—Male holotype from *Peromyscus floridanus,* 10 miles west of Gainesville, Alachua County, Florida, 13 January 1958, J. N. Layne, collector, JNL Mammal No. 3147, deposited in the collections of the U. S. National Museum, type No. 65669. Female allotype as holotype except 31 July 1957, JNL Mammal No. 2883. Paratypes, all from *P. floridanus,* include 122 males and 131 females from Alachua County and 58 males and 59 females from Highlands, Gilchrist, Levy and St. Johns Counties, Florida, all collected by J. N. Layne in 1957 and 1958.

Paratypes have been deposited in the collections of the University of Florida, the U. S. National Museum, the British Museum (Natural History) at Tring, the Chicago Natural History Museum, the Canadian National Collection, Ottawa, and in the collections of the authors.

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Diagnosis.—*P. floridanus*, n. sp., like all known *Polygenis* except *litus* (J. and R.) has 3 rows of bristles on the postantennal area of the head. It belongs to that group of *Polygenis* which have 6 dorsal notches containing large bristles on the metatibia and with only 2 large bristles in the penultimate notch. It is a typical member of *Polygenis* in that the male aedeagus has the sclerotized inner tube reflected ventrally, and the female spermatheca has the hilla (tail) sharply defined from the bulga (body or head) and the bulga does not have the cribriform area elongate. *P. floridanus*, n. sp., is most likely to be confused with *gwyni* (C. Fox), the only other species of *Polygenis* known to occur in the same area with it, but may be separated by the following characters: In life, *floridanus*, n. sp., is paler in color. Male *floridanus* has the distal arm of the ninth sternum (fig. 10) obliquely truncate apically, with small bristles along its entire ventral (posterior) margin and apex, and has a group of 3 (rarely 2 or 4) much longer bristles at the posteroventral apical angle, rather than being sharply rounded apically and lacking the large bristles as in *gwyni* (fig. 8). The movable finger of the clasper (fig. 9), is broadest subapically so that the anterior and posterior margins are not parallel as in *gwyni* (fig. 7). Female *floridanus* is similar to *gwyni* except in details of the chaetotaxy. In *floridanus* females the seventh sternum (fig. 4) bears the usual vertical row of large bristles, and anterior to this row, an irregularly-spaced row of smaller bristles, some of which extend to the lower level of the sensilium, rather than having only the one row of large bristles. The eighth tergum also has a row of smaller bristles anterior to the vertical median row rather than a patch of small bristles anterior to the median row and all well below the level of the ventral anal lobe. As well, sterna 4 to 6 of *floridanus* females each have from 1 to 5 small bristles anterior to the main row, rather than lacking such bristles or without small bristles on each of these sterna.

Description.—*Holotype, male.* **Head** (fig. 1): Eye large and dark. Preocular row of 3 (3-4)[4] large bristles; frontal row of 5 (4-6) smaller bristles and 2 large postocular bristles. Genal lobe short, acute apically. Postantennal region with 3 rows of bristles. Labial palpi not extending to apex of coxae. **Thorax:** Prosternosome (fig. 1) not projecting noticeably between coxae. **Legs:** Fifth tarsal segment of first leg normal, claws of equal size and this segment more than twice as long as broad. Hind tibia (fig. 6) with 6 dorsal notches containing bristles as follows (base to apex): 2-2-2-3-2-3. **Abdomen:** Basal abdominal sternum with 5 to 6 small bristles laterally on each side (always less than 10). Sterna 3 to 7 with a few scattered small bristles anterior to normal row of large bristles. Typical tergum with 2 rows of bristles, first of 10 to 14 small, pale bristles on each side; second of 8 to 12 larger bristles separated by intercalary hairs. **Modified segments** (fig. 2): Eighth tergum with 7 to 10 small bristles on each side above spiracle; 1 small bristle and 1 to 2 large ones below or at level of spiracle. Fixed process of clasper (P. and fig. 9) with notch on posterior margin near apex; large acetabular bristle at middle of level of insertion of movable process. Movable process or finger of clasper (F. and fig. 9) with anterior margin almost straight to level of subapical tooth; rounded apically; posterior margin convex so that finger is broadest subapical-

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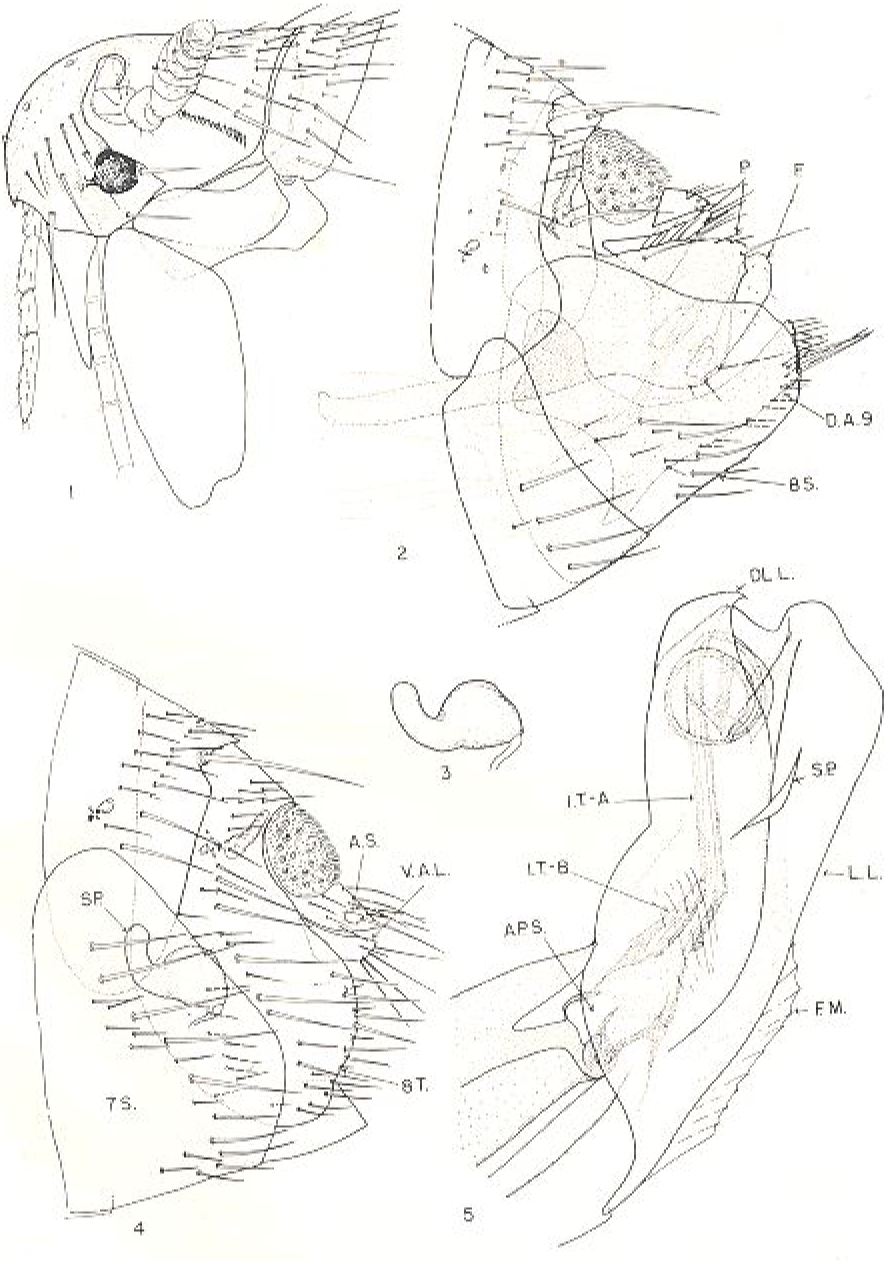
[4] Variations in paratypes given in parentheses.



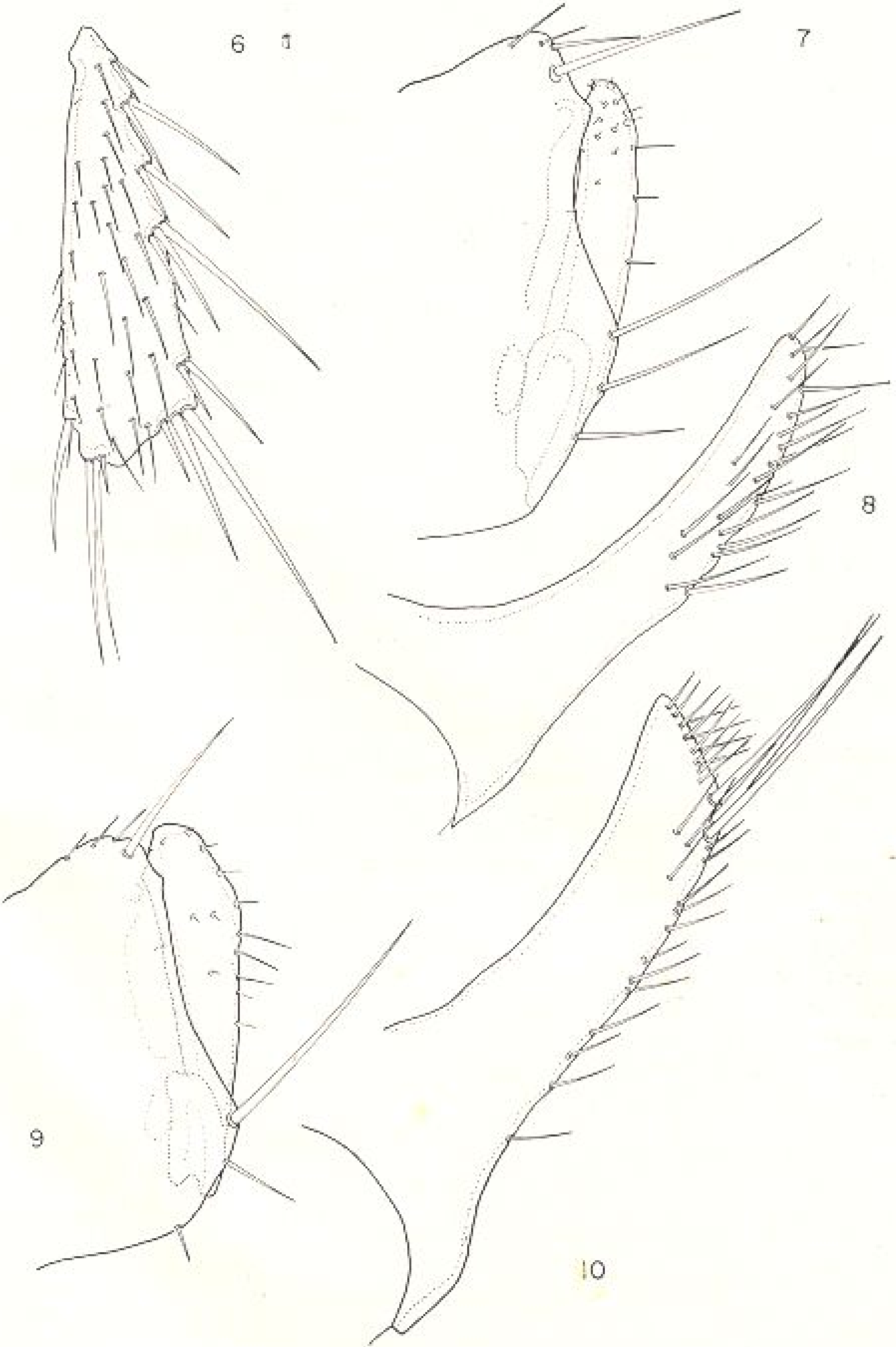
Polygenis floridanus, n. sp.: Fig. 1, head, holotype; fig. 2, modified segments, holotype; fig. 3, spermatheca, allotype; fig. 4, modified segments, allotype; fig. 5, aedeagal endchamber, paratype from Alachua County. Figures 2 and 4 are not drawn to the same scale.

ly. Eighth sternum (8S), deeply divided ventrally so that the distance from this division to the posterior apex is greater than the distance from the division anteriorly to the row of large bristles. Distal arm of ninth sternum (D.A. 9 and fig. 10) broad, sides parallel, entire structure slightly curved upward toward apex which is obliquely truncate; ventral (posterior) margin and apex with row of small bristles which increase in density as they progress apically; some of small bristles on apex mesal and directed slightly downward; apex with 3 (rarely 2 or 4) much larger bristles at ventroapical angle. **Aedeagus** (fig. 5): Apodeme broad, rounded anteriorly; apodemal and penis rods not much longer than apodeme. Apodemal strut (AP.S.) not greatly flared anteriorly, of normal *Polygenis* type. Basal part of inner tube (I.T.-B) shorter than straight portion of apical part (I.T.-A); apical part reflected ventrally into unevenly coiled spiral. Sidepiece (S.P.) short, subtriangular, with obtuse angle rounded, farther apicad than usual in the genus. Distolateral lobes (DL.L) acuminate apically. Crochet indistinct. Lateral lobes (L.L) apically rounded. Fluted membrane (F.M.) not conspicuously large.

Allotype, female. **Head, thorax** and **legs** as in male except for usual sexual differences. **Abdomen**: Basal abdominal sternum, each side, with fewer than 15 small bristles on lateral surface. Sterna 3 to 6 each with at least 1 small bristle anterior to vertical row of large bristles on at least one side, usually with 2 to 4 small bristles in this position. Typical tergum, each side, with anterior row of 7 to 12 pale medium-sized bristles and posterior row of 9 to 11 large dark bristles separated by small intercalary hairs. **Modified segments** (fig. 4): Posterior margin of seventh sternum (7S.) more or less evenly rounded; seventh sternum with anterior row of small, unevenly spaced bristles and posterior row of large bristles; posterior row extending about to level of ventral anal lobe. Eighth tergum (8T.) each side with one mesal subapical, one lateral subapical, and two medio-lateral rows of bristles; more posterior of two medio-lateral rows with large dark bristles extending from venter to dorsum; anterior medio-lateral row with small, pale bristles, in some specimens this row complete from venter to dorsum, in other specimens lower part of this row an uneven patch of 5 to 6 bristles followed dorsally by a space and then a more even upper row. Above spiracle on eighth tergum, 5 to 9 large and small bristles. Ventral anal lobe (V.A.L.) obliquely truncate apically, apical bristles long. Anal stylet (A.S.) of variable length, typically one and one-half to two times as long as broad, bearing one long apical bristle and one minute hair on ventral margin. Spermatheca (SP. and fig. 3) with hilla sharply separated from bulga, about as long as bulga and less than half as broad; bulga usually not darkly pigmented, dorsally rounded, cribriform area not produced into snout.

Length.—Male holotype: 1.7 mm.; female allotype: 2.1 mm.

Polygenis floridanus, n. sp.: Fig. 6, hind tibia, holotype; fig. 9, clasper, holotype; fig. 10, distal arm of ninth sternum, holotype. *P. gwyni* (C. Fox): Fig. 7, clasper, male from *Didelphis*, Arkansas; fig. 8, distal arm of ninth sternum, male from *Didelphis*, Arkansas. Figures 7 to 10 are all drawn to the same scale.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HOST RELATIONSHIPS OF POLYGENIS FLORIDANUS, N. SP., AND P. GWYNI

In a series of 158 *Peromyscus floridanus* from which all fleas were recovered and determined, *Polygenis floridanus,* n. sp., occurred on 150 (94.9%) of the specimens and was the only flea present in 135 cases. *Polygenis gwyni* occurred on 16 (10.1%) of the mice, *Ctenophthalmus pseudagyrtes* on 8 (5.1%), and *Hoplopsyllus affinis* on 1 (0.6%). The relative abundance of these fleas in the total collection of 365 specimens was as follows: *P. floridanus,* n. sp., 92.3% (337); *P. gwyni,* 5.2% (19); *C. pseudagyrtes,* 2.2% (8); and *H. affinis,* 0.3% (1).

These data show that *Polygenis floridanus,* n. sp., is the typical and only common flea occurring on *Peromyscus floridanus.* Large numbers of fleas have been collected from a variety of small mammals in *Peromyscus floridanus* habitats as well as from other habitat-types, yet no other hosts have thus far been recorded for this flea. Although it is probable that its host restriction is not absolute and that further collecting may produce at least an occasional record on other mammals, there seems to be no question that this flea is indeed narrowly host specific and that *Peromyscus floridanus* is the true host. The fact that the biology of the latter has begun to be studied only during the past few years explains why *Polygenis floridanus,* n. sp., has escaped notice until so recently.

In contrast to its low incidence on the Florida deer mouse, *Polygenis gwyni* is the most common flea encountered on other small rodents in Florida. In these studies it has been the only flea recorded from the cotton rat, rice rat (*Oryzomys palustris*), harvest mouse (*Reithrodontomys humulis*), cotton mouse (*Peromyscus gossypinus*), and oldfield mouse (*Peromyscus polionotus*). It occurs with greatest frequency and abundance on the cotton rat, which is probably the true host. Although taken fairly regularly on the rice rat, it has been recorded only rarely from the harvest mouse, cotton mouse, and oldfield mouse. Each of these hosts frequently occurs in association with cotton rats.

The relatively few occurrences of *Polygenis gwyni* on *Peromyscus floridanus* have been in habitats in which cotton rats were particularly abundant and probably can be classed as accidental transfers. In 9 of the 16 instances of *P. gwyni* being found on *Peromyscus floridanus, Polygenis floridanus,* n. sp., was also present. That *gwyni* has been the species involved in these transfers is not unexpected, for the variety of hosts known for the former together with its more extensive geographic distribution would appear to indicate a broader environmental tolerance than that of *floridanus,* n. sp.

ZOOGEOGRAPHIC CONSIDERATIONS

Peromyscus floridanus is a distinctive species of the wide-ranging and varied genus *Peromyscus* whose present limited range is suggestive of a relic form. This species has also been recorded from the Pleistocene in Florida (Sherman, 1952). The current classification of *Peromyscus,* essentially that of Osgood (1909), recognizes several subgenera and a number of species groups and includes *Peromyscus floridanus* as the sole representative of the subgenus *Podomys.* Although the interrelationships of the various subgenera and species groups of this large and complex genus are still much in doubt, a recent study by Hooper (1958) indicates that on the basis of penial structure *P. floridanus* most closely resembles *P. lophurus* and *lepturus* from southern Mexico and Guatemala. The disjunct distributional pattern of *P. floridanus* and the species with which it presently appears to have its closest affinities may be interpreted in terms of Pleistocene events. Presumably a once continuously distributed, warmth-adapted, coastal plain form of *Peromyscus* was forced into separate refuges in Florida and southern Mexico or Central America during glacial advances, the isolated elements of the original population subsequently undergoing evolutionary divergence in the widely separated eastern and western centers. Blair (1958) discusses a number of other cases of east-west discontinuities in the distributional patterns of related taxa of various mammals, amphibians, and reptiles which appear to reflect a similar Pleistocene history. Further examples could be cited from among birds, arthropods, and plants.

Compared with other known species of *Polygenis, P. floridanus,* n. sp., shows great morphological similarity to *P. occidentalis* (Cunha), a South American species. Thus, the distributional pattern of *Polygenis floridanus,* n. sp., and a very closely related species parallels in a striking way that of *Peromyscus floridanus* and its putative allies. The intimate association of the flea and mouse adds further support to the zoogeographic inference based on the morphological evidence of the infrageneric relationships of parasite and host considered separately. The logical explanation of this particular host-flea relationship seems to be that the ancestral *Peromyscus* stock was infested with a species of *Polygenis* whose range was fragmented along with its host's during the Pleistocene. In the case of at least the eastern segment of the *Peromyscus* population the association of the flea with its original host persisted, and both have probably diverged from their respective ancestral species.

FACTORS INVOLVED IN THE HOST SPECIFICITY OF POLYGENIS FLORIDANUS, N. SP.

The marked restriction of *Polygenis floridanus,* n. sp., to *Peromyscus floridanus* requires isolating mechanisms which not only prevent completion of the life cycle in association with other small rodent species occurring in the same habitats but also bar cross-host exchanges of adult fleas. Furthermore, the hypothesis that the present mouse-flea relationship is one that originated during or before Pleistocene times presumes that such isolating mechanisms have been functioning throughout the history of the association.

On the basis of present evidence, the observed host specificity of *Polygenis floridanus,* n. sp., appears to be the result of an interaction between several factors involving the ecology and habits of both host and parasite. *Peromyscus floridanus* is typically a burrow dweller. It frequently uses the deep tunnels of the gopher turtle (*Gopherus* *polyphemus*) and may also inhabit the extensive underground burrow systems of the pocket gopher (*Geomys pinetis*). These burrows apparently provide a distinctive microhabitat in the generally dry environments inhabited by the animals. It is of interest to note that both the gopher turtle and pocket gopher are forms with western affinities, and it is possible that the utilization of the burrows, particularly those of the former, by *Peromyscus floridanus* has had a long history. The Florida deer mouse frequently takes refuge in small ground holes, but to what extent these are used for the nest is unknown. Although other species of small rodents which may occur in association with *Peromyscus floridanus* occasionally utilize gopher turtle or other types of burrows, there is little overlap with the latter in their nest site preferences.

There is also evidence that the nests of *Peromyscus floridanus* differ from those of other small mammals with which it may occur. Two *Peromyscus floridanus* nests found in excavated gopher turtle burrows consisted of a thick platform composed mainly of dry leaves, grasses, and other plant materials in one case and a crude, more or less spherical mass of similar material in the other. These nests, if typical of the species, are quite unlike the snug, well constructed nests of other small rodents, such as the cotton rat and cotton mouse, that may occupy the same habitats.

It appears, therefore, that the primary basis for the restriction of *Polygenis floridanus*, n. sp., to the Florida deer mouse is the fact that no other mammal species within the range of *Peromyscus floridanus* has nesting habits which provide the proper microclimatic conditions for the completion of the flea's life cycle.

Although the immature stages of *Polygenis floridanus*, n. sp., may be narrowly adapted to the particular microenvironment of *Peromyscus floridanus* homesites, this does not explain why the adult fleas should be so highly restricted to this host. Additional ecological factors plus certain behavioral characteristics of the flea appear to play a role in this connection. *Peromyscus floridanus* is closely confined in its ecological distribution to xeric, sandy habitats of generally open vegetative aspect. The principal plant associations in which the species occurs are sand pine scrublands and longleaf pine/turkey oak woodlands. Detailed descriptions of these associations are given by Laessle (1942, 1958). The Florida deer mouse is the characteristic and often the only common small mammal in these habitats; thus its association with other species of small rodents is usually relatively low and this in turn limits the opportunities for accidental transfer of its fleas.

The over-all incidence of fleas and the mean number per infested host on mice captured outside of their nests have been found to be approximately 33 per cent and 2.3, respectively. These data indicate that only a comparatively small adult flea population is ever present on free-ranging mice. In addition, observations made while handling mice on live-trapping studies and when collecting fleas and other ectoparasites from specimens brought into the laboratory, indicate that *Polygenis floridanus*, n. sp., is neither an active nor powerful jumper and does not readily abandon its host.

It seems reasonable to infer, therefore, that the relatively low numbers of fleas on mice outside their nests, together with the poorly developed jumping habits of *Polygenis floridanus*, n. sp., and its reluctance to leave a host, combine with the partial ecological isolation of *Peromyscus floridanus* from other small mammals to very effectively reduce the possibilities of direct cross-host transfers.

Although the ecological and behavioral factors discussed above seem adequate to account fully for the narrow host specificity of *Polygenis floridanus*, n. sp., the existence of certain physiological adaptations of the adult flea to the host cannot be ruled out. For example, from the data presently available, it is impossible to determine whether the flea is potentially polyhaemophagous but because of highly effective ecological and behavioral isolating mechanisms is but rarely able to encounter a new host species or whether there are in fact physiological factors which also contribute to its apparent association with a single host.

In summary, the narrow host specificity of *Polygenis floridanus*, n. sp., appears to be attributable to a combination of ecological and behavioral factors that are particularly successful in preventing dispersal to or survival on other host species. The ultimate isolating factor is probably a narrow adaptation of the flea to the particular microenvironment provided by the characteristic nests and nest sites of the true host, *Peromyscus floridanus*. Secondary factors effective in preventing direct dispersal of adult fleas to other mammals include the partial ecological isolation of the host, a low population of fleas on hosts outside their nests and burrows, and the absence of an active jumping habit in this species of flea and its reluctance to leave a host.

It is believed that the flea-host association under consideration originated during or before the Pleistocene and that the continued existence of such isolating mechanisms as described above has prevented transfer of the flea to new host groups, thus preserving the ancestral relationship.

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