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A NEW SPECIES OF *ANOECIA* (HOMOPTERA: APHIDIDAE) ON RHIZOMES OF *EQUISETUM LAEVIGATUM*

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Abstract.—A new species, ***Anoecia equiseti*** (Homoptera: Aphididae), was found on rhizomes of *Equisetum laevigatum* in Canyon County, Idaho. It differs from other species of *Anoecia* in the number and distribution of setae on the ultimate rostral segment, usually in having a longer ultimate rostral segment, and in its biology.

Key Words: Aphididae, *Anoecia, Equisetum*

An unusual aphid was found on the rhizomes of *Equisetum laevigatum* at several locations in Idaho. It was found to be in the genus *Anoecia,* but could not be matched with any described species. A description and notes on its biology follow.

Anoecia equiseti, NEW SPECIES

DESCRIPTION

Apterous viviparous females (Fig. 1):

Color of living specimens: Body of nymph light cream-colored with no markings; adults slightly darker with grey dashes centered on abdominal segments VI–VIII and grey marginal sclerites. Legs and antennae light brown, darker distally. Siphunculi dark. Abdomen sometimes with pairs of dark pleural spots.

Color of mounted specimens: Body of adult pale with light brown centered dashes on abdominal segments VI–VIII and light brown marginal sclerites. Abdomen often with pairs of brown pleural spots. Sub-genital plate pale, usually with well defined posterior and lateral margins. Head light brown. Antennal segment III paler than other segments. Mid-portions of tibiae concolorous with body and lighter than other segments in legs. Rostrum gradually darker distally. Siphuncular rims dark brown. Some specimens have weak anterodorsal siphuncular sclerites.

Morphology: Body length: 2.1–2.4 mm (Table 1). Secondary rhinaria on antennae (Fig. 2): III:0; IV:0–1; V:0; VI:0. Rhinaria round or irregularly shaped and without distinct rim. Lengths of antennal segments: III—0.20–0.29 mm; IV—0.06–0.12 mm; V—0.10–0.13 mm; VI (base)—0.11–0.15 mm; processus terminalis—0.03–0.05 mm. Antennal segments I and II have 6–25 and 23–29 setae respectively. Processus terminalis conical with 5–9 setae. Ultimate rostral segment with 17–24 accessory setae (Fig. 3) and 0.16–0.18 mm long. Ultimate rostral segment with about 14 setae aligned along the stylet grooves, and always with others scattered on the rest of the segment. Number of facets in eyes variable, 3 (triomatidion only) to 50 with a distinct triomatidion, similar to variation observed in European *Anoecia* (Zwolfer 1957). Frontal tubercles not developed. Flat, round lateral tubercles usually present on prothorax and abdominal segments I–IV and VII, and sometimes present on segments V and VI. Occasional extranumerary tubercles some-

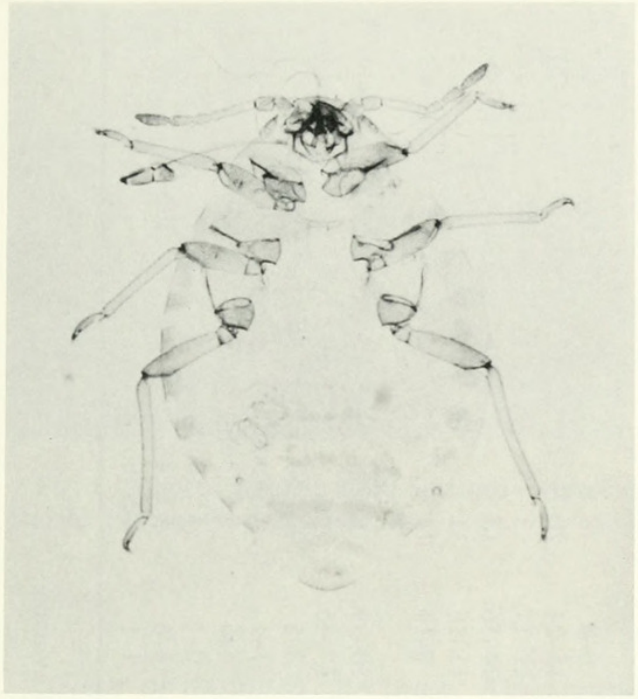

Fig. 1. *Anoecia equiseti,* n. sp. Holotype. Apterous viviparous female.

times also occur. The size and degree of differentiation of these tubercles from surrounding integument is variable. Mean numbers of setae on abdominal segments VI, VII and VIII are 68, 20 and 11 respectively. Siphuncular pores round and on slightly raised cones with 13–39 setae. Siphuncular rims wider anteriorly, appearing reinforced around anterior ⅔ of the circle. Number of setae on the subgenital plate averages 39. First tarsal segments have 3–5 setae longer than 0.03 mm and 0–2 shorter sensory pegs less than 0.015 mm.

Alate viviparous females (intermediate forms (Baker and Turner 1916) with vestigial wings). (Fig. 4):

Color of living specimens: Similar to apterous viviparae, except pterothorax variably sclerotized, sclerotized parts grey, wings vestigial, brown.

Color of mounted specimens: Similar to apterous viviparae except pterothorax variably sclerotized and darker brown, depending on degree of wing development. Wings mottled brown.

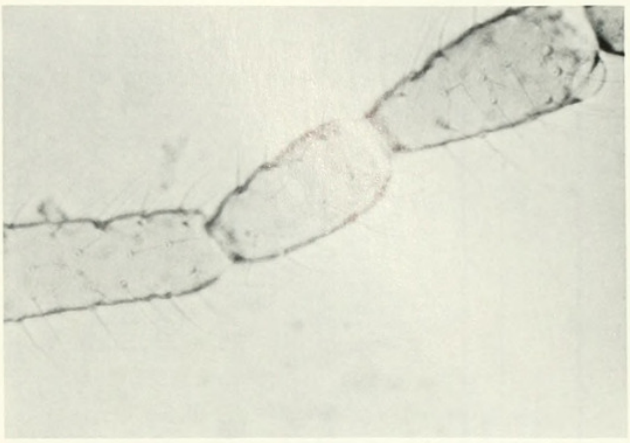

Fig. 2. *Anoecia equiseti,* n. sp. Apterous viviparous female. Antennal segments III, IV and V (left to right) and showing secondary rhinarium on segment IV.

Morphology: Secondary rhinaria on antennae: III:0; IV:0–1; V:0–1; VI:0. Rhinaria round or irregularly shaped, without rim. Numbers of setae on and lengths of antennal segments similar to apterous viviparae (Table 1). Ultimate rostral segment is 0.16–0.18 mm long and has 15–24 accessory setae arranged as in apterous viviparae. Eyes compound with triomatidion present. Lateral abdominal tubercles on segments I–IV and VII, occasionally on V and VI. Forewing development varies from small flaps to paddle-like structures, sometimes with a vestigial stigma or vein. Hindwing similar or absent. Numbers of setae on abdominal segments VII and VIII and subgenital plate similar to apterous viviparae. Abdominal segment VI usually has fewer setae than in apterae, but ranges overlap. Siphuncular rims sometimes protruding slightly (ca 0.04 mm) from the surrounding surface. First tarsal segment setation and length of hind tarsal segment II similar to apterous viviparae.

Alate viviparous female (fully winged). (Fig. 5) (Only one specimen was found and it had one properly formed wing and one deformed wing):

Color of living specimen: Body cream colored, sclerotized parts dusty grey, especially on underside. Stigma grey.

Table 1. Measurements of *Anoecia equiseti*, n. sp.

Structure	Apterous Viviparous Females[b]				Alate Viviparous Females (Vestigial Wings)			Alate Viviparous Females (Developed Wings)	Oviparae		
	Holotype	$\bar{x}$	s	Range	$\bar{x}$	s	Range	(one specimen)	$\bar{x}$	s	Range
Measurements[a]											
Body length	2.17	2.26	0.0945	2.1–2.4	2.23	0.1338	2.0–2.4	1.9	1.93	0.0957	1.8–2.0
Antennal segment III	0.207	0.23	0.0230	0.20–0.29	0.28	0.0190	0.25–0.31	0.26, 0.25	0.19	0.0060	0.18–0.20
Antennal segment IV	0.079	0.10	0.0730	0.06–0.12	0.10	0.0076	0.09–0.11	0.08 (both)	0.08	0.0110	0.05–0.09
Antennal segment V	0.106	0.11	0.0092	0.10–0.13	0.11	0.0093	0.09–0.13	0.11, 0.12	0.10	0.0063	0.09–0.11
Antennal segment VI (base)	0.119	0.13	0.0069	0.11–0.15	0.12	0.0072	0.11–0.13	0.11 (both)	0.11	0.0081	0.11–0.13
Antennal segment VI (process terminalis)	0.039	0.04	0.0055	0.03–0.05	0.04	0.0034	0.04–0.05	0.06 (both)	0.04	0.0075	0.03–0.05
Ultimate rostral segment	0.170	0.17	0.0046	0.16–0.18	0.17	0.0060	0.16–0.18	0.16	0.16	0.0066	0.15–0.16
Hind-tarsal segment II	0.15	0.16	0.0075	0.15–0.19	0.16	0.0068	0.15–0.18	0.14, 0.13	0.15	0.0055	0.14–0.16
Number of Setae[c]											
Antennal segment I	9, 13	13	3.897	6–25	14	2.598	9–17	14, 17	11	1.996	9–14
Antennal segment II	30, 34	28	3.575	23–39	29	3.150	24–34	29, 27	21	1.061	20–23
Antennal segment VI (processus terminalis)	6, 7	7	0.836	5–9	7	0.641	6–8	8, 9	7	0.354	7–8
Ultimate rostral segment	24	20	2.078	17–24	20	3.425	15–24	20	17	2.217	15–20
Along stylet grooves	16	14	1.711	11–17	14	2.406	11–17	13	13	1.258	11–14
Abdominal segment VI	91	68	18.916	33–96	45	10.459	24–56	15	29	13.638	19–49
Abdominal segment VII	24	20	5.342	12–32	14	1.729	11–16	11	10	1.732	9–12
Abdominal segment VIII	10 (+2 missing)	11	1.470	9–13	12	1.703	8–14	14	12	0.957	11–13
Raised area around siphunculus	27, 22	26	5.219	13–39	26	4.951	20–39	16, 22	16	2.200	12–19
Subgenital plate	39	39	3.498	33–48	42	3.098	37–46	36	30	6.185	25–38
Fore-tarsal segment I	5, 4 L	4 L	0.491	3–5	5 L	0.624	3–5	4 L, 5 L	5 L	0.518	4–5
	1, 0 S	1 S	0.143	0–1	1 S	—	1–1	1 S (both)	1 S	—	1–1
Mid-tarsal segment I	4, 5 L	4 L	0.373	4–5	5 L	0.496	4–5	5 L (both)	5 L	0.756	4–6
	1, 1 S	1 S	0.143	1–2	1 S	0.229	0–1	1 S (both)	1 S	—	1–1
Hind-tarsal segment I	4, 5 L	4 L	0.513	4–5	5 L	3.268	4–6	5 L, 4 L	4 L	1.195	2–6
	1, 1 S	1 S	0.140	0–1	1 S	—	1–1	1 S (both)	1 S	—	1–1

[a] Measurements in mm.
[b] Numbers of specimens measured: 26 apterous viviparous females; 10 alatae with vestigial wings; 4 oviparae.
[c] L = long; S = short.

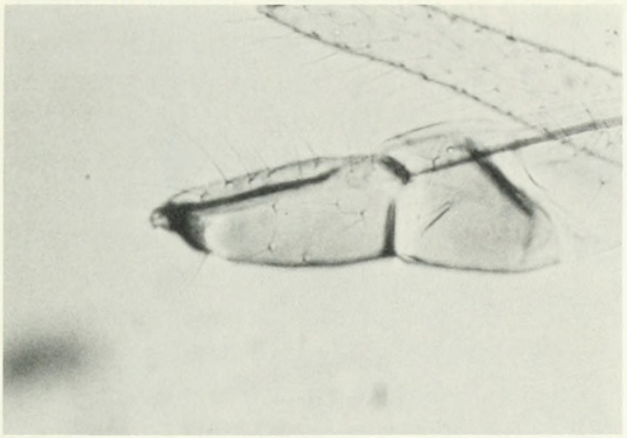

Fig. 3. *Anoecia equiseti,* n. sp. Apterous viviparous female. Ultimate rostral segment.

Fig. 4. *Anoecia equiseti,* n. sp. Alate viviparous female with vestigial wings.

Color of mounted specimen: Abdominal segments II–VIII with light brown centered dorsal dashes and light brown sclerotized areas laterally, around the siphuncular rims and posteriorly. Dorsal dashes increasing in length posteriorly, broken anteriorly. Appendages light brown. Thorax, head and siphuncular rims dark brown.

Morphology: As for viviparous females with vestigial wings except as follows: Antennal segment III with 1–2 rhinaria. Lengths of antennal segments are: III—0.25; IV—0.08; V—0.10, VI (base + processus terminalis) – 0.11 + 0.06 (Table 1). Compound eyes fully developed with triomatidion. Pterothorax well developed. Wings slightly fuscous and about equal in length to body length. Radial sector distinctly S curved; media once branched, as is typical in *Anoecia.* Abdominal segment VI with fewer setae than in other forms. Measurements are similar to those of apterous viviparae except that hind tarsal segment II is shorter (0.14 mm).

Oviparous female:

Color.—As for apterous viviparae except dorsal dashes may be missing and lateral sclerites much paler than those of apterous viviparae.

Morphology: Body shorter than apterous viviparae (1.8–2.0 mm), otherwise similar to apterous viviparae except antennal segments, especially segment III, tend to be shorter (Table 1). Eyes with only 3 facets. Setation similar to apterous viviparae, except for a tendency toward fewer setae on antennal segments I and II, abdominal segment VI and subgenital plate. Hind tibiae are not swollen, and no pseudosensoria are present.

Types

Holotype:

Holotype is on deposit at the United States National Museum. It is an apterous viviparous female collected by Susan Halbert and June Connelly on *Equisetum laevigatum* A. Braun on 3 VI 86 (Table 1).

Morphotype:

An alata with vestigial wings collected by S. Halbert on 9 IX 86 at Apple Valley and Hurtz Roads is designated as a Morphotype because this morph occurs very commonly. It is also deposited at the USNM.

Type locality:

Apple Valley and Hurtz roads 5 km northwest of Parma, Idaho (T6N; R5W; Section 30).

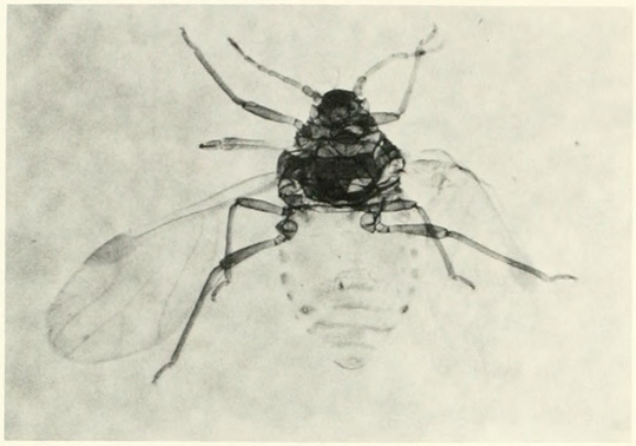

Fig. 5. *Anoecia equiseti*, n. sp. Alate viviparous female.

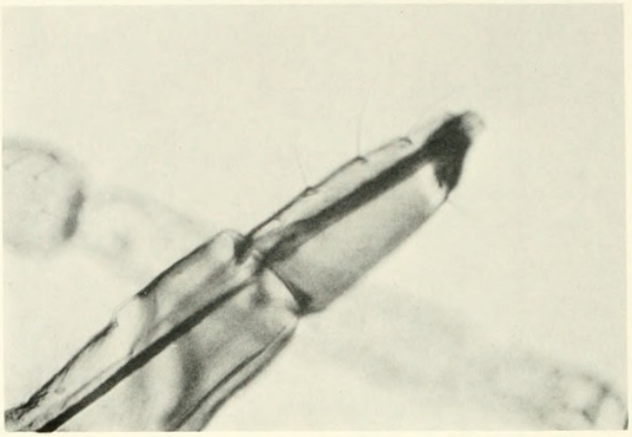

Fig. 6. *Anoecia setariae* Gillette & Palmer. Apterous viviparous female. Ultimate rostral segment.

Paratypes:

Apterae collected from *Equisetum laevigatum* at Apple Valley and Hurtz Roads by S. Halbert and J. Connelly on 20 VIII 85 (collection 1) and vestigial alatae from the same location collected by S. Halbert and J. Connelly on 11 VI 86 are deposited at the University of Idaho main campus at Moscow, Idaho and at the Canadian National Museum. Apterae and alatae with vestigal wings from Collection 1 are deposited at the British Museum of Natural History and the Illinois Natural History Survey. The remainder of the paratypes are in possession of the author. In addition to the initial collection on 20 VII 85 *Anoecia equiseti* was collected from the location at Apple Valley and Hurtz on 15 V 86, 3 VI 86, 19 VII 86, and 19 IX 86. *Anoecia equiseti* has also been found 6.3 km south of Parma at Rodeo and Dixie Rds. (T4N; R5W; Section 4) on 16 X 85, and at the Windell Holloway Farm 6.3 km north of Middleton, Idaho (T5N; R3W; Section 13) on 29 VI 86. The extent of the distribution of this species is unknown.

Name

The aphid is named for its unusual host plant. The name is the genitive singular form of *Equisetum.*

Comparison with other species in the genus *Anoecia*

Anoecia equiseti differs from *Anoecia cornicola* (Walsh) and *Anoecia corni* (Fabricius) in the absence of a dorsal quadrate patch on the alatae and in that it does not overwinter on *Cornus. Anoecia equiseti* differs from *Anoecia graminis* Gillette & Palmer and *Anoecia oenotherae* Wilson in having more setae on the ultimate rostral segment. It further differs from *Anoecia oenotherae* in having straight or slightly curved setae as opposed to setae bent at right angles which are characteristic of *Anoecia oenotherae. Anoecia graminis* has more antennal rhinaria than *Anoecia equiseti* and a diagnostic fingerlike processus terminalis not present in *Anoecia equiseti.* Both the identity and the biology of *Anoecia panici* (Thomas) are unknown. There are no types (Hottes and Frison 1931), and the original description (Thomas 1878) is poor and may, according to Thomas, even be based upon an immature specimen. Thus, there is no way to compare it with *Anoecia equiseti.*

Anoecia equiseti is quite similar morphologically and biologically to *Anoecia setariae* Gillette & Palmer from which it can be separated by the number and arrangement of setae on and usually by the length of the

ultimate rostral segment, and by host preference. The ultimate rostral segment of *Anoecia equiseti,* excluding oviparae, is 0.16–0.18 mm long, while that of *Anoecia setariae* is 0.13–0.16 mm long, with *Anoecia setariae* alatae with vestigial wings falling at the upper end of that spectrum. (*Anoecia setariae* measurements are based on 47 specimens from 10 different collections including collections from *Echinochloa crusgalli, Hordeum jubatum* and *Setaria viridis.*) All of the *Anoecia equiseti* examined had 15–24 setae on the ultimate rostral segment with two rows along the stylet grooves and others scattered on the rest of the segment. *Anoecia setariae* had only 5–12 setae, all of which were in rows along the stylet grooves. (Fig. 6).

Experiments showed that *Anoecia equiseti* placed on *Echinochloa crusgalli* roots (host of *Anoecia setariae*) in plastic containers did not feed. *Anoecia setariae* placed on *Equisetum laevigatum* rhizomes died or languished at the bottom of the container until a fresh *Echinochloa crusgalli* root was introduced, after which those which were still alive began to feed and reproduce on the fresh root. Ants found associated with aphid colonies were included in the containers.

Key to *Anoecia* reported in North America

1. Alata with dorsal quadrate patch; holocyclic on *Cornus* 2
1′. Alata with dorsal dashes but no solid patch; species not associated with *Cornus* 3
2. Rhinaria on antennal segment III strongly transverse ..... *A. corni*
2′. Rhinaria on antennal segment III round ..... *A. cornicola*
3. Setae on head conspicuously bent so they lie parallel with the surface from which they arise ..... *A. oenotherae*
3′. Setae on head not bent; perpendicular to the surface from which they arise 4
4. Processus terminalis constricted at the base and fingerlike; apterous viviparae usually with well defined rhinaria on antennal segments III–VI; ultimate rostral segment with 4 accessory setae ..... *A. graminis*
4′. Processus terminalis conical and not constricted at the base; apterous viviparae with occasional rhinaria with indistinct rims on segment IV only; ultimate rostral segment with more than 4 accessory setae. 5
5. Ultimate rostral segment with 5–12 accessory setae arranged along stylet grooves; living on Gramineae ..... *A. setariae*
5′. Ultimate rostral segment with 15–24 accessory setae, some of which are not along stylet grooves; living on *Equisetum* ..... *A. equiseti*

Biology and Comments

Anoecia equeseti was found about 15 cm underground on rhizomes of *Equisetum laevigatum.* Colonies were sometimes clustered just below the bud for the next season's growth and sometimes on straight rhizomes between joints. *In situ,* these pale aphids make a striking contrast to the dark rhizomes of the host plant.

In the autumn, both *Anoecia equiseti* and *Anoecia setariae* produce a generation of alatae, the majority of which have vestigial wings. I examined more than 100 colonies of *Anoecia setariae* from Canyon County, Idaho collected from *Echinochloa crusgalli* in September and October, 1986 and found abundant alatae with vestigial wings but only a few alatae which might be capable of flight. Occasionally alate *Anoecia setariae* are also collected in the Western Regional Suction Trap Network in early summer. The single alate *Anoecia equiseti* with nearly functional wings emerged in late June. Emergence traps placed over the most heavily infested patch of *Equisetum laevigatum* never collected any alate *Anoecia equiseti,* nor did a yellow water pan trap also placed in the patch. Colonies of both species may produce a few flight-capable alatae in late spring and again in the fall. Evidently, the vestigial wings are an adaption for living underground. This is in agreement with Baker and Turner (1916) who suggest that intermediate forms will occur when a taxon is in the evolutionary process of losing wings.

Oviparae of *Anoecia equiseti* were obtained by rearing progeny of the 20 VIII 85

collection in plastic containers for about 2 months. Eggs were observed in October, 1985. Eggs of *Anoecia setariae* were observed in September, 1986. In neither case were eggs attached to plants. Ants gathered eggs of *Anoecia setariae* and may also gather eggs of *Anoecia equiseti,* but this behavior was not observed. It is unknown whether eggs were viable. One *Anoecia setariae* nymph which may be a male was found. No males of *Anoecia equiseti* were found.

Ants were observed to search out and carry *Anoecia setariae* but not *Anoecia equiseti.* Ants associated with colonies of both species were all in the genus *Lasius.*

Other species of *Anoecia* which may have similar biological relationships (monoecious on roots and producing eggs underground) include *Anoecia zirnitsi* Mordvilko, *Anoecia pskovica* Mordvilko, *Anoecia graminis* and *Anoecia oenotherae* (Palmer 1952, Heie 1980). Males of *Anoecia graminis* and *Anoecia oenotherae* are unknown. Males of *Anoecia pskovica* are rare (Heie 1980). Zwolfer (1957) suggests that *Anoecia zirnitsi* produces parthenogenetic eggs.

Only two other species of aphids are known to infest *Equisetum*: *Aphis equiseticola* Ossiannilsson and *Sitobion equiseti* Holman (Ossiannilsson 1964). Both of these are found on the aerial parts of the plant and are reported from British Columbia (Forbes and Chan 1989) but not from the United States. Though *Equisetum* is a primitive plant, and *Anoecia* may be a primitive aphid genus (Shaposhnikov 1987), the association between *Anoecia equiseti* and its host is probably relatively recent.

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