

Notes on mites of the genus *Pygmephorus* (Acari: Heterostigmata) associated with North American mammals

(With 5 figures)

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Abstract: The phoretic genus *Pygmephorus* (Acari: Heterostigmata) collected on 16 species of North American small mammals was studied. A total of 221 specimens was examined and 12 species of the mites were found, two of them being new. The descriptions of the new taxa are published separately. The taxonomic analysis was carried out, with a stress put on intraspecific variability. For the following 6 species new synonyms are proposed: *Pygmephorus stammeri* Krczal, 1959 (= *P. brevicaudae* Smiley & Whitaker, 1979: syn. nov.), *P. johnstoni* Smiley & Whitaker, 1979 (= *P. wrenschae* Smiley & Whitaker, 1979: syn. nov.), *P. spinosus* Kramer, 1877 (= *P. hamiltoni* Smiley & Whitaker, 1979: syn. nov.), *P. scalopi* Mahunka, 1973 (= *P. utamarae* Smiley & Whitaker, 1984: syn. nov.), *P. whitakeri* Mahunka, 1973 (= *P. sylvilagus* Kaliszewski & Rack, 1985: syn. nov.) and *P. designatus* Mahunka, 1973 (= *P. equitrichosus* Mahunka, 1975: syn. nov.).

Keywords: Acari (Heterostigmata), phoretic *Pygmephorus* from mammals, taxonomy, North America.

Introduction

The phoretic genus *Pygmephorus* Kramer, 1877 (Acari: Heterostigmata) represents a distinct taxon within the family Pygmephoridae, chiefly due to its strikingly enlarged terminal limbs of the first pair of leg. This character is well reflected in the common German name for these mites, literally "Fäustchenmilben" (= fisted mites). The highly modified tibiotarsi I and their large ribbed claws are transformed into a bristle-grasping apparatus which they use for passive dispersal by small mammals. The mites have usually been found in the furs of various mammals (Insectivora, Rodentia, Lagomorpha), less frequent in their nests and only occasionally in soil or litter samples. Their biology is practically unknown.

Despite a long taxonomic history of the genus, its phylogenetic status within the family is unclear and this is also valid for particular species. Very little is known about morphological variability of the hitherto described 55 world taxa. However, the majority of the species descriptions are of little value

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for phylogenetic analysis, since they are either insufficient or sometimes misleading. It leads to assumption that numerous *Pygmephorus* taxa may turn out to be synonyms.

From North America 34 species of *Pygmephorus* s. str. have been reported (Mahunka 1973, 1974, 1975, Rack 1975, Smiley 1978, Smiley & Whitaker 1979, 1984, Whitaker et al. 1982, Kaliszewski & Rack 1985, Dastych & Rack 1991) and most of them are known only from that continent. The exception are two species described from Europe, i. e. *Pygmephorus spinosus* Kramer, 1877 and *P. islandicus* Sellnick, 1940. From the United States 32 taxa and Canada 7 are recorded. Two of them, *P. lukoschusi* Smiley & Whitaker, 1984 and *P. russellae* Smiley & Whitaker, 1984 are known only from the latter country.

Several years ago one of us (N. W.) donated to the Zoological Institute and Zoological Museum, University of Hamburg, a large collection of pygmephorid mites mostly from the U.S.A. They were found on 16 species of small mammals (and in one case, on a bird) or they were extracted from their nests. Most of this material represents the genus *Pygmephorus*. We determined 12 species of the genus and among them two taxa proved to be new. Their descriptions are published separately (see Dastych & Rack 1991). We recognized 6 synonyms and they are listed at the descriptions of particular species.

The objective of the present paper is a taxonomic analysis of *Pygmephorus* species from the collection, with a stress put on their intraspecific variability. Discussion on morphology of these mites, including results obtained from SEM studies, their host specificity, distribution and phylogeny is in progress and will be published in an separate paper.

Material and methods

The paper is based on 221 specimens of *Pygmephorus* from Alaska, Iowa, Indiana and New Zealand (Niue Island, South Pacific: 1 individual), collected between the years 1959–1980. The locality data, hosts and collectors are listed at the descriptions of particular taxa. The mites were preserved in 70% ethanol and later mounted on microslides in Berlese's and Swan's liquid. Cover slips were ringed with a varnish (Nitro Rubbel). Observations and measurements were carried out in phase or interference contrast.

The type material of 18 North American species of the genus has been analysed additionally. It was loaned from the National Museum of Natural History (Washington) and the Hungarian Museum of Natural History (Budapest) by kind arrangements of Mr. R. L. Smiley and Dr. S. Mahunka, respectively. For comparison we used also material from the Zoological Institute and Zoological Museum, University of Hamburg, and it comprised more than 170 specimens belonging to 24 *Pygmephorus* taxa. The above individuals originated from the Holarctic, chiefly from Europe.

Terminology of structures and setal notation is adopted from Lindquist (1977, 1986), who first homologized the standard terminology for heterostigmatic mites introduced by Granjean (1939, 1940, 1941). That terminology for the material under consideration is already explained in Dastych & Rack (1991), i. e. in the paper which is an integrate part of present work.

All specimens, with the exception of one paratype (op. cit.) are housed in the Zoological Institute and Zoological Museum, University of Hamburg.

Survey of species

Pygmephorus idei Smiley & Whitaker, 1979 (Fig. 2)

Material examined: 1 female.

IOWA: From *Blarina brevicauda* (Say, 1823), Cedar Falls, Black Hawk County, 31 Dec 1971, coll. G. M. Banowetz.

Remarks: The body is 340 μm long. The specimen characters agree well with those found in the holotype. Gnathosomal dorsum with three pairs of setae.

Cheliceral setae ch_1 and ch_2 are long and distinctly barbed, supracoxal setae pp are short and smooth. Setae on idiosomal dorsum have long and thin barbs. Setae e are 40 μm long, setae h_2 are 36 μm in length. Distance between setae e and f is large. Setae 1c are slightly flattened in apical parts and their lateral edges are thickened and barbed. Between the edges there occurs a thin and weakly sclerotized chitinous membrane which in transmitted light microscope gives an impression of the seta bifurcation. Setae 2c are thicker than setae 2b (1.4 and 1.1 μm wide, respectively) and they are similar in shape. Setae GeIV v' are blade-like and smooth. Setae TiIV v' are slightly barbed. Smooth and small claws II-III are similar in shape and size and without thickened base. Claws IV are slightly larger. Empodia on legs II-III are distinctly trilobate (Fig. 2).

P. dei is similar to *P. igleharta* Smiley & Whitaker, 1984. The latter taxon can be separated by its thick and short barbs on dorso-idiosomal setae, rod-like and thicker setae 2c as compared to 2b (in the holotype of *P. igleharta* they are 3.3 and 2.2 μm wide, respectively), different shape of empodia (comp. Figs. 1 and 2) and by its larger claws II. In *P. igleharta* the claws II are ribbed and with thickened bases as compared to smooth and simple claws III and IV. Moreover, setae in *P. dei* are relatively thin and setiform but thicker and rod-like in *P. igleharta*.

Distribution: Hitherto reported from *Sorex* sp. and a waste facility in Montana and Ohio, respectively (Smiley & Whitaker 1979). New for Iowa.

Pygmephorus stammeri Krczal, 1959
(Fig. 3)

1979 *Pygmephorus brevicaudae* Smiley & Whitaker (new synonym)

Material examined: 14 females.

IOWA: 3 ♀ from *Blarina brevicauda* (Say, 1823), Sageville, Dubuque Co., 16 Nov 1977, coll. N. Wilson; 2 ♀, same host, Waterloo, Black Hawk Co., 30 Sept 1978, coll. B. V. Dumkrieger; 1 ♀, same host, Cedar Falls, Black Hawk Co., 14 Sept 1976, coll. N. Wilson. ALASKA: 6 ♀ from *Peromyscus sitkensis* Merriam, 1897, Baranof I., Sitka 8.8 km N (Starrigavan Creek), 16 June 1979, coll. G. E. Haas; 1 ♀ from nest of Bank Swallow (*Riparia riparia* [Linnaeus, 1758]), Yukon River, Tops Haul Road Bridge, 31 Aug 1978, coll. T. Rumpfelt; 1 ♀ from *Clethrionomys rutilus* (Pallas, 1778), Yakutat, 4.4 km SE, 21 June 1979, coll. G. E. Haas.

Remarks: The body length is 235–350 μm . A variable species. The taxon is well characterized by its strikingly large distance between bases of setae e and f, barbed and relatively long setae e and h_2 and by characteristic roundish chitinous thickening inside the tibiotarsus I, near solenidia ϕ . The thickening is distinctly separated from the lateral wall of the limb, as seen in the optical plane of solenidia ϕ (Fig. 3). Cheliceral setae ch_1 and ch_2 are almost equal in length, relatively long and barbed; setae pp are short and smooth. The length of hysterosomal setae varies, setae e and h_2 are more or less barbed, the setae e are longer and thicker. The setae h_2 are 41–83 % of the length of setae e ($n = 12$) and they are usually $\frac{1}{3}$ thinner. The distance between their bases is large (15–23 μm). Apodemes 5 and poststernal apodeme are inversely "Y" shaped. The following setae on legs II–IV are blade-like and smooth: TaIII pl', TrIV v', FeIV v' and TaIV pl'. Setae GeIV v' are setiform and barbed. Seta TiIV v' is formed as a long and distinctly barbed spine. Seta FeII v' is placed distinctly anterior of seta FeII d. Seta FeIII v' and FeIII d are long, setiform and barbed. From all tarsal setae on leg II, the setae TaII tc' are the widest. Claws II and III are similar in size, relatively small, with thickened bases and smooth. Two specimens have these claws with barely discernible ribbing. The specimens from Alaska differ slightly from the remaining material by the reduced number and size of the setal barbs

(particularly on setae ps_1 - ps_3 which are either smooth or with only 1-2 barbs) and by relatively smaller distance between setae e and f (9-14 μ m).

The characters of the examined specimens agree well with those found in the comparative material of *P. stammeri* Krczal, 1959 from Europe and Japan, determined on the base of syntype (Rack 1975). They also agree well with the holotype of *P. brevicaudae* Smiley & Whitaker, 1979. Some discrepancies between the type specimen of *P. brevicaudae* and its original description are as follow. Seta 4b is longer than that one depicted (Smiley & Whitaker 1979: Fig. 21) and seta 1c is only apparently bifurcated, being shaped as that in *P. idei*. Moreover, some discrepancies between the holotype and its original illustration (op. cit.: Fig. 22) occur in the chaetotaxy of tibiotarsus I.

The above data indicate that *P. brevicaudae* and *P. stammeri* are conspecific and the former taxon is recognized here as a junior synonym of *P. stammeri*. Remarkably, another similar species, *P. similis* Mahunka, 1969 described from Mongolia, may also prove to be a synonym of the above taxon. The difficulties to separate those species have been discussed in Rack (1975).

Distribution: Known from Germany, Norway and Japan (Rack 1975). Under the name of *P. brevicaudae* it was described from one specimen found in Indiana (Smiley & Whitaker 1979). Its recent presence also in a bird nest is, to our knowledge, the first case of such a habitat for the genus *Pygmephorus*. New for Alaska and Iowa.

Pygmephorus johnstoni Smiley & Whitaker, 1979

1979 *Pygmephorus wrenschae* Smiley & Whitaker (new synonym)

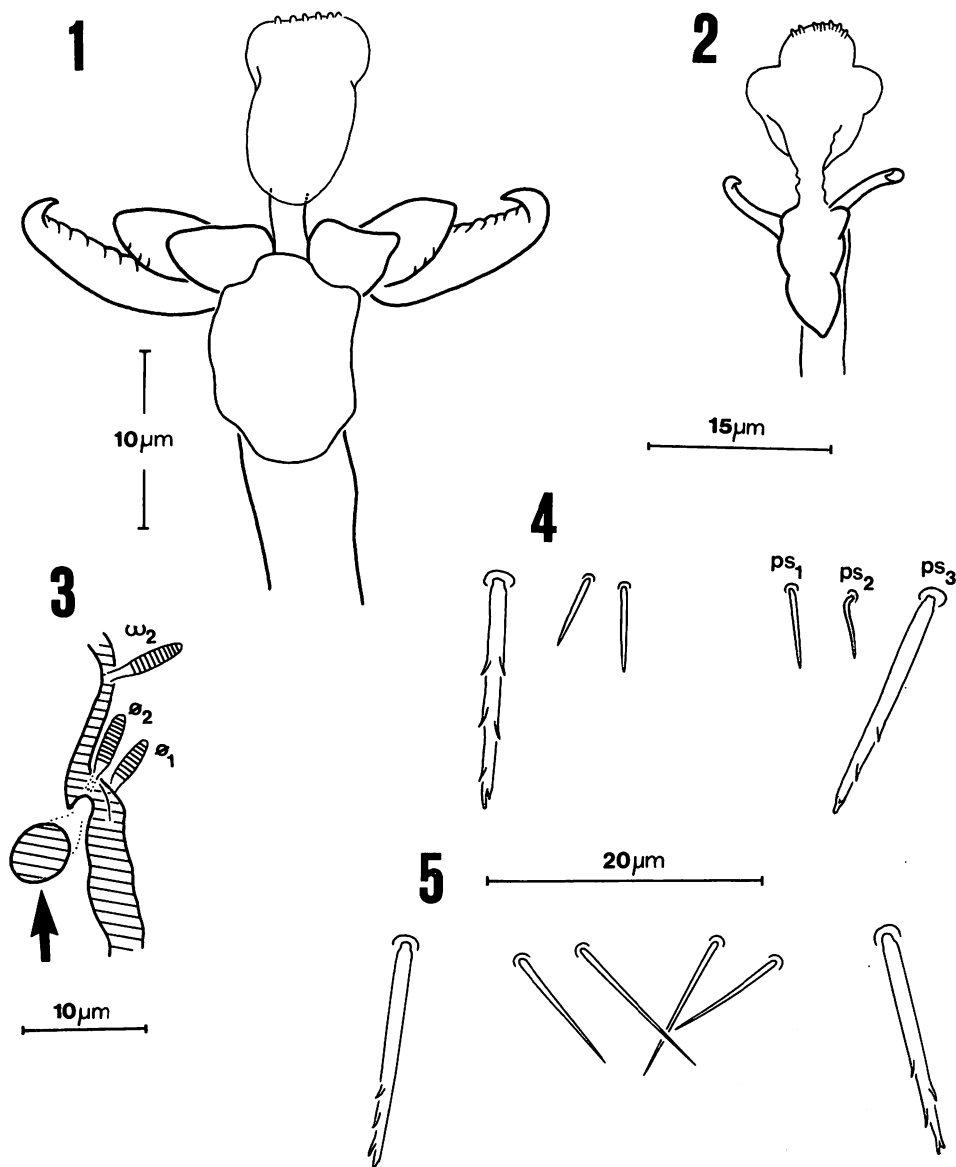
Material examined: 2 females.

IOWA: 1 ♀ from *Rattus norvegicus* (Berkenhout, 1769), Sageville, Dubuque Co., 23 Sept 1977, coll. N. Wilson. INDIANA: 1 ♀ from a Starling (*Sturnus vulgaris* [Linnaeus, 1758]), West Lafayette, Tippecanoe Co., 16 May 1959, coll. T. L. Chandler.

Remarks: Length 361 and 395 μ m. Specimens agree well with holotype and original description. Three pairs of dorsal smooth gnathosomal setae (ch_1 , ch_2 , pp) are present. Caudal setae ps_1 and ps_2 are smooth, setae ps_1 are slightly longer. Setae ps_3 are the longest and with 1-2 small barbs. Tips of setae FeI d are terminated with 2 small denticles. Tibiotarsus I is deprived of characteristic chitinous thickening. Claws II and III are of similar size and relatively small. The claws II have either barely discernible traces of ribbing or, like claws III, they are smooth.

The species is strikingly similar to *P. whitakeri* Mahunka, 1973 but differs by its rod-like seta FeII v" which is blade-like or spiniform in the latter taxon (but more or less barbed in both species). Moreover, *P. whitakeri* has larger and distinctly ribbed claws II and III as compared to those in *P. johnstoni*.

The characters observed in holotype of *P. wrenschae* Smiley & Whitaker, 1979, another similar species, are formed similarly as those in the holotype of *P. johnstoni*. No significant specific differences could be detected in the original illustrations of these taxa as well (Smiley & Whitaker 1979: Figs. 32-36 and Figs. 37-41). The describers separated *P. wrenschae* from *P. johnstoni* (op. cit.) by "setae ph_2 being longer and equal in length to ph_1 , whereas ph_2 is short and unequal in length to ph_1 on *johnstoni*. Setae pi and pr are equal in length on *johnstoni* and unequal on *wrenschae* ... Seta 1c is not bifurcate on *wrenschae* but is bifurcate on *johnstoni* ...". The statement about differences between setae ph_1 and ph_2 (= ps_1 and ps_2) is rather unclear. In the type material of these both species the setae are similarly developed, i. e. setae ps_1 are slightly longer than setae ps_2 (ps_1 = 5.5 μ m, ps_2 = 4.4 μ m in *P. wrenschae*; 6.0 and 5.5 μ m in *P.*



Figs. 1-5: 1 - *Pygmephorus iglehartae* Smiley & Whitaker, claws of leg II (holotype); 2 - *Pygmephorus idei* Smiley & Whitaker, claws of leg II; 3 - *Pygmephorus stammeri* Krczal, fragment of tibiotarsus I with thickening (arrow); 4-5 - *Pygmephorus spinosus* Kramer, caudal setae (Figs. 4-5: specimens from Holland.)

johnstoni). Moreover, there is no significant differences between the length of setae pr and pi ($= v_1$ and sc_2) in these taxa. The setae v_1 are slightly longer (60 μm) and than sc_2 (58 μm) in the holotype of *P. johnstoni* (thus, they are not equal in length). On the other hand, in the holotype of *P. wrenschae* the setae v_1 and sc_2 are of the same length (40 μm) on one side of the propodosoma, but the seta v_1 (43 μm) is slightly longer than the seta sc_2 (38 μm) on the other side of the body. The setae $1c$ are similarly developed in both examined holotypes, i. e. each seta is characteristically but only apparently separated along its median line. This

character is also well visible in the holotype of *P. wrenschae*, but only on one side of the body, where the seta is positioned dorso-ventrally. In its lateral position, as seen on another side of the body, the seta 1c makes an impression as being setiform, thus, is visible there as "not bifurcate".

The lack of significant differences between type specimens of the above taxa indicates that *P. wrenschae* should be recognized as a synonym of *P. johnstoni*.

Distribution: Reported from Ohio, Indiana and Oregon on small mammals, in old straw and manure (Smiley & Whitaker 1979). Present record of occurrence of the species on a bird is, to our knowledge, the first case of such a host for the genus *Pygmephorus*. New for Iowa.

Pygmephorus spinosus Kramer, 1877
(Figs. 4–5)

1979 *Pygmephorus hamiltoni* Smiley & Whitaker (new synonym)

Material examined: 28 females.

IOWA: 3 ♀, from *Blarina brevicauda* (Say, 1823), Cedar Falls, 23 Nov 1979, coll. N. Wilson; 3 ♀, the same host and locality, 25 Oct 1972, coll. D. V. McCalley; 2 ♀, as above, 22 Sept 1971, coll. G. M. Banowetz; 1 ♀, the same host, Finchford, (Cedar Hills, Sand Prairie), 30 Oct 1969, coll. R. E. Brunk; 1 ♀ from *Peromyscus leucopus* Rafinesque, 1818, Cedar Falls, 20 March 1978, coll. N. Wilson; 1 ♀, same host, Waterloo, 26 Oct 1977, coll. M. F. Dursa; 1 ♀ from *Procyon lotor* (Linnaeus, 1758), Cedar Falls, 12 Dec 1978, coll. N. Wilson (all the above sites are situated in Black Hawk Co.); 2 ♀ from *Blarina brevicauda* (Say, 1823), Lehigh (Brushy Creek Recreation Area), Webster Co., 30 Sept 1979, coll. N. Wilson; 1 ♀, the same host, Pella (0.5 km S, 4 km W), Marion Co., 10 Oct 1971, coll. J. B. Bowles; 1 ♀ from *Peromyscus maniculatus* (Wagner, 1845), Pella, Marion Co., 2 May 1972, coll. K. D. Curry; 9 ♀ from *Scalopus aquaticus* (Linnaeus, 1758), Cleghorn (1.6 km N, 6.4 km E), Cherokee Co., coll. D. J. Witt. INDIANA: 1 ♀ from *Blarina brevicauda* (Say, 1823), Marshall (Turkey Run State Park), Parke Co., 30 Sept 1964, coll. R. E. Mumford. ALASKA: 1 ♀ from *Sorex vagrans* (Baird, 1858), Skagway, 4 km NE, 15 Aug 1980, coll. G. E. Haas; 1 ♀ from *Sorex vagrans* (Baird, 1858), Pedro Bay, 11 Sept 1979, coll. G. E. Haas.

Remarks: The body length is 330–518 µm. Gnathosomal dorsum with only one pair of cheliceral setae ch_1 which are short and smooth. Supracoxal setae pp are also short. Seta FeI d terminates as an asymmetrical, flattened and sharp-tipped spine. In one specimen the setae are slightly bidentated at their tips. Chitinous thickening inside tibiotarsus I is well developed and cone-like, as compared to roundish shaped in *P. stammeri*. Its wide tip is coalesced with lateral wall of the limb, as seen in the optical plane of solenidion ϕ . Claws II and III are large and distinctly ribbed and with thickened bases. Apodemes 5 are perpendicular to the median axis of the body, wide and rather strongly sclerotized.

The confused taxonomy of *P. spinosus*, a type species for the genus, has been discussed by Krczal (1959) and Rack (1966). The species is recognized as a highly variable taxon (Rack 1975). Its type material cannot be traced and consequently, recent redescription of *P. spinosus* (see Smiley & Whitaker 1979) is based on "specimens obtained from Gisela Rack, University of Hamburg". Unfortunately the authors provide no other data about the origin of the material and the collection of *P. spinosus* housed in Hamburg comprises numerous and variable specimens of the species from the whole Holarctic, including those from terra typica, i. e. Northern Germany.

The specimen of *P. spinosus* figured by Smiley & Whitaker (1979, 1984: Fig. 1) has relatively long caudal setae ps_1 and ps_2 , a character rarely found by us among the reexamined European individuals deposited in Hamburg (Fig. 5). The majority of specimens (listed in Rack 1975) have the setae distinctly shorter (Fig. 4) and that also includes the North American material discussed here.

Moreover, distances between caudal setae vary considerably. Often the distance between setae ps_1 and ps_2 is equal to that between setae ps_2 and ps_3 . The shape of setae ps_3 and their barbs is also a subject to variation. They are often not rod-like but setiform and almost smooth (then with 1–2 barbs) or even completely smooth as found in 3 specimens. The length ratio between the setae FeII d and FeII v' illustrated by Smiley & Whitaker (1979: Fig. 4) should be considered as an extreme case for *P. spinosus*, where the seta FeII v' is only 40 % of the length of the seta FeII d. That ratio, a highly variable character, usually lies between 53–90 % ($n = 28$). Setae FeII v" are not setiform in numerous specimens but short and spine-like, similar to those in *P. whitakeri* Mahunka, 1973. They are always more or less barbed. It should be noted that the length of setae h_2 also varies and they can be considerably shorter as those figured by the above authors (op. cit.).

P. spinosus closely resembles *P. hamiltoni* Smiley & Whitaker, 1979. It should differ by longer setae ps_1 , ps_2 and 2c as compared to those in the latter taxon (see Smiley & Whitaker 1979). Moreover, *P. hamiltoni* is characterized by "...large palpal solenidia and the extremely long solenidia (W_1 and W_2)..." and "setae ph_1 and ph_2 being almost contiguous..." (op. cit.). However, these and other characters observed in the holotype of *P. hamiltoni* agree well with those found in the examined specimens of *P. spinosus* from Europe and North America. The variability of these characters falls inside the range known for the latter species. It is worthy noting that solenidia ω_1 and ω_2 which are 14 and 15 μm long in the holotype of *P. hamiltoni* (its palpal solenidium is 7.7 μm long), are even slightly smaller than those which we have observed in the largest specimens of *P. spinosus*. Moreover, and that should be stressed, both taxa have only one pair of cheliceral setae (ch_1).

Another character which should separate these two species and was presented in identification key (op. cit.: couple 43 and 44) is the length ratio between setae e and f (termed there: pe_2 and pe_1 , respectively). For *P. spinosus* seta pe_2 should be " $\frac{1}{2}$ length of pe_1 " and for *P. hamiltoni* "clearly shorter than $\frac{1}{2}$ length of pe_1 " (op. cit.). That ratio, however, varies considerably in *P. spinosus* and in the European material the length of seta e is 28–48 % of the length of seta f ($\bar{x} = 40.2\%$; $n = 21$) and 39–46 % in the specimens from the U.S.A. ($\bar{x} = 42.3\%$; $n = 10$). In the holotype of *P. hamiltoni* the ratio is equal 44 %.

Considering the above data and the high variability of *P. spinosus* we propose to recognize *P. hamiltoni* as a junior synonym of the former taxon.

Distribution: *P. spinosus* has been found on many species of small mammals in the Holarctic (see Krczal 1959, Mahunka 1973, Rack 1975, Smiley & Whitaker 1979). In the U.S.A. it has been reported from Minnesota, Indiana and New Jersey. As *P. hamiltoni* it is recorded from North Carolina and Indiana. New for Alaska and Iowa.

Pygmephorus rackae Smiley & Whitaker, 1979

Material examined: 2 females.

IOWA: 1 ♀ *Blarina brevicauda* (Say, 1823), Lehigh (Brushy Creek Recreation Area), Webster Co., 30 Sept 1979; 1 ♀, the same host, Cedar Falls, Black Hawk Co., 15 Sept 1976: both specimens collected by N. Wilson.

Remarks: The body is 392 and 406 μm long. In general, the specimens agree with original description and holotype. However, caudal setae ps_1 and ps_2 are longer (including holotype) as those figured by Smiley & Whitaker (1979: Fig. 10), i. e. they are of the same length as setae ps_3 or are only slightly shorter. All caudal setae are covered with strongly reduced 1–3 barbs. The bases of setae FeII d and FeII v' are aligned almost transversely (see Smiley & Whitaker 1984:

Fig. 21). Several small barbs occur on seta TiIV v' in the holotype and in one of the examined specimens. Another individual with strongly reduced barbs has the setae ps₁, ps₂ and TiIV v' smooth. Apodemes 5 are strongly sclerotized and very gently arched, i. e. almost perpendicular to the main body axis.

According to Smiley & Whitaker (1979) *P. rackae* closely resembles *P. horridus* Mahunka, 1973 and *P. moreohorridus* Mahunka, 1975. However, that taxon is more similar to *P. spinosus* and *P. scalopi* Mahunka, 1973. *P. rackae* can be distinguished from *P. spinosus* by transversal alignment of setae FeII d and FeII v' (the seta FeII v' is located much more anteriorly relative to FeII d in the latter taxon), longer setae ps₁ and ps₂ and usually slightly barbed setae TiIV v' (smooth in *P. spinosus*). Moreover, in *P. rackae* dorsal setae d, f, h₁ and h₂ are relatively longer.

The considered species differs chiefly from very similar *P. scalopi* by the length and shape of setae h₂ and shape of apodemes 5. In *P. rackae* the needle-like setae h₂ are smooth and about ½ shorter and thinner than setae e. In *P. scalopi* the setae h₂ are barbed, longer and thicker and apodemes 5 (and poststernal apodeme) are inversely "Y" shaped. The insertion of setae FeII d and FeII v' is similarly developed in these both taxa.

Presence of only one pair of cheliceral setae (ch₁) in *P. spinosus* and two pairs in *P. rackae* and *P. scalopi* also helps to separate the discussed taxa.

Distribution: Known from Indiana, Minnesota and Missouri (Smiley & Whitaker 1979). New for Iowa.

Pygmephorus scalopi Mahunka, 1973

1984 *Pygmephorus utamarae* Smiley & Whitaker (new synonym)

Material examined: 3 females.

IOWA: 2 ♀ from *Blarina brevicauda* (Say, 1823), Cedar Falls Black Hawk Co., 22 Sept 1971, coll. G. M. Banowetz; 1 ♀, the same host, Lehigh (Brushy Creek Recreation Area), Webster Co., 17 Sept 1979, coll. N. Wilson.

Remarks: A highly variable species. The examined specimens agree with 2 paratypes and original description. Cheliceral setae ch₁ and ch₂ are smooth. The length of hysterosomal setae d, f and h₁ increases posteriorly and they are distinctly longer as compared to related taxa. Setae v₂ have tiny barbs. Caudal setae ps₁ and ps₂ are about ¼ shorter than ps₃ and distinctly barbed. Setae h₂ are relatively long (their length is 70–95 % of the length of setae e) and scarcely barbed; in the smallest specimen they are, however, smooth. Apodemes 5 and poststernal apodeme are inversely "Y" shaped. The modified subunguinal seta s on tibiotarsus I is short. Seta FeII d and FeII v' are aligned almost transversely. Seta GeIV v' is spine-like but more or less barbed and slightly longer than seta FeIV v'. Seta TiIV v' has several barbs. Empodial stalks III are relatively long.

Examined holotype of *P. utamarae* Smiley & Whitaker, 1984 agree well with 2 paratypes of *P. scalopi* and 3 specimens studied here. In our opinion these two taxa are conspecific and *P. utamarae* is a junior synonym of *P. scalopi*.

Distribution: Recorded from several mammalian hosts in Indiana, Minnesota, Illinois and Missouri (Mahunka 1973, 1975, Smiley & Whitaker 1979). As *P. utamarae* it was described from the two latter states. New for Iowa.

Pygmephorus trisetosus Dastyh & Rack, 1991

Material examined: 3 females.

ALASKA: 2 ♀ from vole nest, Good News Bay, 15 Nov 1978, coll. G. E. Haas; 1 ♀ from *Sorex vagrans* (Baird, 1858), Scammon Bay, 13 June 1980, coll. G. E. Haas & S. Goodman.

Remarks: The species, characterized by unique presence of three setae on femur IV, has been described separately (Dastych & Rack 1991).

Pygmephorus plurispinosus Mahunka, 1975

Material examined: 40 females.

IOWA: 11 ♀ from *Sorex cinereus* (Kerr, 1792), Finchford, Black Hawk Co., 24 April 1971, coll. N. Wilson; 2 ♀ from *Blarina brevicauda* (Say, 1823), Lehigh (Bushy Creek Recreation Area), Webster Co., 30 Sept 1979, coll. N. Wilson. ALASKA: 15 ♀ from *Sorex vagrans* (Baird, 1858), Scammon Bay, 13 June 1980, coll. G. E. Haas & S. Goodman; 8 ♀ from *Sorex vagrans* (Baird, 1858), Kenai Peninsula, Seward, 3 Nov 1979, coll. G. E. Haas & T. Rumpfelt; 2 ♀ from *Sorex cinereus* (Kerr, 1792), Tuluksak, 1 Aug 1980, coll. G. E. Haas; 1 ♀ from *Clethrionomys rutilus* (Pallas, 1778), Dillingham, 26 Oct 1978, coll. G. E. Haas; 1 ♀, the same host, Grayling, 30 Aug 1979, coll. G. E. Haas.

Remarks: The body length is 238–560 µm. The specimens agree well with holotype and original description. Only one pair of cheliceral setae (ch_1) is present. The setae ch_1 are short and smooth. In specimens from Alaska the setae ch_1 bear usually 1–3 tiny barbs. Apodemes 5 are similar in shape to those in *P. scalopi*. Caudal setae ps_1 and ps_2 are more or less barbed and distance between them is slightly larger than that figured by Mahunka (1975: Fig. 11). The setae e and h_2 are always smooth, the latter ones are usually slightly shorter and thinner than setae e . The length of setae h_2 is 70–93% of the length of setae e . In one specimen both setae are of equal length. The modified subunguinal seta s is relatively long. Seta FeII d is usually about $\frac{1}{2}$ longer than that one illustrated by Mahunka (1975: Fig. 12). Setae FeIII v' are always smooth and blade-like and usually $\frac{1}{2}$ – $\frac{1}{2}$ shorter than setae FeIII d. Claws II and III are of median size and more or less ribbed. The claws III are smooth in the smallest specimen. Setae TiIV v' are usually smooth, but in two Alaskan specimens they are provided with 1–4 minute barbs. These barbs are developed in two specimens only on one leg.

P. plurispinosus is the only species known from North America with blade-like and smooth setae FeIII v'. In the genus *Pygmephorus* this character has been found in two other taxa, i. e. *P. sicarius* Mahunka, 1969 from Mongolia and *P. kumadai* Sasa, 1961 from Japan. From these taxa *P. plurispinosus* can be readily separated by its only one pair of cheliceral setae (ch_1) (two pairs, ch_1 and ch_2 , in the mentioned taxa) and its setiform and barbed setae FeII v' which are blade-like and completely smooth in *P. sicarius* and *P. kumadai*.

Distribution: Hitherto known from only one specimen found in Washington (Mahunka 1975). New for Alaska and Iowa.

Pygmephorus whitakeri Mahunka, 1973

1985 *Pygmephorus sylvilagus* Kaliszewski & Rack (new synonym)

Material examined: 84 females.

IOWA: 64 ♀ from *Blarina brevicauda* (Say, 1823), Lehigh (Brushy Creek Recreation Area), Webster Co., 7 and 30 Oct 1979, coll. N. Wilson; 2 ♀, the same host, Cedar Falls, 5–6 Sept 1974 and 31 Oct 1980, coll. N. Wilson; 1 ♀, same host, Cedar Falls, 23 Oct 1971, coll. G. M. Banowetz; 1 ♀ from *Mustela erminea* Linnaeus, 1758, Cedar Falls, 22 Nov 1978, coll. N. Wilson; 1 ♀ from *Sorex cinereus* Kerr, 1792, Finchford, 24 April 1971, coll. N. Wilson (all sites in Black Hawk Co.); 4 ♀ from *Blarina brevicauda* (Say, 1823), Sageville, Dubuque Co., 12 Nov 1977, coll. N. Wilson; 1 ♀ from *Peromyscus leucopus* Rafinesque, 1818, 7 Oct 1977 (the data as above); 1 ♀ from *Blarina brevicauda* (Say, 1823), Pella (0.5 km S, 5 km W), Marion Co., 10 Oct 1971, coll. J. B. Bowles. ALASKA: 4 ♀ from *Sorex vagrans* (Baird, 1858), Pedro Bay, 11 Sept 1979, coll. G. E. Haas; 2 ♀, the same host, Yakutat (4.4 km SE), 20 June 1979, coll. G. E. Haas; 1 ♀, the same host, Seward, Kenai Peninsula, 3 Nov 1979, coll. G. E. Haas & T. Rumpfelt; 1 ♀ from *Sorex cinereus* (Kerr, 1792), Klukwan (9.5 km NW), 11 Aug 1980; 1 ♀ from *Sorex vagrans* (Baird, 1858), Skagway, 15 Aug 1980 (both specimens coll. G. E. Haas).

Remarks: A variable species. The body length is 255–512 μm . The examined specimens agree with two paratypes and original description. Dorsal gnathosomal setae (ch_1 , ch_2 , pp) are relatively short and smooth. Setae h_2 are short and usually they are $\frac{1}{4}$ – $\frac{1}{3}$ of the length and width of setae e . Seta 1c is flattened in its apical part, barbed and thickened on its lateral edges and only apparently bifurcated (see remarks in *P. ideii*). The location of setae ps_2 is highly variable. According to Mahunka (1973) the distances between setae ps_1 , ps_2 and ps_3 are "approximately equal". However, such a distribution of setae has been only found in 18 % of the examined individuals. Usually the setae ps_2 are located more or less close to setae ps_3 . The equal distances between these setae have been often found only on one side of the body and different on another side. Seta ps_2 is slightly smaller than ps_1 and they both are always smooth. The setae ps_3 are setiform and with 2–3 small barbs; often they are smooth. Chitinous thickening inside tibiotarsus I is formed similarly to that in *P. spinosus* Kramer. Seta TrI v' is relatively long and distinctly barbed. Setae FeI d are terminated as asymmetrical, sharp and flat spines. Setae FeII v'' are spine-like, shorter than FeII d but variable in length and more or less barbed. Seta TiIV v' is relatively long, spine-like and always smooth. Claws II and III are large, distinctly ribbed and with thickened bases.

P. whitakeri is strikingly similar to *P. sylvilagus* Kaliszewski & Rack, 1985. The reexamination of type material of *P. sylvilagus* (holotype, paratype) and its comparison with that of *P. whitakeri* leaves no doubt that both taxa are conspecific. Moreover, the type specimens of *P. sylvilagus* agree well with the material examined in present studies. Thus, the taxon is recognized here as a junior synonym of *P. whitakeri*. Some discrepancies observed between type specimens of *P. sylvilagus* and its original description are as follow. Seta 1c is only apparently bifurcated (see remarks in *P. ideii*). Seta TrI v' is not short, smooth and directed anteriorly as originally depicted (Kaliszewski & Rack 1985: Fig. 2) but 3–4 times longer, distinctly barbed and directed ventrally. The notation of the legs setae differs in several aspects from that proposed by Lindquist (1976).

P. whitakeri can be easily misidentified as *P. spinosus* Kramer when its setae FeII v'' are spine-like and the location and length of setae ps_2 considerably varies. However, its different number of cheliceral setae (2 pairs versus 1 pair in *P. spinosus*) well separate these species.

Distribution: Reported from numerous small mammalian hosts and localities in the U.S.A. and Canada (Mahunka 1973, 1975, Smiley & Whitaker 1979, Whitaker et al. 1982). The type material of *P. sylvilagus* was erroneously listed as being from Terre Haute, Iowa. This should be corrected to Terre Haute, Vigo Co., Indiana. New for Iowa and Alaska.

Pygmephorus designatus Mahunka, 1973

1965 ? *Pygmephorus* sp. nr. *spinosus* Cross: 267, Figs. 59–60

1975 *Pygmephorus equitrichosus* Mahunka (new synonym)

Material examined: 16 females.

IOWA: 1 ♀ from *Didelphis virginiana* Kerr, 1792, Cedar Falls, Black Hawk Co., 16 Dec 1978, coll. N. Wilson; 1 ♀ from *Spermophilus tridecemlineatus* Mitchell, 1821, as above, 22 April 1974, coll. G. B. Porter; 2 ♀ from *Peromyscus leucopus* Rafinesque, 1818, Sageville, Dubuque Co., 12 Nov 1977, coll. N. Wilson; 1 ♀ from *Rattus norvegicus* (Berkenhout, 1769), 23 Sept 1977, as above; 2 ♀ from *Blarina brevicauda* (Say, 1823), Osborne, Clayton Co., 15 May 1976, coll. N. Wilson; 1 ♀ from *Blarina brevicauda* (Say, 1823), Lehigh (Brushy Creek Recreation Area), Webster Co., 30 Sept 1979, coll. N. Wilson. INDIANA: 7 ♀ from *Blarina brevicauda* (Say, 1823) nest, Hovey (Cypress Slough), Posey Co., 13 April 1958, coll. N.

Wilson. NEW ZEALAND (Palai, Niue Island): 1 ♀ from *Rattus rattus* (Linnaeus, 1758), 19 May 1971, coll. L. Touelima.

Remarks: A variable species. The body is 272–434 μm long. Two pairs of cheliceral setae; the setae ch_1 are about $\frac{1}{4}$ longer than setae ch_2 and bear 2–3 small barbs. Setae pp are in longitudinal alignment with the setae ch_2 and they are placed anteriorly. The shape of propodosomal setae v_2 varies. The setae are formed either as a short and smooth spines or they are longer and then covered with a few barbs. Between these two types, intermediate stages have been found. Setae sc_2 , c_2 , f and h_1 are long. The setae sc_2 are slightly longer than setae h_1 or they are equal in length. Setae e and h_2 are blade-like and always smooth; the setae h_2 are usually slightly shorter. The length of setae e is 17–28 μm (\bar{x} = 21.0 μm ; n = 15), the seta h_2 is 17–25 μm long (\bar{x} = 17.4 μm ; n = 15). The length of setae h_2 is 66–95 % of the length of setae e (\bar{x} = 85.0 %; n = 15). The location of the bases of setae e and f varies and they are rarely in transversal alignment. Setae $1c$ are not bifurcated and they are formed similarly to those in *P. whitakeri*. Setae ps_1 – ps_3 are long and distinctly barbed. They are either equal in length or the setae ps_3 are slightly longer. The distance between setae ps_1 and ps_2 vary. Usually, distance between both setae ps_1 is shorter than that between ps_1 and ps_2 . Apodemes 5 and poststernal apodeme resemble to some degree inverted “Y”.

Modified subunguinal seta s on tibiotarsus I is relatively long. Seta $FeI d$ is short, flattened and with asymmetrically terminated tip. Setae $FeII v'$ are inserted anteriorly of setae $FeII d$. Among all tarsal setae on leg II, the setae $TaII tc'$ are the widest and bear strong barbs. Setae $TiIV v'$ are usually smooth, but in 4 specimens they are covered with several strongly reduced barbs. Claws II and III are small, with thickened bases and either smooth or with barely discernible ribbing.

No significant specific differences could be detected between type material (holotype, paratype) of *P. designatus* Mahunka, 1973 and that of *P. equitrichosus* Mahunka, 1975. No such differences have been found in original descriptions of these taxa as well. The distinctly shorter setae ps_1 and ps_2 figured in *P. designatus* by Mahunka (1973: Fig. 3), as compared to those in *P. equitrichosus* have been found in the paratype of the former species. However, that length difference is due to broken off tips of the setae. Moreover, in original figure of *P. equitrichosus* setae h_2 seem to be slightly barbed (Mahunka 1975: Fig. 1), but in the paratype they are smooth.

Smiley (1978) separates these taxa (op. cit.: p. 127, identification key, couple 4) basing on “blade-like seta on tibia IV” (= $TiIV v'$) which is “slender and slightly barbed” in *P. equitrichosus* and “stout and not barbed” in *P. designatus*. In the holotype of *P. equitrichosus* the seta $TiIV v'$ is smooth on both legs, but in paratype it is smooth on one leg only and covered with four tiny barbs on another leg. In the type material of *P. designatus* the setae are smooth on both legs. Thus, that character varies and the mentioned differences are recognized here as an intraspecific variability of only one species. The above remark includes the variable length ratio between setae e and h_1 (comp. Smiley & Whitaker 1979: p. 386, couple 10 and 13) as well.

In our opinion these taxa are conspecific and *P. equitrichosus* is a junior synonym of *P. designatus*.

Distribution: Known from several mammalian hosts in Indiana, Virginia, North Carolina and Illinois (Mahunka 1973, 1974, 1975; Smiley & Whitaker 1979, 1984). New for Iowa and New Zealand (Niue Island).

Pygmephorus horridus Mahunka, 1973

Material examined: 28 females.

ALASKA: 6 ♀ from *Sorex vagrans* (Baird, 1858), Kenai Peninsula, Hidden Lake Creek, 23 May 1978, coll. G. E. Haas; 5 ♀ from *Clethrionomys rutilus* (Pallas, 1778), Yakutat (4.4 km SE), 21 June 1979, coll. G. E. Haas; 8 ♀ from *Sorex vagrans* (Baird, 1858), as above, 20–21 June 1979, coll. G. E. Haas & S. Strange; 3 ♀ from *Sorex cinereus* (Kerr, 1792), as above, 20 June 1979, coll. G. E. Haas; 2 ♀ from *Microtus longicaudus* (Merriam, 1888), as above, 21 June 1979; 1 ♀ from *Chlethrionomys rutilus* (Pallas, 1778), Cordova (15.2 km SE: Cabin Lake Camp Ground), 13 June 1978, coll. G. E. Haas; 1 ♀ from *Sorex cinereus* (Kerr, 1792), as above, 14 June 1978; 1 ♀ from *Peromyscus sitkensis* (Merriam, 1897), Baranof I., Sitka (8.8 km N: Starrigavan Creek), 16 July 1979, coll. G. E. Haas; 1 ♀ from *Sorex vagrans* (Baird, 1858), Haines (13.5 km NW), 13 Aug 1980, coll. G. E. Haas.

Remarks: The body is distinctly elongated and has 341–568 µm in length. In general, the examined specimens agree with original description and mutilated type material (holotype, paratype). They, however, fit particularly well description and illustration of the species given by Rack (1975: Fig. 9–12) for *P. magnisetosus*. The latter taxon was synonymized with *P. horridus* by Smiley & Whitaker (1979). The species is well characterized by its very long dorsal setae sc_2 , c_1 , c_2 and d , covered by peculiar granulation composed of irregular in shape, tiny and irregularly distributed granules. Cheliceral setae ch_1 and ch_2 are relatively long, the setae ch_2 are slightly shorter. The setae are covered with minute, reduced barbs. Setae pp are short and smooth.

Strikingly elongated segment D bears a pair of long characteristic crests (folds) on its dorsum. They form some kind of longitudinal and strongly sclerotized lists which run almost paralelly to lateral edges of the segment. Similar structures, but very short and strongly reduced occur between aveoles of setae e and f on segment EF. No information about these crests is given in the original description (Mahunka 1973), but they are recorded and figured by Rack (1975). The structures have been illustrated for the first time by Willmann (1952) in *P. forcipatus*, then however, incorrectly.

Setae e are spine-like and bear more or less reduced barbs. Setae h_2 are shaped as short, blunt spines and they are usually smooth. In 7 specimens, however, they are covered with several minute and irregularly shaped granules. The length of the setae h_2 is 34–63 % of the length of setae e ($\bar{x} = 49.1\%$; $n = 27$) and the setae h_2 are about $\frac{1}{4}$ thinner. The setae e are 17–39 µm long, the setae h_2 have 9–20 µm in length. Setae $1c$ are not bifurcated but with thickened and barbed edges which are coalesced in a common tip (see remark in *P. ideii*). Caudal setae ps_1 and ps_2 are shorter than ps_3 and all these setae are covered with several reduced barbs. In 5 specimens the setae ps_1 and ps_2 are smooth. Modified subunguinal seta s is relatively long. Tibiotarsus I has distinct thickening inside, near solenidia ϕ , which is similarly shaped as that in tibiotarsus of *P. spinosus*. Seta $FeI d$ is short and flattened but terminated with two tiny denticles, usually of unequal size (see also Rack 1975: Fig. 11). Setae $TiIV v'$ are covered with short and thin barbs. Claws II and III are large, distinctly ribbed and with thickened bases.

In most characters *P. horridus* closely resembles *P. mahunkai* Smiley & Whitaker, 1979 and they belong to monophyletic group termed the “*forcipatus*”-complex (see Dastych & Rack 1991). Both taxa share the same shape of dorsal setae covered with peculiar granulation. According to Smiley & Whitaker (1979), setae e and h_2 and subunguinal seta s differ these species. The setae e and h_2 are smooth and the seta s is relatively shorter in *P. mahunkai*. The comparison between two type specimens (both badly preserved) of both species confirmed only these differences. The setae h_2 are rather blunt and relatively short in *P. horridus* but slightly longer and sharp-pointed in *P. mahunkai*. However, the

smooth setae in the holotype of *P. mahunkai* bear traces of a few minute granules (phase contrast) which may represent mentioned setal granulation. Additional material is needed to assess the taxonomic status of *P. mahunkai* and its variability. One can not exclude that its status may be downgraded to the subspecies-level or even to any ecomorph of *P. horridus*.

Distribution: Recorded frequently and abundantly on various mammalian hosts from many localities in the U.S.A. (Indiana, Minnesota, Virginia, Illinois, North Carolina, Pennsylvania, California, Alabama, Oregon, Georgia, Washington, New York) and Canada (British Columbia, Ontario, New Brunswick) (Mahunka 1973, Rack 1975, Smiley & Whitaker 1979, Whitaker et al. 1982). The species has been erroneously reported from Europe, instead of Canada (Rack 1975: "Niederlande, Hadmer"; then as *P. magnisetosus*). For that indicates the labelling of type specimens of *P. magnisetosus*, with no European locality data. New for Alaska.

Pygmephorus arcuatus Dastych & Rack, 1991

Material examined: 1 female.

ALASKA: From *Peromyscus sitkensis* Merriam, 1897, Baranof I., Sitka, 8.8 km N (Starrigavan Creek), 16 June 1978, coll. G. E. Haas.

Remarks: The species, described in separate paper (see Dastych & Rack 1991), belongs to the "*forcipatus*"-complex and is characterized by peculiar shape and size of its longitudinal crests on segment D and EF and differentiated claws II and III.

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Zusammenfassung

Es wurden phoretomorphe Weibchen der Milbengattung *Pygmephorus* (Acari: Heterostigmata), die auf 16 verschiedenen, nordamerikanischen Kleinsäugerarten festgeheftet waren, untersucht. Das Material umfaßt 221 Weibchen, die 12 Arten zugeordnet werden können. Zwei Arten davon sind neu für die Wissenschaft und werden an anderer Stelle beschrieben. Bei der systematischen Analyse der gefundenen Arten wurde besondere Aufmerksamkeit der bisher wenig bekannten morphologischen Variabilität geschenkt. So können sechs neue Synonyme in der Gattung *Pygmephorus* festgestellt werden.

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ERRATA

- p. 164, 25 and 26th line from bottom - should read: ...(Linnaeus, 1758)] nest...
- p. 166, 28th line from bottom - should read: ...Cherokee Co., 24 June 1980...
- p. 169, 13th line from bottom - the dates should read: 30 Sept and 7 Oct...
- p. 172, 11th line from top - the date should read: 16 June 1979...
- p. 173, 18th line from top - the date should read: 16 June 1979...
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