

# Probable Tritonymphal Sexual Dimorphism in *Alycus roseus* (Bimichaeliidae: Acariformes: Acari)<sup>1</sup>

J. Kethley

Field Museum of Natural History  
Chicago, IL 60605

---

J. Entomol. Sci. 26(1): 130-135 (January 1991)

**ABSTRACT** Grandjean's 1942, 1943, observations on the presence of eugenital setae in nymphs of three species of *Bimichaelia* are reviewed. New data are presented on the presence of eugenital setae in tritonymphs of *Alycus roseus* Koch. In *A. roseus*, it is suggested that male-forming tritonymphs possess two pairs of eugenital setae, and female-forming tritonymphs lack eugenital setae. The presence of eugenital setae in nymphs of species of Bimichaeliidae is hypothesized to represent an ontogenetic acceleration, a derived condition.

**KEY WORDS** Juvenile eugenital setae, juvenile sexual dimorphism, Bimichaeliidae, *Alycus roseus*, Tritonymphs.

---

The collected works of François Grandjean constitute the corner-stone of modern acarine morphology. His detailed developmental studies made possible the recognition of ontogenetic patterns that are applicable to numerous groups of acariform mites. Grandjean (1939) noted that mites possessing eugenital setae in the genital vestibule, but lacking ecdysial line  $\delta$  are adults, and individuals possessing  $\delta$  but lacking eugenital setae are juveniles. Clearly these ontogenetic correlations permit discrimination between adult and juvenile mites. However, the importance of deviations from this pattern have been overlooked. In this context, eugenital setae in an immature, or  $\delta$  in an adult represent unusual departures.

The present work reviews Grandjean's accounts of eugenital setae in nymphs of two genera of Bimichaeliidae, a condition unknown for juveniles in any other group of Acariformes. New data for *Alycus roseus* Koch, representing a third genus of Bimichaeliidae, are presented concerning tritonymphs, some possess eugenitals, some do not. A rationale is presented to permit discrimination between adults and tritonymphs of *A. roseus*. Recognition of two morphs of tritonymphs forms a probable basis of tritonymphal sexual dimorphism.

## Material Examined

The only available species of Bimichaeliidae represented by four morphs possessing 3 pairs of genital papillae was *Alycus roseus* Koch (= *Pachygnathus dugesi* Grandjean). One series, 19 females, 18 males and 8 tritonymphs was collected in the Desoto National Wildlife Refuge, 5 miles north of Fort Calhoun, Washington County, Nebraska on 15 May 1982 in flood plain-litter by Walter Suter

---

<sup>1</sup> Accepted for publication 30 October 1990.

(FMNH lot #82-144). A second series, 40 females, 26 males and 34 tritonymphs was collected at Braidwood, Will County, Illinois, on 23 July 1985 in oak leaf litter by J. Kethley and J. A. Wagner (FMNH #85-222). All tritonymphs (or abberant adults) possess the ecdysial line  $\delta$ .

**Presence of eugenital setae in nymphal Bimichaeliidae.** In early derivative Acariformes, sexual dimorphism is not pronounced as genitalia are unobservable and the numbers of genital and aggenital setae may overlap (Grandjean, 1943, pp. 11, 42, 49). The only known difference between sexes is the number of eugenital setae (Table 1), but the greater number can be in either the male or female, depending on the the taxon.

In these early derivative mites, it has been commonly held that immatures lack eugenital setae, consequently the distinction between juvenile and reproductive stages could be based on respectively, the absence or presence of eugentals. However, in the Bimichaeliidae, the eugenital chaetome is not restricted to the adults.

In the introduction to his second work on the Endeostigmata, Grandjean (1942, p. 134) stated: "Des poils eugénitaux peuvent exister avant l'adulte. J'ai constaté ce fait, pour la première fois, chez *Bimichaelia* et *Petrallycus*." The basis for this remarkable observation was given subsequently (Grandjean 1943) for three species of *Bimichaelia*. The number of eugenital setae present in the penultimate nymphs (not necessarily tritonymphs, see footnote Table 1) and respective adults is summarized in Table 1. Unfortunately, he did not provide equivalent observations for the nymphs *Petrallycus unicornis* Grandjean.

**Table 1. Number of eugenital setae in penultimate nymph and adult of 3 species of *Bimichaelia*, based on Grandjean 1943.**

Species	Stage*	Nymph		Adult	
		morph A	morph B	Female	Male
<i>B. arbusculosa</i>	N3	0	4	6	12
<i>B. campylognatha</i>	N3	2	4	4	15
<i>B. diadema</i>	N2**	2	—**	6	—**

\* N2 = deutonymph; N3 = tritonymph.

\*\* Grandjean (1943, p. 51) suggested that *Bimichaelia diadema* is parthenogenetic and lacks a tritonymph.

Grandjean's determination of the morphs indicated in Table 1 as juveniles was probably influenced by two factors: the presence of ecdysial line  $\delta$  in juveniles, and fewer eugenital setae than their respective adults. Obviously other attributes such as differences in general body size; differences in the leg, aggenital, and genital chaetotaxies; and differences in the diameter of the posterior (third) pair of genital papillae, could have influenced his determinations. However, these latter characters reflect only a relative degree of difference between nymphs and adults, and are known to vary across taxa. Conversely, the ecdysial line is an attribute of all known juveniles of early derivative Acariformes, irrespective of systematic position.

Because eugenital setae have been considered as an adult attribute, it is necessary to consider whether the specimens examined by Grandjean were juveniles or abberant adults, and if immatures and adults can be discriminated with reasonable certainty.

To avoid circular reasoning, one must establish a reference point. The reference in this study is a gravid individual, which defines an adult female (except in paedomorphic forms, e.g., Ochoa 1989). For Bimichaeliidae, gravid individuals lack  $\delta$  and possess eugenital setae and 3 pairs of genital papillae. The lack of  $\delta$  assists in the discrimination in a second morph which never contains eggs, but possesses 3 pairs of genital papillae and a different eugenital chaetome. It can be inferred that the second morph is a male.

A third morph can be recognized by the presence of 3 pairs of genital papillae and  $\delta$ , and absence of eugenital setae. This morph is inferred to be the tritonymph. At this point, the inferences of a male and tritonymph are logically and internally consistent.

For some Bimichaeliidae, a forth morph has been recognized with attributes of adults and the above tritonymph, namely, 3 pairs of genital papillae, ecdysial line  $\delta$ , and eugenital setae. To establish the identity of the fourth morph it is necessary to examine different character sets. Grandjean (1942) noted other attributes to distinguish adults from nymphs, specifically, an increase in the number of setae of the genital valves and the surrounding aggenital region.

In the study collection from *Alycus roseus* (Koch) (see Material Examined above), there are four morphs with 3 pairs of genital papillae. Using the above criteria, there are females, males, tritonymphs, and the unknown morph. The numbers of genital and aggenital setae in the four morphs were tabulated (Table 2). Both females and males consistently possess more genitals and aggenitals than tritonymphs. The counts for the fourth morph are consistently more similar to the tritonymph than to the adults. From these data one can infer that individuals of the fourth morph are more likely to be tritonymphs than aberrant adults. Although the presence of eugenital setae can no longer be taken as an unambiguous indication of an adult, the presence of  $\delta$  does continue to be an unambiguous indication of a juvenile.

**Table 2. Mean and range of number of pairs of genital and aggenital setae in *Alycus roseus* from Illinois population.**

Group	Genital setae	Aggenital setae	Number examined
Female	22.3 (18-28)	25.9 (19-31)	10
Male	20.4 (16-24)	20.1 (16-25)	10
N3 w/o*	13.1 (11-14)	12.3 (11-13)	10
N3 with*	14.6 (11-17)	12.3 (11-16)	10

**Probable tritonymphal sexual dimorphism.** Based on the presence or absence of eugenital setae, there are two tritonymphal morphs in *A. roseus* and the bimichaelid species described by Grandjean (1943), *Bimichaelia arbusculosa* and *B. campylognatha*. However, Grandjean mentioned the eugenitals, but did not discuss possible implications.

The existence of two tritonymphal morphs raises the possibility of juvenile sexual dimorphism. In the absence of pharate penultimate nymph-adult material, one can only seek to develop inferential evidence in possible support of this

supposition. Clearly any attempt of this nature without pharates requires the following conditional assumption: if nymphal sexual dimorphism exists, then it may be possible to correlate a specific nymphal condition with a specific adult condition.

There are two possible types of nymph-adult correlations that can be developed. One approach is to apply the criterion of ontogenetic setal constancy, stated as a "rule" by Grandjean (1938, p. 1835). Ontogenetic setal constancy means that a seta present in a given juvenile is also present in subsequent stages. An application of this criterion herein would predict that the number of eugenital setae present in a particular nymphal morph must be less than or equal to the number present in one of the adults. Similarly, by extension, if the number of eugenital setae of only one adult morph is derivable from only one of the nymphal morphs, then a sexual nymph-adult correlation exists. The second approach is to compare the frequency of each juvenile morph with the frequency of each adult to seek congruence when the adult sex ratio is not 50:50.

Unfortunately, an application of the criterion of ontogenetic setal constancy of *Bimichaelia* species is not useful because the number of eugenital setae in either adult is derivable from either nymphal condition (Table 1). Likewise, an estimation of the sex ratio is not possible, because Grandjean did not provide any data for *Bimichaelia* that would permit an estimate of the frequency of either tritonymphal morph. It should be noted that the deutonymph of *B. diadema* Grandjean, which possesses a single pair of nude eugenital setae, *must* be a female-forming deutonymph; this is a logical extension of Grandjean's assumption that this species is parthenogenetic.

Based on the study material, the criterion of ontogenetic setal constancy can be applied, and the frequency of each tritonymphal and adult morph computed.

*Ontogenetic setal constancy.* Of the 42 tritonymphs, 26 lack eugenital setae, and 16 possess two pairs of stellate eugenital setae (Fig. 1). Males of *A. roseus* possess 9-10 pairs of eugenital setae and females one pair (Grandjean 1936; 1937, Figs. 3B, 3C). Ontogenetic setal constancy indicates that tritonymphs possessing two pairs of eugenital setae are the penultimate stage of the male, and tritonymphs lacking eugenital setae are the penultimate stage of the female. The reverse interpretation would require the suppression of one pair in the female, and violate this criterion.

*Frequency of each morph.* The sample size is relatively small for the Nebraska population, but appears to have a sex ratio of 50:50 ( $N = 37$ ), a value that does not permit a correlation between respective juvenile and adult morphs. The Illinois population is larger and slightly skewed with 60% females and 40% males ( $N = 66$ ). Of the 34 tritonymphs in the Illionis sample, 23 (67%) lack eugenital setae and 11 (33%) possess two pairs of eugenital setae. Congruence is found between the relative frequencies of males (40%) with tritonymphs possessing two pairs of eugenital setae (33%) and females (60%) with tritonymphs without eugenital setae (67%).

From a hypothetical perspective, there are three possible developmental combinations: A) a tritonymph with two pairs of eugenitals gives rise to the male, and a tritonymph without eugenitals gives rise to the female; B) the reverse of A; and C) the presence of eugenital setae in tritonymphs has no relevance because either state gives rise to a male or a female. It should be noted that each developmental possibility requires an interpretation of an acceleration of the expression of the eugenital setae. I have found support for possibility A from the

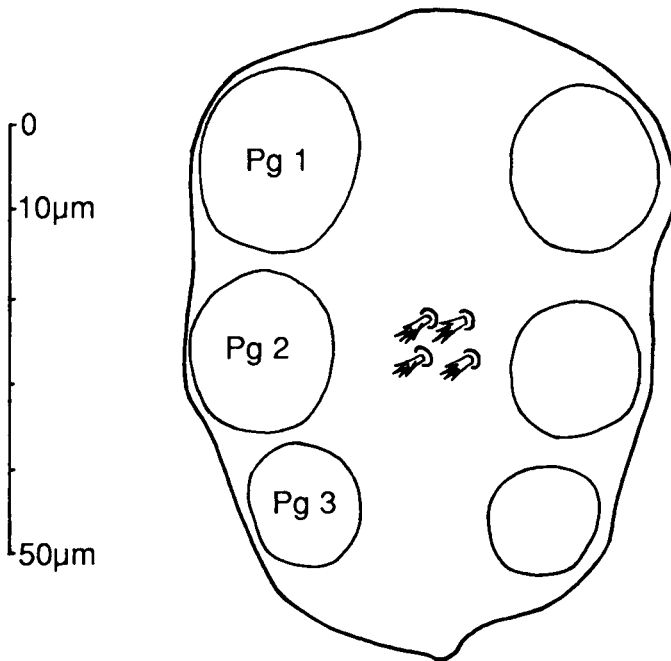


Fig. 1. *Alycus roseus*, tritonymph (male?), Nebraska population, genital vestibule with 4 eugenital setae, genital valves not shown. Abbreviations: Pg 1-3 = genital papillae of N1, N2 and N3 respectively.

standpoint of ontogenetic setal constancy as well as a slightly skewed sex ratio (in the Illinois population). There is no basis to support possibility B. Possibility C infers a random distribution, therefore one might expect a 50:50 distribution of the character states. Because the distribution is skewed in the Illinois population, I reject this possibility. Final resolution of this question requires a long series of pharate tritonymph-adult specimens.

**Character state polarity of the presence of juvenile eugenital setae.** Lindquist (1984) and OConnor (1981, 1984) considered the presence of eugenital setae in adults to represent an ancestral condition for Acariformes. OConnor's hypothesis is faulty because his stated out-group Bimichaeliidae was included *within* his in-group Acariformes. Lindquist's assessment, which seems justified, was based on the presence of eugenital setae equivalents in non-mite arachnid out-groups such as Opiliones and Palpigradi. However, the presence of eugenital setae in juveniles of acariform mites is not shared with juveniles of Opiliones and Palpigradi, and is hypothesized to represent an ontogenetic acceleration, a derived condition for Bimichaeliidae. Knowledge of the distribution of this state among early derivative acariform mites, is of significance in any hypothesis of relationship among these taxa.

**Possible origin of juvenile eugenital setae.** If eugenital setae in juveniles are **not** restricted to the Bimichaeliidae, are there any character states of Bimichaeliidae that might suggest a rationale to expect eugenital setae to be present in nymphs of other taxa? One possible character state pertains to the presence of an often extensive neotrichy in Bimichaeliidae (Grandjean 1942). In one sense, the development of neotrichy can be viewed as a type of ontogenetic character release. The presence of eugenital setae in juveniles can also be viewed in a similar context, i.e., an ontogenetic character release of a state previously restricted to the adult morph, although such changes are typically regarded as simply an acceleration. If the presence of eugenital setae in juveniles has become developmentally linked with neotrichy, then this hypothesis can be tested by an examination of other neotrichous taxa, such as species of *Speleorchestes* Trägårdh (Nanorchestidae), in which the relative number of eugenitals in adults is reversed.

### Acknowledgments

I am grateful to W. Suter, Carthage College, Kenosha, WI, for the initial sample that yielded the material for this study, and to R. A. Norton, State University of New York, Syracuse, NY, and W. T. Atyeo, University of Georgia, Athens, GA, for carefully reviewing the manuscript and providing constructive criticism.

### References Cited

- Grandjean, F.** 1936. Le genre *Pachygnathus* Dugès (*Alycus* Koch) (Acariens). 1<sup>re</sup> partie. Bull. Mus. Nat. Hist. Natur., Sér. 2, 8: 398-405.
- Grandjean, F.** 1937. Le genre *Pachygnathus* Dugès (*Alycus* Koch) (Acariens). (Deuxième partie). Bull. Mus. Nat. Hist. Natur., Sér. 2, 9: 56-61.
- Grandjean, F.** 1938. La suppression d'organes dan l'évolution d'une série homéotype. C. R. Séanc. Acad. Sci., 206: 1853-1856.
- Grandjean, F.** 1939. Quelques genres d'acariens appartenant au groupe des Endeostigmata. Ann. Sci. Nat. Zool., Sér. 11, 2: 1122.
- Grandjean, F.** 1942. Quelques genres de'acariens appartenant au groupe des Endeostigmata (2 Sér.). Première partie. Ann. Sci. Nat. Zool., Sér. 11, 4: 85-135.
- Grandjean, F.** 1943. Quelques genres d'acariens appartenant au goupe des Endeostigmata (2 Sér.). Deuxième partie. Ann. Sci. Nat. Zool., Ser. 11, 5: 1-59.
- Lindquist, E. E.** 1984. Current theories on the evolution of major groups of Acari and on their relationships with other groups of Arachnida with consequent implications for their classification. In: Griffiths, D. A., and Bowman, C. E. Acarology VI, 1: 28-62.
- Ochoa, R.** 1989. A note on paedogenesis in Tetranychoida. Intl. J. Acarology 15: 117-118.
- OConnor, B. M.** 1981. A systematic revision of the family-group taxa of the non-Psoroitidid Astigmata. PhD. thesis, Cornell University, Ithaca, New York. 594 p. (Unpubl.)
- OConnor, B. M.** 1984. Phylogenetic relationships among higher taxa in the Acariformes, with particular reference to the Astigmata. In: Griffiths, D. A., and Bowman, C. E. Acarology VI, 1: 19-27.