December 1989

Apionidae from North and Central America. Part 1. Notes on the classification of the *Apion* subgenus *Trichapion* Wagner with description of new species from the United States of America. (Coleoptera)

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Apionidae from North and Central America. Part 1. Notes on the classification of the *Apion* subgenus *Trichapion* Wagner with description of new species from the United States of America. (Coleoptera)

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Abstract

Selected taxonomic characters of *Apion* species are redefined and explained including subcephalic ridge, sensory seta and macrochaeta. New species described are *Apion (Trichapion) memnonmonum* Kissinger, Black Mountains, North Carolina and *Apion (Trichapion) nelsoni* Kissinger from Davis Mts, Texas and Santa Rita Mts, Arizona. Supplemental descriptions or new records are given for the following species: *Apion aequabile* Fall, *A. brunnicornis* Fall, *A. eccentricum* Fall, *A. minor* Smith, *A. punctulirostre* Sharp and *A. submetallicum* Boheman.

A statistical test is used to evaluate the importance of a character in defining species groups in the *Apion* subgenus *Trichapion* Wagner. Eighteen characters met this criterion and were used to define 12 species groups. A method is presented to evaluate membership in a species group. The inclusion probabilities for a list of 82 species is given for each of 12 species groups of *Trichapion* occurring in North and Central America.

Introduction

This is the first of a series of papers which will summarize new distribution and bionomic records and will update the taxonomy of *Apion* from North and Central America. Recently new host plant records based on rearing have been published (Kissinger, 1988b). Because of widespread destruction of habitats in recent years, particularly in the tropics, it is important to document the recent capture of species known from very few sites.

Since the publication of Kissinger (1968) many new species of *Apion* have been identified from North and Central America based on some 12,000 recently collected specimens. Even though about 300 species of *Apion* have been described from this region, Whitehouse (1977) suspects that about 90% of the Central American *Apion* remains unknown. This points out the large effort needed to describe and differentiate the species of *Apion* from the region and the need to develop methods and procedures to ease the process.

With the exception of measurements and characters discussed below, terminology of the tegmen follows Alonso Zarazaga (1983) and Kissinger (1988a); other usages and procedures follow Kissinger (1968). The terms for regions of the rostrum follow a revision of African Brentidae (cited in Alonso Zarazaga, 1983) where the mesorostrum is the insertion of the antenna, here redefined to be the anterior margin of the antennal scrobe; the prorostrum is anterior to the mesorostrum; and the metarostrum is basad of the mesorostrum.

Subcephalic ridge refers to the ridge on the ventro-lateral aspect of the head which is a possible extension of the dorsal margin of the antennal scrobe. Presumably these ridges define a kind of pocket into which part of the antenna may fit in repose. The ridges range from absent as in *Apion obrieni* Kissinger to highly developed as in *Apion bryanti* Wagner.

The term, sensory seta, refers to the "specialized seta" of the elytra (Kissinger, 1968), which may be of a distinctive color, brownish to golden, in contrast to the other elytral vestiture. The long variety, such as found in the apical area of intervals 7 and 9 of *Apion herculanum* Smith, are set in a large, distinctive socket-like puncture; the short, erect variety, such as those found along interval 3 in *Apion proclive* LeConte, may lack a special puncture and barely project beyond the surrounding vestiture. I believe that the sensory seta is similar in structure and origin to the large "bristles" on the thorax of *Drosophila* (see Stern, 1958). The term macrochaeta is applied to a microscopic seta with a distinct socket-like base; these occur in sclerotized

areas on the tegmen and other locations. The structure is to be distinguished from microtrichae which do not have such a base and commonly occur on membranous structures. I believe that macrochaetae are analogous to sensory setae in structure and origin and may be under a similar degree of genetic and developmental control, as is known for *Drosophila* and its thoracic setae.

Making and reporting measurements is difficult because *Apion* specimens are so small, usually under 3 mm. For reporting purposes the unit micron (abbreviation μ), 1/1000 millimeter, is suggested because this will eliminate decimal fractions.

The length of the metarostrum, the distance between the mesorostrum and the eye is the shortest distance between anterior margin of the scrobe, which is often well defined, and the front margin of the eye. Previously the measurement was from the front margin of the eye to the (estimated) middle of the articulation of antennomere 1 with the rostrum.

It is difficult to get a true measurement of the length of a tibial mucro on a male, even though the leg is mounted in glycerine and viewed with a compound microscope; it is hard to determine where the mucro actually begins.

The following measurements are suggested to permit a comparison of the "shape" of the rostrum among species of *Apion*. From the side the width of the rostrum is measured at two locations: immediately in front of the eye and at the anterior margin of the scrobe; the measurements are taken at right angles to the longitudinal axis of the rostrum and are estimated. From above the width of the rostrum is measured at three locations: at the anterior margin of the eye, above the anterior margin of the scrobe (this must be estimated), and at the tip. The shape of femur 1 is indicated by length and width measurements.

The smallest unit of measurement at the highest magnification of my Wild M5 stereoscope (100X) is 9μ so that values between multiples of 9μ represent an estimation; this becomes important in attempting to measure the width of scales of the vestiture. Measurements are made with an eyepiece reticule calibrated with a stage micrometer.

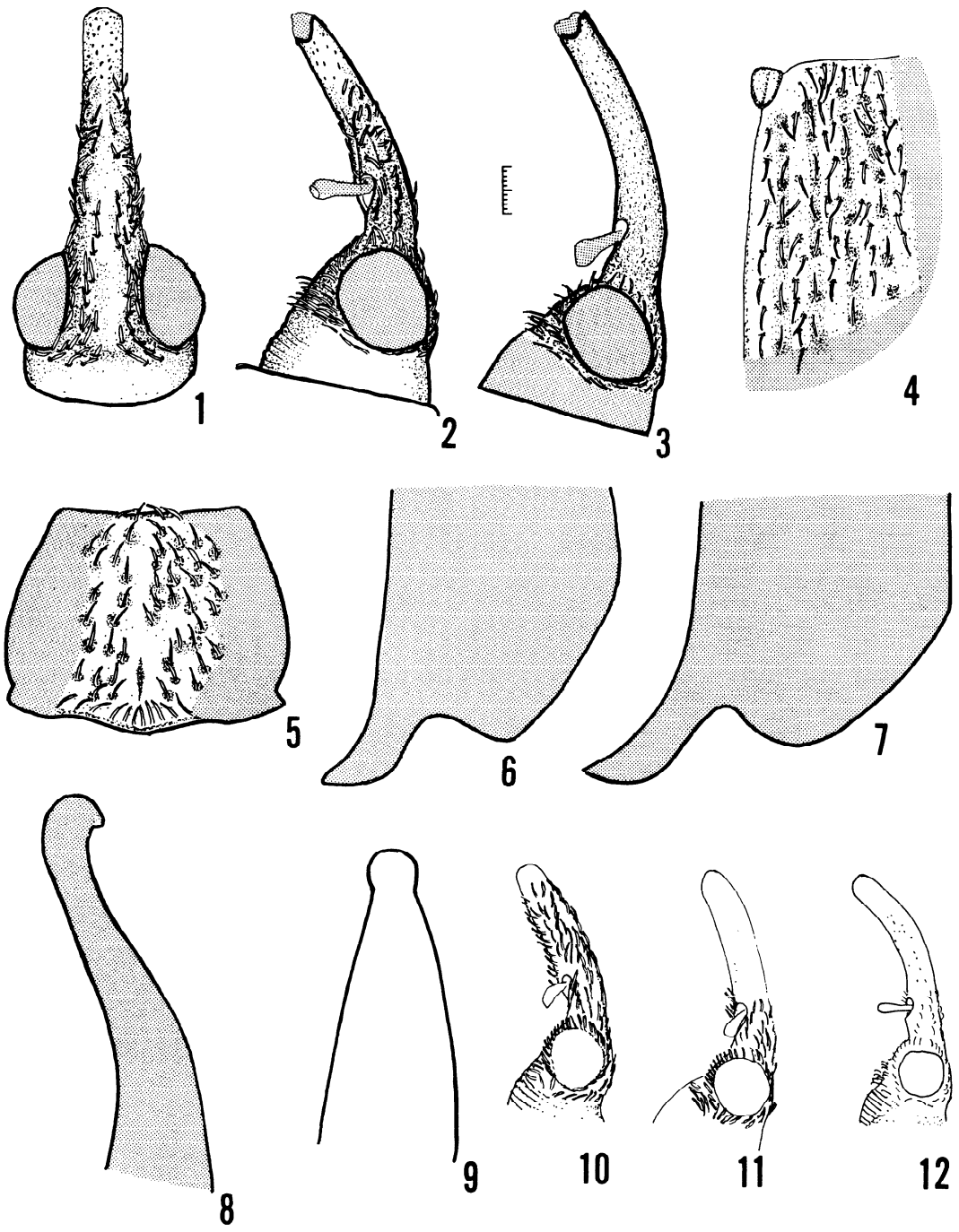
The *Apion* subgenus *Trichapion* Wagner contains about 115 species in North and Central America. Many new species have been discovered and will be subsequently described. The species are difficult because they are so numerous, the individuals are minute, the definition of species is based largely on male characters (some males do not have associated females and the species are hard to determine from females), and the diagnostic characters are difficult to see and difficult to quantify. I will later propose a procedure for dealing with this group that may ease the problem of associating proposed new species with the large number of known species.

The following new species was found while determining specimens for the American Museum of Natural History.

Apion (Trichapion) memnonmonum Kissinger, new species

TYPE SERIES. *Holotype*. Male. North Carolina: Valley of Black Mts.; June 20-30 1906; W. Beutenmuller. (AMNH). **Paratypes**. 7 male, 2 female; same data (AMNH, DGK). The specimens are teneral.

DESCRIPTION. Figures 1-9,13-16. Measurement data on table 1. Male. **General aspect**: Piceous. Vestiture white, fine, sparse, uniform on dorsal surface; slightly coarser on sides of prothorax, denser and coarser under eyes and on anterior face of front coxa. **Rostrum**: Basal 2/3 with surface alutaecous, with fine, indistinct punctures bearing scales 40-50μ long and about 8-10μ wide; apical 1/3 with surface polished, nearly glabrous, with sparse, minute punctures; in profile slightly curved, prorostrum sides tapering irregularly to tip; in dorsal view prorostrum sides tapering to near tip, apical region slightly expanded; dorsal margin of scrobe nearly evenly descending toward base of rostrum, on mesorostrum slightly oblique. **Prothorax**: Basal margin moderately expanded laterally, sides approximately parallel in basal half (rarely slightly wider at middle than base); on dorsal surface punctures 30-50u in diameter, moderately deep, bearing fine scales 30-50μ long; interspaces between punctures 20-50μ wide, finely alutaceous; on flanks scales slightly longer (50-70u) and slightly coarser than scales on dorsal surface. **Elytra**: intervals about twice as wide as striae, with one row of punctures bearing scales similar to those on dorsal surface of prothorax, slightly convex, surface alutaceous; striae moderately coarse and deep, with scales slightly coarser than those on intervals; intervals 7 and 9 each with 1 long sensory seta, interval 3 with several short sensory setae in apical 1/2. **Metepisternum**: Posterior 1/2 with 1 row of punctures bearing scales. **Male characters**: Tibiae 2 and 3 mucronate, mucro curved outward, with ventral apical margin broadly rounded to fine, acute apex, mucro 2 37μ long, mucro 3 43μ long. Median lobe of aedeagus in profile distinctly produced on upper margin at apex; in dorsal view sides converging from orifice to moderately fine, rounded apex, apex about 1/3 as wide as median lobe near base; endophallus with 4 rows of 15-21 small tooth-like



Figures 1 - 12. *Apion* (*Trichapion*) *memnonmonum* Kissinger, new species. Valley of Black Mts., NC (AMNH). 1) Head of male, dorsal view; 2) head of male, lateral view; 3) head of female, lateral view; 4) right elytron, basal region, screened area outline only; 5) prothorax, dorsal view, screen area outline only; 6) apical region of tibia 2 of male, lateral view; 7) apical region of tibia 3 of male, lateral view; 8) apical region of median lobe of aedeagus, lateral view; 9) apical region of median lobe of aedeagus, dorsal view. *Apion* (*Trichapion*) *nelsoni* Kissinger, new species. Santa Rita Mts., Madera Canyon, AZ (USNM). 10) Head of male, lateral view; 11) head of female, lateral view. *Apion* (*Trichapion*) *aequabile* Fall. Huachuca Mts., Ramsey Canyon, AZ (DGK). 12) Head of female, lateral view. Scale = 100μ for Fig. 1-5, 15μ for Fig. 6-9, 200μ for Fig. 10-12.

structures 13-25μ long. Tegmen parameroid lobes broad, long, with distinct sclerotized apical region delineated from basal membranous part of structure, each lobe with 3 macrochaetae 4-7μ long (about as long as microtrichae), fenestrae joined medially; free ring of basal piece articulated with short projection (31μ long) from tegminal plate; basal plate flat.

Female. In comparison with male, head and rostrum with finer, sparser scales; metarostrum nearly glabrous beyond row of scales around eye.

Etymology: According to Brown (1956), Memnon was a fabled king of the Ethiopians, thus the Latin word for black, memnonius. Mons, a Latin word for mountain, has been modified into 'monum' to produce the specific epithet that means essentially Black Mountain, the type locality. The epithet also is the lyrics of a song sometimes sung on Sesame Street, which my children enjoyed.

The distinctive features of this species are: 1) parameroid lobes of tegmen membranous with defined apical sclerotized region. 2) parameroid lobes of tegmen bear minute macrochaetae about the same length as microtrichae. 3) basal plate of paramere flat medially. 4) subcephalic ridges low and short. 5) elytral intervals with single row of scales and with long sensory seta on intervals 7 and 9 and short sensory setae on interval 3. 6) mucrones 2 and 3 similar in shape, acute.

In Kissinger (1968), a key to species of *Trichapion* based on males, the species traces to couplet 68; the following change is suggested for the key.

68. Rostrum not less than 1.3 as long as prothorax 69
Rostrum not more than 1.2 as long as prothorax 68a

68a. Mucro on tibia 3 subangulate; parameroid lobes membranous in apical half . . . . . MODICUM Kissinger
Mucro on tibia 3 simple; parameroid lobes with apical sclerotized region . . . . . MEMNONMONUM Kissinger

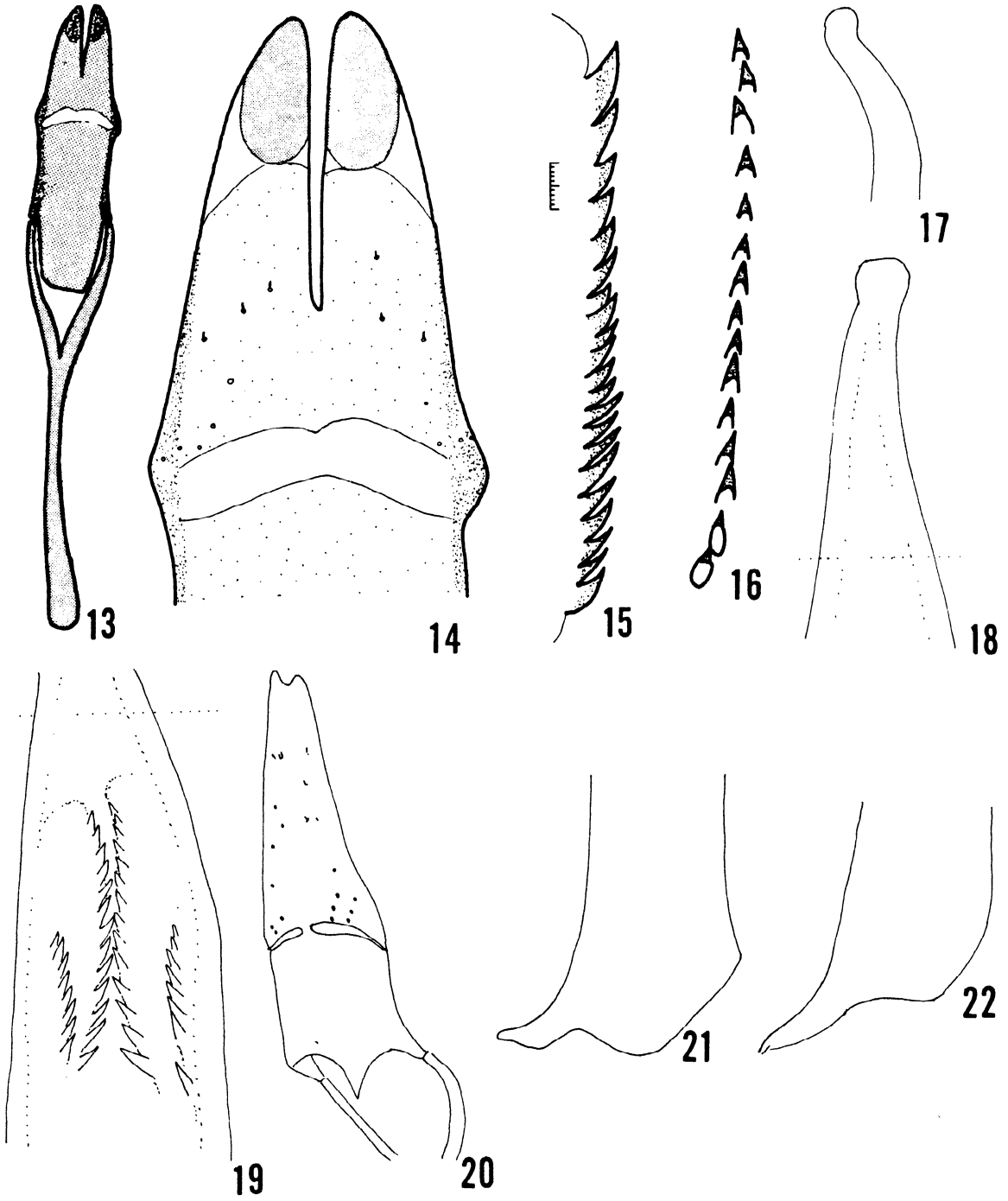
In comparison to *modicum* Kissinger, *memnonmonum* is larger and has comparatively finer and sparser vestiture; also the side of the metarostrum of the female is nearly glabrous beyond the 1 row fringe of scales around the eye. The side of the metarostrum of the female of *modicum* has scales similar in length and coarseness to those around the eye.

The species of *Apion* from the mountainous regions of Big Bend Texas and southern Arizona are incompletely known. The following species has been known for some time from females; Dr. Nelson found a series which associates both sexes.

Apion (*Trichapion*) *nelsoni* Kissinger new species

TYPE SERIES. Holotype. Male. Arizona: Santa Rita Mts., Madera Canyon, 10 July 1961, G. H. Nelson and family, sweeping grasses, etc. (USNM). **Paratypes.** 3 male, 10 female; 11, same data as holotype (DGK, GHN); 2, Texas: Davis Mts. State Park, 30 July 1969, G. H. Nelson, sweeping grass (DGK, GHN).

DESCRIPTION. Figures 10,11,17-22. Measurement data on table 2. Male. **General aspect**: Piceous. Vestiture white, fine, moderately sparse, uniform on dorsal surface; slightly coarser on sides of prothorax, denser on anterior surface of front coxa and on mesepisternum. **Rostrum**: Basal 4/5 with surface alutaceous, with fine, dense punctures bearing scales 46-64μ long, 7-9μ wide; apical 1/5 with surface polished, nearly glabrous, with sparse, minute punctures; in profile slightly curved, prorostrum sides tapering to tip; in apical third prorostrum somewhat compressed, at that point approximately 120μ wide from above and 156μ wide from side; in dorsal view prorostrum sides converge to about middle, in apical half of prorostrum sides nearly parallel; dorsal margin of scrobe slightly oblique over antennal insertion. **Head**: Subcephalic ridge moderately high, converge to low, "V" shaped basal ridge behind eyes. **Prothorax**: Basal margin moderately expanded laterally, sides parallel in basal half; on dorsal surface punctures 25-40μ in diameter, deep, bearing fine scales 55-75μ long, 7-9μ wide, interspaces between punctures 25-40μ wide, alutaceous; on flanks scales 55-83μ long, 9-13μ wide, coarser scales tend to be more ventral in location. **Elytra**: at middle of elytra interval 3 about 2.5 as wide as stria 3, other intervals similar, slightly convex, surface alutaceous; striae moderately coarse, deep, with scales similar to those on adjacent intervals; intervals 7 and 9 each with 1 long sensory seta, interval 3 with several short sensory setae. **Metepisternum**: Posterior 1/2 with 1 row of punctures bearing scales. **Male characters**: Tibiae 2 & 3 each with acute, simple mucro 50μ long. Median lobe of aedeagus in profile with tip simple; in dorsal view sides converge from orifice to moderately fine apex, apex slightly, roundly expanded laterally; endophallus with 2 rows of 14 tooth-like structures 15-22μ long, 2 rows of 8 tooth-like structures 12-19μ long. Tegmen parameroid lobes very short, membranous, area distad of fenestrae elongate, sclerotized, with 3-4 macrochaetae 6-7μ long; fenestrae narrowly separated medially; free ring of



Figures 13 - 22. *Apion (Trichapion) memnonmonum* Kissinger, new species. Valley of Black Mts., NC (AMNH). 13) tegmen of male genitalia, dorsal view; 14) apical region of tegminal plate, dorsal view; 12) row of teethlike structures in endophallus, top of page is toward orifice, lateral view; 15) same but dorsal view. *Apion (Trichapion) nelsoni* Kissinger, new species. Santa Rita Mts., Madera Canyon, Az (USNM). 17) Apical region of median lobe of aedeagus, lateral view; 18) same but dorsal view, dashed line corresponds to Fig. 19; 19) middle region of median lobe of aedeagus, dorsal view (see Fig. 18); 20) paramere of tegmen, dorsal view, tilted; 21) apical region of tibia 2 of male, lateral view; 22) apical region of tibia 3 of male, lateral view. Scale = 77μ for Fig. 13, 15μ for Fig. 14-16, 50μ for Fig. 17-19,21,22, 100μ for Fig. 20.

basal piece articulated with moderately long projection (37μ long) from tegminal plate; basal plate flat medially.

Female. Basal area of rostrum alutaceous, with sparse, fine punctures and scales; prorostrum slightly curved, nearly glabrous, narrowed in basal 1/4, apical 3/4 nearly cylindrical, polished, nearly impunctate;

Etymology: The species is named in honor of the collector, Gayle H. Nelson, an authority on Buprestidae and an outstanding teacher of human anatomy.

The distinctive features of this species are: 1) parameroid lobes of tegmen very short, membranous. 2) paramere elongate between fenestrae and lobes, sclerotized, with minute macrochaetae about the same length as microtrichae. 3) basal plate of paramere flat. 4) subcephalic ridges moderately high, connected with low basal ridge. 5) elytral intervals with two rows of scales and with long sensory seta on intervals 7 and 9 and short sensory setae on interval 3. 6) mucrones 2 and 3 similar in shape and size, acute. 7) female rostrum largely glabrous, impunctate, polished and cylindrical in apical half.

In Kissinger (1968), key to species of *Trichapion* based on males, the species traces to couplet 86; the following change is suggested for the key.

86. Frons not less than 1.25 as wide as dorsal tip of beak; paramere with moderately long basal lateral projection to articulation with basal piece 86A
Frons less than 1.1 as wide as dorsal tip of beak; paramere with short basal lateral projection to articulation with basal piece 87

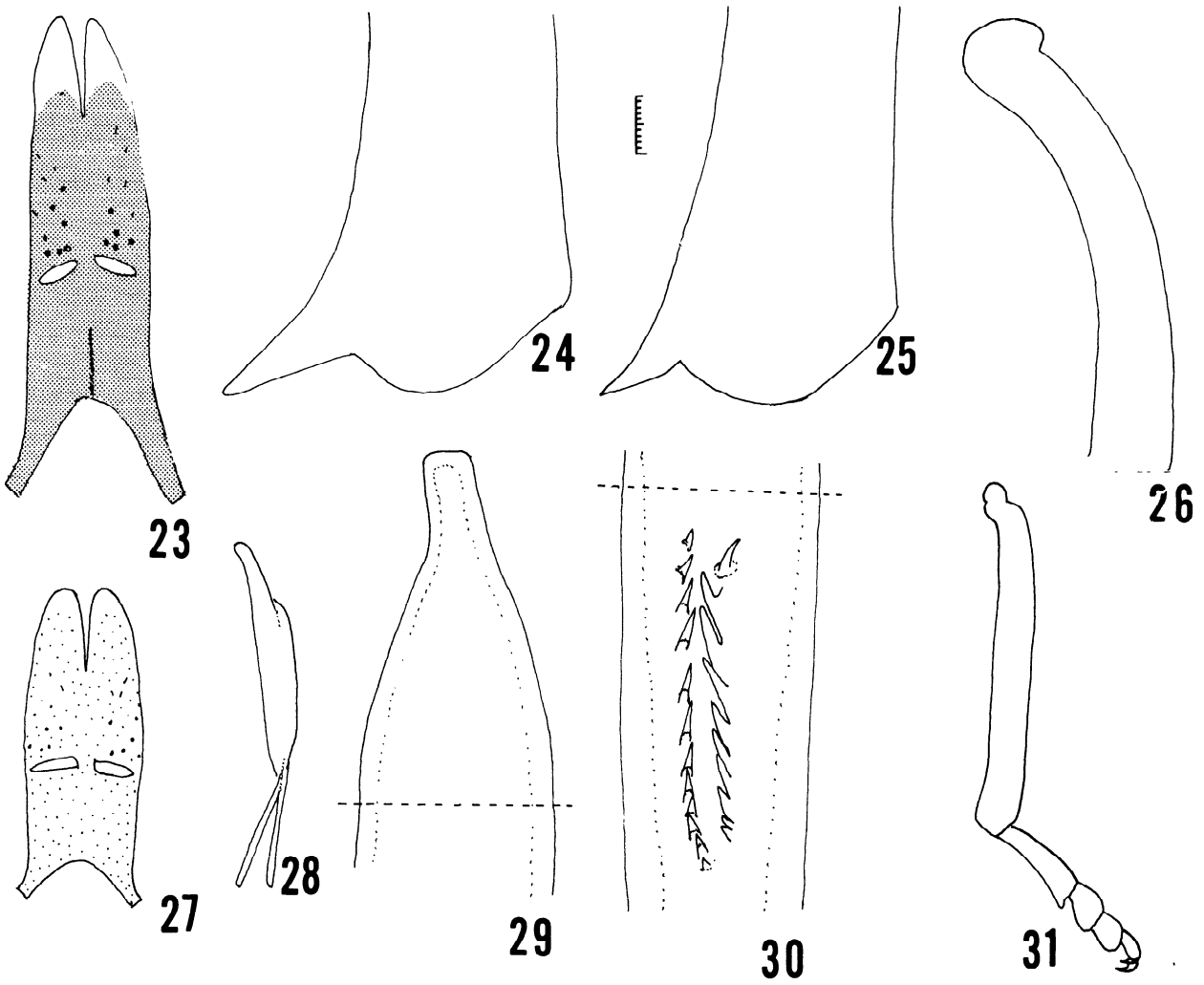
86A. Dorsal margin of antennal scrobe produced into acute, dentiform process; vestiture on prorostrum sparse; mucro 2 subangulate; parameroid lobes long, slender; basal plate of paramere with low, median carina . . . . . AEQUABILE Fall
Dorsal margin of antennal scrobe slightly oblique on mesorostrum; vestiture on prorostrum apparent in basal 2/3; mucro 2 simple; parameroid lobes very short; basal plate of paramere flat NELSONI Kissinger

Apion nelsoni is similar to members of the SUBMETALLICUM species group based on the subcephalic ridges, the shape of mucro 2, and the general structure of the paramere; in contrast it has the vestiture at the base of elytral interval 3 nearly uniform, not especially denser.

In Arizona the species most similar is *A. aequabile* Fall; besides the differences already detailed for males (including the compressed rostrum of *nelsoni*), the female of *nelsoni* is distinctive with its short, slightly curved rostrum which is glabrous, nearly impunctate, and nearly cylindrical in the apical half; the female of *aequabile* has the dorsal margin of the antennal scrobe produced into an angulate process, the rostrum distinctly curved, distinctly punctured on the sides, and somewhat depressed near the tip (see Figure 12).

Apion (Trichapion) submetallicum Boheman. See Kissinger (1968) for description and illustrations; also Figure 26. The following records indicate that this species occurs in Arizona (**NEW STATE RECORD**). This Mexican species formerly was known to occur in the US based on 1 specimen from Texas. Chiricahua Mts., 9 mi above Portal, AZ; 22 VII 1975, G.H.Nelson; on Muhlenbergia longiligula Hitchcock (1 specimen: DGK). Huachuca Mts., Parker Canyon Lake, AZ; 20 VIII 1967, C.D.Johnson (1 specimen: NAU). Santa Rita Mts., Madera Canyon, AZ; [5-10] VIII 1961, G.H.Nelson & Family; sweeping grass, etc (10 specimens: GHN, DGK); Bog Springs Camp, 5000 feet; 15 VIII 1967, C.D.Johnson (2 specimens: NAU, DGK). Davis Mts. State Park, TX; 30 VII 1969, G.H.Nelson; sweeping grass (2 specimens: GHN, DGK).

Apion (Trichapion) eccentricum Fall. See Kissinger (1968) for description and illustrations; also Figures 23, 24. This species was known previously from a few specimens from Arizona. Santa Rita Mts., Madera Canyon, from topmost parking loop to turn off to Bog Springs campground, Pima Co./Santa Cruz Co.,AZ; 3 IX 1988, D.G.Kissinger; on fruit and flowers of *Desmodium* (in company with *A. decoloratum* Smith and *A. chiricahuae* Kissinger) (100+ specimens: DGK). The male was not adequately described or illustrated in Kissinger (1968). **Male characters**: Tibia 2 with simple mucro about 68μ long; all femora stouter than those of female. Median lobe of aedeagus and paramere similar to that of **A.** *punctulirostre* Sharp; endophallus with 4 rows of tooth-like structures, 1 pair of 10-11 gradually increasing in length from base to orifice, 9 - 31u, 1 pair of 11-13 about 10μ long. Parameroid lobes broad, moderately long, membranous apically, with 2-3 macrochaetae 5-7μ long, fenestrae separated medially; free ring of basal piece articulates with projection from tegminal plate about 45μ long; basal plate with low basal median carina. The species is similar to *Apion punctulirostre* Sharp which occurs in Mexico to Honduras. The following differences were detected: *eccentricum* has the mucro on tibia 2 about 50% longer and more uniformly narrowed from base to apex; the basal half of the prorostrum in both sexes is more dense-



Figures 23 - 31. *Apion (Trichapion) eccentricum* Fall. Santa Rita Mts., Madera Canyon, AZ (DGK). 23) paramere of tegmen, dorsal view; 24) apical region of tibia 2 of male, lateral view. *Apion (Trichapion) punctulirostre* Sharp. Huauchinango, Puebla, Mexico (DGK). 25) Apical region of tibia 2 of male, lateral view. *Apion (Trichapion) submetallicum* Boheman. Santa Rita Mts., Madera Canyon, AZ (DGK). 26) Apical region of median lobe of aedeagus, lateral view. *Apion (Trichapion) brunnicornis* Fall. Huachuca Mts., AZ (DGK). 27) Paramere of tegmen, dorsal view. 28) median lobe of aedeagus, lateral view. 29) same, dorsal view of apical region. 30) same, dorsal view of armature of endophallus, dashed line matches that of Figure 29. 31) left tibia 1 and tarsus, lateral view. Scale = 54μ for Fig. 23, 27; 27μ for Fig. 24-26, 28-30; 110μ for Fig. 31.

ly punctured and provided with longer vestiture; and in profile the prorostrum of the male is more distinctly, uniformly narrowed from mesorostrum to apex.

The male of *Apion (Trichapion) punctulirostre* Sharp has the paramere with a low basal median carina (much like *A. eccentricum* Fall); this was incorrectly described in Kissinger (1968). See Figure 25 for detail of the mucro on tibia 2 of the male.

The male characters of *Apion (Trichapion) brunnicornis* Fall were incompletely described in Kissinger (1968). **Male characters**: Figures 27-31. All femora stouter than those of female; tibia 2 with simple mucro 27μ long; tarsus 1 segment 1 elongate, with small process on inner apical margin. Median lobe of aedeagus in profile with apex simple, not elongate, in dorsal view apex strongly narrowed to short, finely blunt apex; endophallus

with 2 rows of tooth-like structures 5-40μ long. Parameroid lobes broad, moderately long, membranous apically, with 2-3 macrochaetae about 6μ long, fenestrae separated medially, free ring of basal piece articulates with projection from tegminal plate about 24μ long; basal plate flat medially.

The following items should be added to the description of *Apion* (*Trichapion*) *minor* Smith in Kissinger (1968): the basal median area of the paramere is flat; elytral interval 3 of both sexes have short sensory setae in the apical region. This appears to be a rare species; selected distribution records follow: Pochahontas Co., Kaslow Prairie, IA, 16 VI 85, JE Wappes (DGK). Barnes Co., Bald Hill Dam, ND 7 VI EU Balsbaugh (DGK). Richland Co., Mirror Pool, ND, 20 VIII 65, DG Aarhus (DGK). Sissoton, SD. 2-7 VI 67 VM Kirk (DGK). The omission of this species from the key to males of *Trichapion* in Kissinger (1968) is corrected as follows.

92. Elytral intervals with 2 rows of scales per interval; vestiture may be denser at base of elytral interval 3 93
Elytral intervals with 1 row of scales; vestiture not denser at base of elytral interval 3 . . . . . 92A

92A. Elytra black with reddish aeneous luster; pronotum with fine, shallow punctures; rostrum > 1.45 length of prothorax, subcylindrical in apical 1/2; Florida, Mexico . . . . . GULARE Fall
Elytra black; pronotum with deep punctures 18-30μ in diameter; rostrum < 1.3 length of prothorax, tapered in apical 1/2; Illinois, North Dakota, New Mexico MINOR Smith

More than 115 species from North and Central America are assigned to the *Apion* subgenus *Trichapion* Wagner. Kissinger (1968) arranged these into 14 groups using hand techniques. Consequently the consistency and distribution of characters within the groups is difficult to evaluate. Likewise, the similarity of one species to all of the groups is difficult to determine because of the large number of species and characters. Computer programs PAUP (Swofford, 1985) and PHYLIP (Felsenstein, 1988) were examined to help solve this problem but the capacity on a PC is too small.

A procedure is proposed to estimate the probability that a species is to be included in a species group. It differs from traditional numerical taxonomic techniques in at least two ways. (1) The user selects a set of characters optimal for the differentiation of the groups; the characters are not selected at random. (2) The user provides group definitions and assigns the species to the groups accordingly; the process does not attempt to find the best of all possible arrangements of the species and groups. Thus, the procedure is essentially a tool to indicate how well species fit in a proposed model grouping of supra-specific categories.

The procedure is based on Hartigan (1975) and is a statistical model for partitions; in the present application, a species group is considered to be a partition. Based on the set of species groups with the attending distribution of character states, the procedure estimates inclusion probabilities for each species in each group. The characters are categorical in nature, the categories are ordered, the characters are not weighted and variance for each character is assumed to be constant within the groups.

My personal preference is along this line because the logic of the procedure and its results are similar to what I would expect as a traditional taxonomist, even though it involves computer manipulation of data. The procedure is reasonably robust because the inclusion of a species in a "wrong" group results in a high estimated inclusion probability in the "right" group. The results of incorrect data for a taxon, a species or species group, are largely restricted to that taxon. Also, the results of the procedure do not depend on the order of the input data.

The computer used is an 8MH AT clone running MS DOS 3.2. The computer languages used are Turbo C 2.0 and dBXL 1.2 (a dBASE III+ clone). FORTRAN source from Hartigan was translated into "C" by the author. Test data and results were included with the source from Hartigan so that the success of the translation process could be checked by comparison with results obtained by Hartigan on an IBM mainframe computer.

The data are stored as dBASEIII+ files; the power of dBASE is used to manage the files, i.e. update data, remove/add variables, or output data for analysis with other programs such as PAUP or PHYLIP. The input data and source for the program are available from the author.

Table 3 lists the characters used to define the groups and includes a character state code dictionary. Table 4 presents a F ratio statistical test for each character on table 3. In each case the F ratio exceeds 3.31, the critical value of F at the 0.001 level of significance with 12 and 60 df; the ratio on table 3 actually has 12 and 69 df so that the critical value would be smaller than 3.31. The F ratio is the mean square of variance between the groups divided by the mean square of variance within the groups. A significant F ratio means that the character varies more from group to group than it does within the groups; this is consistent with the individual character contributing to the definition of the groups.

Table 5 is an analysis of the males of 82 species of the *Apion* subgenus *Trichapion* distributed into 12 groups; for each species the inclusion probability for each group is listed. These species were selected because the data for them is complete. Table 6 lists the mean code state for each variable in each of the 12 groups.

In the following discussion groups named using all capitals were proposed in Kissinger (1968). The groups on table 5 have not been presented in any particular order; names for the groups have not been assigned here.

Group 1 corresponds to the AURICHALCEUM group without change. This highly distinctive group contains the type species of the subgenus, *A. aurichalceum* Wagner. Group 2 includes members formerly assigned to the PROCLIVE, NIGRUM, and PATRUELE groups. Some of the members exhibit measurable inclusion values for groups 4, 6, and 7. Group 3 is the GLYPHICUM group plus *Apion proclive* LeConte.

Group 4 is the CRIBRICOLLE group plus several species with mucronate tibia 1 in the male. Group 5 is mainly the SPINITARSE group; unfortunately data is incomplete for many of the species that may belong to this group. Group 6 is the METALLICUM group without change. It shows some similarity to the next group.

Group 7 includes members from the PROCLIVE and SUBMETALLICUM groups; both *A. memnonmonum* Kissinger and *A. nelsoni* Kissinger belong here. Group 8 is the TENUIROSTRUM group plus *A. hastifer* Sharp, a species with otherwise unclear affinities. Group 9 is the NIGRUM group restricted to *A. nigrum* Herbst and some "close" relatives; also, *A. simile* Kirby shows more affinity to this group than any other.

Group 10 is the BRACHYSPINOSUM group plus *A. macropus* Wagner, a tropical species with no stronger affinities. Group 11 is the highly distinctive PLEURITICUM group unchanged. Group 12 is the well-defined COXALE group unchanged.

Tables 3 - 6 demonstrate first that it is possible to divide the large subgenus *Trichapion* into smaller groups using a reasonably small number of characters in a demonstrably consistent way as indicated by inclusion probabilities. Secondly, they suggest that the suitability of characters in defining the groups can be measured by the F ratio statistic.

An assertion that remains to be investigated is that the group of characters that are useful in defining the species groups may be different from the characters needed to differentiate between members of a group of closely similar species.

Acknowledgments

I am indebted to the following for the loan of material; symbols indicating the location of specimens are given in parentheses. Dr. R. S. Anderson, Department of Entomology, Texas A & M University, College Station, TX 77843 (RSA); Dr. H. R. Burke, Department of Entomology, Texas A & M University, College Station, TX 77843 (TAMU); Dr. W. E. Clark, Department of Entomology, Auburn University, AL 36849 (WEC); Dr. N. M. Downie, 505 Lingle Terr., Lafayette, IN 47901 (NMD); Dr. L. H. Herman, Department of Entomology, American Museum of Natural History (AMNH); Dr. H. A. Hespenheide, Department of Biology, University of California, Los Angeles, CA 90024 (HAH); Anne Howden, Department of Biology, Carleton University, Colonel By Drive, Toronto, Ontario, K1S 5B6 (HAHC); Dr. C. D. Johnson, Northern Arizona University, Flagstaff, AZ 86011 (NAU); Dr. G. H. Nelson, College of Osteophathic Medicine of the Pacific, College Plaza, Pomona CA 91766 (GHN); Dr. C. W. O'Brien, Department of Entomology, Florida A & M University, Tallahassee, FL 32307 (CWOB); R. T. Thompson, Department of Entomology, British Museum (Natural History) (BMNH); R. H. Turnbow., Jr., Directorate of Engineering and Housing, Bldg. 1404, Fort Rucker, AL 36362 (RHT); Dr. D. R. Whitehead, National Museum of Natural History (USNM); and the personal collection of the author (DGK).

Literature Cited

Alonso-Zarazaga, M. A. 1983. Studies on Ethiopian Apionidae (Coleoptera). 1. Comments on the genus *Apiomorphus* Wagner, 1911, with description of a new South African species. J. ent. soc. S. Africa 46(2):241-247.

Brown, R. W. 1956. Composition of scientific words. Published by the author, Baltimore, Md. 882 p.

Felsenstein, J. 1988. PHYLIP (Phylogeny Inference Package) Version 3.1. Department of Genetics SK-50, University of Washington, Seattle, Washington 98195.

Hartigan, J. A. 1975. Clustering Algorithms. John Wiley and Sons, Inc; New York; 351 pages.

Kissinger, D. G. 1968. Curculionidae subfamily Apioninae of North and Central America. Taxonomic Publ., South Lancaster, Mass. 559 p.

Kissinger, D. G. 1988a. Male characters of the genus *Circapion* Kissinger of the tribe Aplemonini (Coleoptera: Apionidae). Coleopt. Bull. 42: 15-16.

Kissinger, D. G. 1988b. New host and distribution records for Apionidae from North and Central America (Coleoptera: Apionidae). Coleopt. Bull. 42: 302-304.

Stern, C. 1954. Two or three bristles. Amer. Sci. 42: 213-247.

Swofford, D. L. 1985. PAUP Phylogenetic Analysis Using Parsimony. Version 2.4. Illinois Natural History Survey, 607 East Peabody Drive, Champaign, Illinois 61820.

Whitehead, D. R. 1977. New *APION* (*COELOCEPHALAPION*) species (Curculionidae: Apioninae) from fruits of *Pterocarpus* (Leguminosae: Faboideae) in Central America. Coleopt. Bull. 31: 165-172.

TABLE 1. Measurement data for *Apion memnonmonum* Kissinger. M = male; F = female; B = both sexes. "N" is the number of observations included in mean and standard deviation. Definition of measurements as in Kissinger (1968) or this paper. All measurements are in microns (0.001 millimeters).

Character	Range	Mean	Standard Deviation	N
Body Length (B)	1560-2005	2000	57.2	10
Rostrum Length (M)	410-510	497	35.4	8
Rostrum Length (F)	550-600	576	38.9	2
Length of Metarostrum (M)	150-170	162	6.8	8
Length of Metarostrum (F)	150-160	150	6.4	2
Mesorostrum Width from Side (M)	120-140	127	5.1	8
Mesorostrum Width from Side (F)	109	109	0.0	2
Mesorostrum Width from Above (M)	130-160	147	9.5	8
Mesorostrum Width from Above (F)	120-130	123	6.4	2
Rostrum Width at Tip from Above (B)	80-90	89	4.4	10
Frons Width (B)	135-155	140	7.6	10
Prothorax Length (B)	370-480	457	16.7	10
Prothorax Width at Base (B)	440-590	585	31.0	10
Prothorax Width at Apex (B)	380-460	438	12.7	10
Elytra Width at Humeri (B)	680-840	786	25.8	10
Elytra Width (B)	860-1010	941	37.9	10
Elytra Length (B)	1006-1480	1406	48.3	10
Femur I Length (B)	440-620	594	19.6	10
Femur I Width (B)	120-180	176	10.8	10

TABLE 2. Measurement data for *Apion nelsoni* Kissinger. M = male; F = female; B = both sexes. N is the number of observations included in mean and standard deviation. Definition of measurements as in Kissinger (1968) or this paper. All measurements are in microns (0.001 millimeters).

Character	Range	Mean	Standard Deviation	N
Body Length (B)	1938-2204	2077	81.7	14
Rostrum Length (M)	585-658	617	31.2	4
Rostrum Length (F)	622-731	695	38.9	10
Length of Metarostrum (M)	173-210	191	15.1	4
Length of Metarostrum (F)	146-201	180	16.4	10
Mesorostrum Width from Side (M)	164-173	166	4.5	4
Mesorostrum Width from Side (F)	146-164	152	5.5	10
Mesorostrum Width from Above (M)	173-196	186	10.1	4
Mesorostrum Width from Above (F)	164-192	179	9.3	10
Rostrum Width at Tip from Above (B)	91-109	99	4.7	14
Frons Width (B)	146-164	152	7.0	14
Prothorax Length (B)	439-567	478	34.0	14
Prothorax Width at Base (B)	567-676	621	37.1	14
Prothorax Width at Middle (B)	512-603	560	33.9	14
Prothorax Width at Apex (B)	402-558	438	39.6	14
Elytra Width at Humeri (B)	786-932	866	49.3	14
Elytra Width (B)	932-1115	1020	56.9	14
Elytra Length (B)	1292-1596	1457	79.7	14
Femur I Length (B)	567-676	619	34.0	14
Femur I Width (B)	148-175	164	8.4	14

TABLE 3. The characters used to define groups of species in the *Apion* subgenus *Trichapion* Wagner. For each character the code states are indicated.

#	CHARACTER DEFINITION	CODE VALUE	CODE DEFINITION
1	Height of subcephalic ridge (estimated)	1	Flat (absent)
		2	Low
		3	Moderate
		4	High
2	Presence of basal medial ridge connecting left & right subcephalic ridges	1	Flat (absent)
		2	Low
		3	High
3	Location of mesorostrum in relation to length of rostrum	1	< basal 0.2 (narrow)
		2	0.20 - 0.26 (moderate)
		3	0.27 - 0.35 (wide)
		4	0.36 - 0.40+ (very wide)
4	Width of frons compared to character 3	1	about equal (narrow)
		2	1.1 - 1.2 X (moderate)
		3	1.2 - 1.6+ X (wide)
5	Sensory setae on elytral interval 3	1	absent
		2	present
6	Sensory setae on elytral interval 5	1	absent
		2	present
7	Sensory setae on elytral interval 7	1	absent
		2	present
8	Sensory setae on elytral interval 9	1	absent
		2	present
9	Non-mucro modification of male tibia 1	1	absent
		2	present
10	Male tibia 1 mucronate	1	absent
		2	present
11	Male coxa 1 dentate apically	1	absent
		2	present
12	Mucro on male tibia 2; nature of apex	1	acute point (simple)
		2	subangulate
		3	dentate

TABLE 3 continued.

13	Mucro on male tibia 3; nature of apex	1	absent
		2	acute point (simple)
		3	subangulate
		4	dentate
14	Presence of large sclerite in endophallus (> 50 u)	1	absent
		2	present
15	Width of paramere	1	moderate
		2	wide
16	Structure of parameroid lobes	1	membranous apically
		2	apical region sclerotized
		3	mostly sclerotized
17	Length of macrochaetae on parameroid lobes	1	< 10 u (minute)
		2	10 - 20u
		3	21 - 30u
		4	31 - 45u
		5	> 45u
18	Nature of basal medial area of paramere	1	flat
		2	low medial carina
		3	moderately high medial carina
		4	high medial carina

TABLE 4. The F ratio for characters used to define groups of species in the *Apion* subgenus *Trichapion* Wagner. In all cases with 12 and 69 degrees of freedom. ** = highly significant.

#	CHARACTER DEFINITION	F VALUE
1	Height of subcephalic ridge (estimated)	23.0 **
2	Presence of basal medial ridge connecting left & right subcephalic ridges	12.2 **
3	Location of mesorostrum in relation to length of rostrum	14.2 **
4	Width of frons compared to character 3	9.8 **
5	Sensory setae on elytral interval 3	8.4 **
6	Sensory setae on elytral interval 5	6.4 **
7	Sensory setae on elytral interval 7	28.4 **
8	Sensory setae on elytral interval 9	6.3 **
9	Non-mucro modification of male tibia 1	44.1 **
10	Male tibia 1 mucronate	20.4 **
11	Male coxa 1 dentate apically	38.3 **
12	Mucro on male tibia 2; nature of apex	9.9 **
13	Mucro on male tibia 3; nature of apex	13.6 **
14	Presence of large sclerite in endophallus	9.9 **
15	Width of paramere	6.8 **
16	Structure of parameroid lobes	6.2 **
17	Length of macrochaetae on parameroid lobes	15.4 **
18	Nature of basal medial area of paramere	25.1 **

TABLE 5. Males of selected species of *Apion* subgenus *Trichapion* Wagner from North and Central America arranged in 12 species groups based on characters listed on table 3. Inclusion probability for species in group expressed as percent (0 - 100).

GROUP (1)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
AURICHALCEUM Wagner	100	0	0	0	0	0	0	0	0	0	0	0
GODMANI Wagner	100	0	0	0	0	0	0	0	0	0	0	0
GRISEUM Smith	100	0	0	0	0	0	0	0	0	0	0	0
ORIOTES Kissinger	100	0	0	0	0	0	0	0	0	0	0	0
PARCUM Kissinger	100	0	0	0	0	0	0	0	0	0	0	0
SAYI Gyllenhal	100	0	0	0	0	0	0	0	0	0	0	0
GROUP (2)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ALTICOLA Wagner	0	99	1	0	0	0	0	0	0	0	0	0
BICOLOR Gerstaecker	0	99	0	0	0	0	0	0	1	0	0	0
CENTRALE Fall	0	100	0	0	0	0	0	0	0	0	0	0
COMMODUM Fall	0	80	0	19	0	0	0	0	0	0	0	0
CONFERTUM Smith	0	76	0	1	0	17	5	0	0	0	0	0
CORYI Kissinger	0	88	0	6	0	0	6	0	0	0	0	0
EVUSTUM Kissinger	0	100	0	0	0	0	0	0	0	0	0	0
GRACILIROSTRE Sharp	0	99	0	1	0	0	0	0	0	0	0	0
IMITATOR Wagner	0	80	0	0	0	2	17	0	0	0	0	0
MALKANI Kissinger	0	92	0	1	2	1	3	0	0	0	0	0
MANAGUENSE Wagner	0	99	0	0	0	0	1	0	0	0	0	0
MURINUM Gerstaecker	0	100	0	0	0	0	0	0	0	0	0	0
OBLITUM Smith	0	85	0	13	0	1	0	0	0	0	0	0
PATRUELE Smith	0	100	0	0	0	0	0	0	0	0	0	0
PERFORICOLLE Fall	0	98	0	0	0	0	0	0	1	0	0	0
PERSULCATUM Wagner	0	100	0	0	0	0	0	0	0	0	0	0
PORCATUM Boheman	0	100	0	0	0	0	0	0	0	0	0	0
RECONDITUM Gyllenhal	0	100	0	0	0	0	0	0	0	0	0	0
RONNI Kissinger	0	100	0	0	0	0	0	0	0	0	0	0
ROSTRUM Say	0	98	0	0	0	0	0	0	1	0	0	0
RUFIPENNE Gyllenhal	0	100	0	0	0	0	0	0	0	0	0	0
SELANDERI Kissinger	0	97	0	0	0	0	2	0	0	0	0	0
SUBRUFUM Sharp	0	100	0	0	0	0	0	0	0	0	0	0
SUBTINCTUM Fall	0	100	0	0	0	0	0	0	0	0	0	0
TETRICUM Kissinger	0	100	0	0	0	0	0	0	0	0	0	0
GROUP (3)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CHUPAROSAE Fall	0	0	100	0	0	0	0	0	0	0	0	0
DEBORAHAE Kissinger	0	0	100	0	0	0	0	0	0	0	0	0
GLYPHICUM Sharp	0	0	100	0	0	0	0	0	0	0	0	0
PROCLIVE LeConte	0	0	91	0	1	0	7	0	0	0	0	0
GROUP (4)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ACROPHILUM Fall	0	0	0	97	0	0	0	1	1	0	0	0
CORDATUM Smith	0	5	0	95	0	0	0	0	0	0	0	0
CRIBRICOLLE LeConte	0	2	0	94	0	0	0	3	1	0	0	0
FURTIVUM Fall	0	9	0	89	0	0	0	2	0	0	0	0
HATCHI Kissinger	0	0	0	77	0	0	0	22	0	0	0	0

TABLE 5 continued.

GROUP (5)	1	2	3	4	5	6	7	8	9	10	11	12
BETTYAE Kissinger	0	0	11	0	88	0	1	0	0	0	0	0
BRUNNICORNIS Fall	0	0	0	0	68	0	32	0	0	0	0	0
ECCENTRICUM Fall	0	0	0	0	81	0	18	0	0	0	0	0
PUNCTULIROSTRE Sharp	0	0	4	0	91	0	4	0	0	0	0	0
SANCTIFELICIS Sharp	0	26	0	1	51	16	4	0	0	1	0	0
SLEEPERI Kissinger	1	0	0	0	50	0	0	0	0	0	0	48
GROUP (6)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
METALLICUM Gerstaecker	0	1	0	0	0	83	16	0	0	0	0	0
TROGLODYTES Motschulsky	0	2	0	0	0	83	15	0	0	0	0	0
GROUP (7)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
ACANONICUM Kissinger	0	2	0	0	1	17	80	0	0	0	0	0
AEQUABILE Fall	0	2	0	0	0	3	79	0	15	0	0	0
ALBIDULUM Fall	0	13	1	0	0	0	85	0	0	0	0	0
AURIFERUM Wagner	0	0	0	0	0	4	95	0	0	0	0	0
GULARE Fall	0	0	6	0	3	0	91	0	0	2	0	0
HADROMERUM Wagner	0	0	0	0	3	6	91	0	0	0	0	0
IMPORTUNUM Fall	0	0	0	0	0	0	100	0	0	0	0	0
MEMNONMONUM Kissinger	0	0	0	0	0	2	98	0	0	0	0	0
MEXICANUM Wagner	0	0	0	0	0	0	100	0	0	0	0	0
MINOR Smith	0	0	0	0	0	0	100	0	0	0	0	0
MODICUM Kissinger	0	6	0	0	0	11	83	0	0	0	0	0
NELSONI Kissinger	0	0	0	0	2	0	83	0	0	14	0	0
PERPILOSUM Wagner	0	0	0	0	0	4	96	0	0	0	0	0
PROPINQUECORNE Fall	0	0	0	0	1	0	98	0	0	0	0	0
QUICORNE Kissinger	1	0	0	0	1	2	96	0	0	0	0	0
SUBMETALLICUM Boheman	0	0	0	0	3	6	91	0	0	0	0	0
SUBSEQUENS Kissinger	0	11	0	0	0	0	88	0	0	0	0	0
GROUP (8)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
HASTIFER Sharp	0	0	0	1	0	0	1	98	0	0	0	0
IMPEXUM Fall	0	0	0	4	0	0	0	96	0	0	0	0
TENUIROSTRUM Smith	0	0	0	8	0	0	0	92	0	0	0	0
GROUP (9)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
DOLOSUM Fall	0	2	0	0	0	0	0	0	97	0	0	0
HETEROGENEUM Sharp	0	1	0	0	0	0	0	0	99	0	0	0
NIGRUM Herbst	0	0	0	0	0	0	0	0	100	0	0	0
SIMILE Kirby	0	22	0	3	1	1	20	2	51	0	0	0
GROUP (10)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
BRACHYSPINOSUM Wagner	0	0	0	0	0	0	0	0	0	100	0	0
MACROPUS Wagner	0	0	0	0	0	0	0	0	0	99	0	0
ROSEAE Kissinger	0	0	0	1	0	0	0	2	0	97	0	0

TABLE 5 continued.

GROUP (11)	1	2	3	4	5	6	7	8	9	10	11	12
PLEURITICUM Sharp	0	0	0	0	0	0	0	0	0	0	100	0
RECLUSUM Fall	0	0	0	0	0	0	0	0	0	0	100	0
GROUP (12)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
COLON Sharp	0	0	0	0	0	0	0	0	0	0	0	100
COXALE Fall	0	0	0	0	0	0	0	0	0	0	0	100
LASSUM Sharp	0	0	0	0	0	0	0	0	0	0	0	100
NEOCOXALE Kissinger	0	0	0	0	0	0	0	0	0	0	0	100
YUCATANENSE Kissinger	0	0	0	0	0	0	0	0	0	0	0	100

TABLE 6. Mean character state codes for 18 characters used to define 12 species groups in the *Apion* subgenus *Trichapion* Wagner in North and Central America. The characters are listed in full on table 3.

CHARACTER	SPECIES GROUP											
	1	2	3	4	5	6	7	8	9	10	11	12
1 Subcephalic Ridge	3.7	1.6	4.0	1.4	3.3	1.0	2.5	1.0	2.0	2.0	1.5	2.0
2 Basal Median Subcephalic Ridge	1.7	1.0	2.5	1.0	1.8	1.0	1.4	1.0	1.0	1.0	1.0	1.0
3 Length of Metarostrum	1.3	1.8	2.7	3.2	3.5	2.5	2.5	2.0	3.7	3.0	2.0	2.2
4 Width of Frons	3.0	1.8	1.0	1.8	1.8	3.0	2.6	2.3	2.5	1.7	2.0	2.6
5 Interval 3 Sensory Setae	1.8	1.3	2.0	1.2	1.7	2.0	1.6	1.0	1.2	1.3	1.0	2.0
6 Interval 5 Sensory Setae	1.0	1.1	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7 Interval 7 Sensory Setae	2.0	1.2	2.0	1.0	2.0	2.0	2.0	1.3	1.0	2.0	1.0	2.0
8 Interval 9 Sensory Setae	2.0	2.0	2.0	2.0	2.0	2.0	1.9	2.0	2.0	2.0	2.0	2.0
9 Male Tibia 1 Non-mucro Modification	2.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10 Male Tibia 1 Mucro	1.0	1.1	1.0	2.0	1.0	1.0	1.0	2.0	1.0	2.0	1.0	1.2
11 Male Coxa 1 Dentate	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.0	1.0	2.0
12 Male tibia 2 Mucro	1.0	2.1	2.2	1.8	1.0	1.0	1.4	1.0	2.5	1.0	1.0	1.0
13 Male tibia 3 Mucro	2.3	3.2	3.0	2.0	1.0	2.0	2.4	1.0	2.5	1.7	2.0	2.0
14 Endophallus with Large Sclerite	1.0	1.0	1.0	1.2	1.0	1.0	1.1	1.0	1.0	1.0	2.0	1.0
15 Paramere Width	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.3	1.0	1.0
16 Parameroid Lobe Structure	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0	1.0	1.0	1.0	1.0
17 Length of Setae on Parameroid Lobes	1.0	2.8	1.0	2.2	1.7	2.0	1.0	1.0	1.5	1.7	1.0	2.0
18 Basal Medial Area of Paramere	1.0	1.2	1.0	1.0	1.3	1.0	1.1	1.3	2.5	3.0	4.0	1.0