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Characters and states for treehopper nymphs. Partly because character states were appended as discovered, and partly because of their plasticity, we recommend that, if these characters are used in a cladistic analysis, they be treated as unordered states.

### **Overall body**

- 1a. Cross-section: (0) weakly vertically depressed; (1) subcircular; (2) subtriangular; (3) weakly laterally compressed; (4) extremely laterally compressed; (5) vertically oval; (6) strongly dorsally depressed.
- 1b. Chalazal density on thorax and abdomen (except scoli if present): (0) completely absent; (1) sparse, almost absent; (2) dense, obvious throughout body; (3) many on meso- and metathorax, absent on abdomen and prothorax.
- 1c. Chalazal setal length: (0) absent; (1) short; (2) long.
- 1d. Parts of body covered with waxlike, usually white substance: (0) no; (1) yes.
- 1e. Dorsal contour of abdomen in lateral view including segment IX in resting position. (0) linear; (1) curvilinear; (2) irregular.
- 1f. Overall body in dorsal view: (0) elongate; (1) subcircular.

### **Head**

- 2a. Scoli pair: (0) without scoli; (1) with simple conical scoli (Fig. 1); (2) with bifurcate scoli; (3) two pairs of scoli with separate bases next to eye.

- 2b. Projected direction of scoli: (0) scoli absent; (1) anterad; (2) dorsad; (3) bifurcate, dorsad and ventrad; (4) curvate ventrally; (5) curvate posteriorly; (6) dorsoanteriorly; (7) anterolaterally.
- 2c. Dorsal or anterior rounded protuberances: (0) present; (1) absent.
- 2d. Chalazal bases: (0) tuberculate; (1) short stalked (narrowing distally, length 2 X basal width; (2) long stalked (parallel-sided, length more than 2 X basal width); (3) chalazae absent.
- 2e. Chalazal setae: (0) simple, needle- or hairlike; (1) short subcylindrical; (2) broadly paleate; (3) chalazae absent; (4) narrowly paleate.
- 2f. Compound eye surface setae: (0) absent; (1) present.
- 2g. Enlarged chalazae between eyes: (0) absent; (1) present as a single pair; (2) present as pair of vertical rows; (3) present and multiple but not in rows.
- 2h. Scoli length relative to basal width, excluding apical seta: (0) scoli absent; (1) scoli about as tall as basal width; (2) scoli about 2-4 X basal width; (3) scoli at least 5 X basal width; (4) scoli about 8 or more X basal width; (5) scoli about half as tall as basal width.
- 2i. Enlarged chalazae in front of ventral margin of eye: (0) absent; (1) present.
- 2j. Enlarged chalazae adjacent to central margin of eye: (0) absent; (1) present.
- 2k. Frons extended over central margin of eye: (0) no; (1) yes.
- 2l. Single enlarged chalaza behind eye: (0) absent; (1) present.
- 2m. Paired crescent-shaped callosity near mid line (along inner margin of dorsal protuberances if present): (0) absent; (1) present.

### **Prothorax**

- 3a. Premetopidium structures: (0) enlarged chalazae and scoli absent; (1) paired scoli; (2) paired enlarged chalazae.

- 3b. Premetopidium scolar direction: (0) scoli absent; (1) directed anteriorly; (2) directed dorsally; (3) dorsoanteriorly; (4) slightly curvate.
- 3c. Postmetopidium structures: (0) absent; (1) paired scoli; (2) paired enlarged chalazae.
- 3d. Postmetopidium scolar direction: (0) scoli absent; (1) directed anteriorly; (2) directed dorsally; (3) directed dorsoposteriorly; (4) curvate; (5) laterally; (6) dorsoanteriorly.
- 3e. Posterior extension of pronotum: (0) not surpassing anterior margin of metanotum; (1) surpassing anterior but not posterior margin of metanotum; (2) surpassing posterior margin of metanotum but not attaining abdominal apex; (3) attains abdominal apex.
- 3f. Dorsal pronotal single medial horn bud: (0) absent; (1) present.
- 3g. Pronotal lateral margin: (0) rounded or simple carinate; (1) emarginate carinate.
- 3h. Postmetopidium immature elevated and carinate (which is not expressed in adult): (0) no; (1) yes (but not expressed in adult); (2) postmetopidium medially carinate (expressed in adult).
- 3i. Pronotal suprahumeral horn buds: (0) absent; (1) present.
- 3j. Premetopidium scoli length relative to basal width, excluding apical seta: (0) scoli absent; (1) scoli about as tall as basal width; (2) scoli 2-4 X basal width; (3) scoli 5-7 X basal width; (4) 8 or more X basal width; (5) scoli about half as tall as basal width.
- 3k. Postmetopidium scoli length relative to basal width, excluding apical seta. (0) scoli absent; (1) scoli about as tall as basal width; (2) scoli 2-4 X basal width; (3) scoli 5-7 X basal width; (4) 8 or more X basal width; (5) scoli about half as tall as basal width.
- 3l. Metopidial sulcus form: (0) not incised, continuous with adjacent surface above (or posterior to) and below (or anterior to) it; (1) deeply incised; (2) weakly incised.
- 3m. Posterior extension concavity in dorsal view: (0) narrowly convex or acute; (1) broadly convex.

## **Mesothorax**

- 4a. Dorsal structures (maximum development): (0) without projections; (1) paired enlarged chalazae; (2) paired cluster of enlarged chalazae; (3) paired scoli (Fig. 1); (4) single middorsal projection; (5) single middorsal plate.
- 4b. Scolar chalazae: (0) scoli absent; (1) scoli present but scolar chalazae absent; (2) bearing tuberculate chalazae (as in Figs. 9, 10); (3) bearing stalked chalazae (Fig. 11).
- 4c. Scolar direction: (0) scoli absent; (1) directed anteriorly; (2) dorsally or almost so; (3) posteriorly; (4) dorsoanteriorly; (5) dorsolaterally; (6) dorsoposteriorly.
- 4d. Forewing pad distal 2/3rds costal margin form: (0) emarginate; (1) sinuate, not emarginate; (2) straight.
- 4e. Forewing pad surface chalazae density: (0) absent; (1) sparse and short setae; (2) continuously covered and short setae; (3) densely covered and long setae; (4) dense, setae absent.
- 4f. Dorsal scoli length relative to basal width, excluding apical seta: (0) scoli absent; (1) scoli about as tall as basal width; (2) scoli 2-4 X basal width; (3) scoli 5-7 X basal width; (4) 8 or more X basal width; (5) scoli about half as tall as basal width.
- 4g. Cluster of enlarged chalazae on anterior side of base of scoli. (0) scoli absent; (1) chalazal cluster absent; (2) chalazal cluster present.
- 4h. Forewing pad costal chalazae. (0) absent; (1) along entire costal margin; (2) only present on base of costal margin.
- 4i. Lateral longitudinal row of enlarged chalazae, if 1 or more such rows present on abdomen, extending onto meso- and metathorax: (0) abdomen without lateral row of enlarged chalazae; (1) lateral row present on abdomen but not extended onto meso- or metanotum; (2) extended onto meso- or metanotum or both.

4j. Clearly delimited subcircular depressed callosity above wingpad and adjacent to pronotal margin: (0) absent; (1) present. Many membracids have a poorly delimited callosity in this region of the mesonotum.

### **Metathorax**

5a. Dorsal structures (maximum development): (0) without projections; (1) paired enlarged chalazae; (2) paired cluster of enlarged chalazae; (3) paired scoli; (4) paired bulbous or acute subhemispherical projections wider than high; (5) single middorsal projection; (6) single middorsal plate.

5b. Scolar chalazae: (0) scoli absent; (1) scoli present but scolar chalazae absent; (2) bearing tuberculate chalazae; (3) bearing stalked chalazae.

5c. Initial scolar direction: (0) scoli absent; (1) directed anteriorly; (2) dorsally or almost so; (3) posteriorly; (4) dorsally at base, posteriorly in distal portion; (5) dorsoanteriorly; (6) dorsoposteriorly.

5d. Dorsal scoli length relative to basal width, excluding apical seta: (0) scoli absent; (1) scoli about as tall as basal width; (2) scoli 2-4 X basal width; (3) scoli 5-7 X basal width; (4) 8 or more X basal width; (5) scoli about half as tall as basal width.

### **Legs**

6a. Chalazae of tibia: (0) on anterior and posterior lateral margins, absent or very few on dorsal surface; (1) on posterior margins only; (2) on lateral margins and many on dorsal surface; (3) chalazae absent.

- 6b. Prothoracic tibia form: (0) subcylindrical or dorsally flattened but without extended margins; (1) foliaceus.
- 6c. Metathoracic tarsal length relative to pro- and mesothoracic tarsal length. (0) subequal; (1) distinctly shorter; (2) distinctly longer.
- 6d. First tarsomere relative lengths: (0) all first tarsomeres distinctly shorter than second tarsomeres (Fig. 5); (1) metathoracic leg with first tarsomere subequal to second tarsomere (Figs. 6, 8).

**Abdominal terga III-VIII** (I, II, X, XI normally not visible)

- 7a. Terga V-VIII ventrolateral margins: (0) without enlarged chalazae or other lateral extensions; (1) with a single especially enlarged chalaza; (2) with linear row (4 or more) enlarged chalazae; (3) with flattened lamellar extensions; (4) with acuminate lateral extensions; (5) with sparse setae; (6) with enlarged chalazae irregularly arranged in ventrolateral region (not in a row); (7) with 2 especially enlarged chalazae.
- 7b. Terga III-VIII dorsal scoli relative sizes to each other: (0) scoli absent; (1) all scoli subequal in size; (2) scolar size increasing posteriorly; (3) scolar size decreasing posteriorly; (4) scolar sizes very unequal, but not clinally along abdomen.
- 7c. Terga III-VIII tallest dorsal scoli length relative to basal width, excluding apical seta: (0) scoli absent; (1) about as tall as basal width; (2) scoli 2-4 X basal width; (3) scoli 5-7 X basal width; (4) scoli 8 or more X basal width; (5) scoli about half as tall as basal width.
- 7d. Tergum IV dorsal scolar direction preapically: (0) scoli absent; (1) directed dorsoanteriorly; (2) directed dorsally or almost so; (3) directed dorsoposteriorly; (4) directed posteriorly, appressed or nearly so to following tergum; (5) dorsolaterally; (6) posteriorly, not appressed.

- 7e. Tergum IV dorsal scolar direction apically: (0) scoli absent; (1) scoli dorsally; (2) directed posteriorly; (3) directed dorsoposteriorly; (4) dorsolaterally.
- 7f. Terga III-VIII lateral rows: (0) not manifested; (1) bearing 2 rows enlarged chalazae; (2) manifested as scoli; (3) bearing 3 rows enlarged chalazae; (4) bearing 1 row of enlarged chalazae. When a lateral row is present, often its setae is also lengthed.
- 7g. Tergum III dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.
- 7h. Tergum IV dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.
- 7i. Tergum V dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.
- 7j. Tergum VI dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli; (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.
- 7k. Tergum VII dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli; (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.
- 7l. Tergum VIII dorsal structures: (0) without dorsal projections; (1) paired enlarged chalazae; (2) paired apically acute scoli; (3) paired apically rounded or blunt scoli; (4) single middorsal projection; (5) single middorsal plate.

- 7m. Lamellar structure. (0) lamellae absent; (1) lateral margins subparallel, apex rounded; (2) lateral margins converging, apex subacute; (3) lateral margins short and parallel, apex truncate.
- 7n. Lamellar chalazae. (0) lamellae absent; (1) lamellae present, but lamellar chalazae absent; (2) lamellar chalazae marginal only; (3) lamellar chalazae marginal and dorsal.
- 7o. Scolar chalazae. (0) scoli absent; (1) scoli present but chalazae absent; (2) scoli bearing tuberculate chalazae (Figs 9, 10); (3) scoli bearing stalked chalazae (Fig. 11).
- 7p. Adominal tergum VIII separation equality: (0) tergum VIII scoli absent; (1) all abdominal scoli separated equally; (2) tergum VIII scoli separated distinctly more than anterior scoli.
- 7q. Scolar appression: (0) scoli absent; (1) scoli splayed away from each other (diverging); (2) scoli parallel and tightly appressed to each other; (3) scoli parallel, not appressed to each other; (4) single medial scolus per segment, not plate like; (5) single medial plate-like scolus per segment; (6) paired swellings on some segments, single swellings on others; (7) paired scoli on some segments, single middorsal scolus on others,

**Segment IX (tergite and sternite fused, forming tube)**

- 8a. Shape of distal (distal to pregenitalia) half in cross-section: (0) subtriangular; (1) subcircular; (2) laterally compressed.
- 8b. Relative dorsal length. (0) subequal to length of segment VIII; (1) subequal to combined length of segments VII and VIII; (2) subequal to combined length of segments VI-VIII; (3) subequal to combined length of segments V-VIII; (4) subequal to combined length of segments IV-VIII; (5) subequal to combined length of remaining visible abdominal terga (usually III-VIII; Fig. 1); (6) longer than combined length of remaining abdominal terga but shorter than length of rest of body; (7) longer than rest of body.



- 8c. Dorsal structures before apex: (0) chalazae absent; (1) paired row of enlarged chalazae; (2) single medial scolus; (3) row of paired scoli; (4) single middorsal plate; (5) irregularly covered with chalazae
- 8d. Dorsal structures at apex: (0) none; (1) paired enlarged chalazae; (2) single medial scolus; (3) paired scoli.
- 8e. Ventral extension: (0) subequal to dorsal extension; (1) greater than dorsal extension (Fig. 1).
- 8f. Position of fused portion of segment IX relative to unfused portion: (0) distal to unfused portion; (1) above unfused portion, appearing bilobed. State 0 is by far the most common condition among membracids.
- 8g. Form of unfused portion (around pregenitalia) distally: (0) not bifurcate; (1) strongly bifurcate.
- 8h. Direction of apical scoli or enlarged chalazae: (0) scoli ad enlarged chalazae absent; (1) posteriorly; (2) laterally.